APPENDIX T: ENVIRONMENTAL MANAGEMENT PROGRAMME

Environmental Management Programme for the Underground Coal Gasification Project and Associated Infrastructure in support of co-firing of gas at the Majuba Power Station, Amersfoort, Mpumalanga Province

Draft

Eskom Holdings SOC Ltd

DEA Ref: 14/12/16/3/3/3/61

DMR Ref: MP 30/5/1/1/2/10031 MR

DWA Ref: 16/2/7/2/C113/B053

July 2014

Eskom

Royal HaskoningDHV
Enhancing Society Together

DOCUMENT DESCRIPTION

Client:

Eskom Holdings SOC Ltd

Project Name:

Environmental Management Programme for the Underground Coal Gasification Project and Associated Infrastructure in support of co-firing of gas at the Majuba Power Station, Amersfoort, Mpumalanga Province

Royal HaskoningDHV Reference Number:

E02.JNB.000308

Authority Reference:

DEA Ref: 14/12/16/3/3/3/61

DMR Ref: 30/5/1/1/2/10031 MR

Compiled by:

Prashika Reddy & Bronwen Griffiths

Date:

June 2014

Location:

Pretoria

Review & Approval: Malcolm Roods

_____

Signature

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 APPLICABLE DOCUMENTATION 1
1.2 OBJECTIVES OF THE EMPR 4
1.3 STRUCTURE OF THE EMPR 4
1.4 EMPR AS A "LIVE" DOCUMENT 5
1.4.1 PLAN 6
1.4.2 DO 6
1.4.3 CHECK 6
1.4.4 ACT 6
1.5 DETAILS OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER 7
1.6 DEPARTMENT OF ENVIRONMENTAL AFFAIRS EMPR REQUEST 7

2 ENVIRONMENTAL LEGISLATION, POLICIES AND GUIDELINES 8

3 MANAGEMENT AND MONITORING PROCEDURES 12
3.1 ORGANISATIONAL STRUCTURE AND RESPONSIBILITY 12
3.1.1 MAJUBA UCG SITE MANAGER 12
3.1.2 ENVIRONMENTAL OFFICER 13
3.1.3 ENVIRONMENTAL CONTROL OFFICER 14
3.1.4 CONTRACTORS 15
3.1.5 INDEPENDENT AUDITOR 15
3.2 ROLES AND RESPONSIBILITIES SUMMARY 16
3.3 ENVIRONMENTAL MONITORING 16
3.4 COMPLIANCE WITH THE EMPR 17
3.4.1 NON-CONFORMANCE AND CORRECTIVE ACTION 18
3.4.2 PENALTIES FOR NON-COMPLIANCE 18
3.5 DOCUMENTATION AND REPORTING 19
3.5.1 RESPONSIBILITY MATRIX AND ORGANOGRAM 20
3.5.2 ENVIRONMENTAL INSPECTIONS AND MONITORING 20
3.5.3 WEEKLY REPORTING 20
3.5.4 NON-CONFORMANCE REPORT 20
3.5.5 ENVIRONMENTAL EMERGENCY RESPONSE 21
3.5.6 METHOD STATEMENTS 21
3.5.7 PUBLIC COMMUNICATION AND LIAISON WITH I&APS 22

4 ENVIRONMENTAL AWARENESS PLAN 24
4.1 GENERAL TOPICS 24
4.2 ACTIVITY SPECIFIC TOPICS 25
4.3 TAKE-HOME TOPICS 25

5 ENVIRONMENTAL MANAGEMENT PROGRAMME: PRE-CONSTRUCTION 26
5.1 GENERAL CONTROLS FOR PRE-CONSTRUCTION 27
5.2 PLANT AND ANIMAL RESCUE AND PROTECTION 28
5.3 OPEN SPACE MANAGEMENT 29

6 ENVIRONMENTAL MANAGEMENT PROGRAMME: CONSTRUCTION 30
6.1 SITE PREPARATION, CONSTRUCTION CAMP, STORAGE OF MATERIALS AND HEALTH & SAFETY 30
6.2 DRILLING OF WELLS 33
6.3 HYDROGEOLOGY 34
6.4 HYDROLOGY & FRESHWATER RESOURCES 34

6.5 WETLANDS 37
6.6 SOILS 39
6.7 EROSION MANAGEMENT AND CONTROL 41
6.8 FAUNA AND FLORA 42
6.9 ALIEN INVASIVE VEGETATION MANAGEMENT 43
6.10 RE-VEGETATION AND REHABILITATION PLAN 44
6.11 OPEN SPACE MANAGEMENT 44
6.12 NEW SERVICE ROAD 45
6.13 WASTE MANAGEMENT 46
6.14 SOCIAL 47
6.15 AIR QUALITY 48
6.16 HERITAGE, ARCHAEOLOGY AND PALAEONTOLOGY 49
6.17 NOISE 50
6.18 TRAFFIC MANAGEMENT AND TRANSPORTATION 50
6.19 VISUAL 51

7 ENVIRONMENTAL MANAGEMENT PROGRAMME: OPERATIONS 52
7.1 GEOLOGY 52
7.2 HYDROGEOLOGY 53
7.3 HYDROLOGY & FRESHWATER RESOURCES 56
7.4 IRRIGATION 58
7.5 WETLANDS 59
7.6 SOILS 60
7.7 EROSION MANAGEMENT AND CONTROL 61
7.8 ALIEN INVASIVE VEGETATION MANAGEMENT 61
7.9 OPEN SPACE MANAGEMENT 61
7.10 WASTE MANAGEMENT 62
7.11 AIR QUALITY 64
7.12 VISUAL 64

8 ENVIRONMENTAL MANAGEMENT PROGRAMME: DECOMMISSIONING & REHABILITATION 65

LIST OF TABLES

TABLE 1: DETAILS OF EAP 7
TABLE 2: ADDITIONAL REQUEST FROM DEA 7
TABLE 3: RELEVANT ENVIRONMENTAL LEGISLATION, GUIDELINES AND POLICIES APPLICABLE TO THE PROJECT 8
TABLE 4: RESPONSIBLE PARTIES 16
TABLE 5: PRE-CONSTRUCTION – GENERAL ACTIVITIES 27
TABLE 6: PRE-CONSTRUCTION – PLANT AND ANIMAL RESCUE AND PROTECTION ACTIVITIES 28
TABLE 7: PRE-CONSTRUCTION – OPEN SPACE MANAGEMENT 29
TABLE 8: CONSTRUCTION – SITE PREPARATION, CONSTRUCTION CAMP, STORAGE OF MATERIALS, HEALTH AND SAFETY 30
TABLE 9: CONSTRUCTION – DRILLING OF WELLS (I.E. GASIFIERS) 33
TABLE 10: CONSTRUCTION – HYDROGEOLOGY 34
TABLE 11: CONSTRUCTION – HYDROLOGY AND FRESHWATER RESOURCES 34
TABLE 12: CONSTRUCTION – WETLANDS 37
TABLE 13: CONSTRUCTION – SOILS 39
TABLE 14: CONSTRUCTION – EROSION MANAGEMENT AND CONTROL 41
TABLE 15: CONSTRUCTION – FAUNA AND FLORA 42
TABLE 16: CONSTRUCTION – ALIEN INVASIVE VEGETATION MANAGEMENT 43
TABLE 17: CONSTRUCTION – RE-VEGETATION AND REHABILITATION PLAN 44
TABLE 18: CONSTRUCTION – OPEN SPACE MANAGEMENT 44
TABLE 19: CONSTRUCTION – NEW SERVICE ROAD SPECIFIC 45
TABLE 20: CONSTRUCTION – WASTE MANAGEMENT 46
TABLE 21: CONSTRUCTION – SOCIAL ISSUES 47
TABLE 22: CONSTRUCTION – AIR QUALITY 48
TABLE 23: CONSTRUCTION – HERITAGE, ARCHAEOLOGY AND PALAEONTOLOGY 49
TABLE 24: CONSTRUCTION – NOISE 50
TABLE 25: CONSTRUCTION – TRAFFIC MANAGEMENT AND TRANSPORTATION 50
TABLE 26: CONSTRUCTION – VISUAL 51
TABLE 27: OPERATIONS – GEOLOGY 52
TABLE 28: OPERATIONS – HYDROGEOLOGY 53
TABLE 29: OPERATIONS – HYDROLOGY AND FRESHWATER RESOURCES 56
TABLE 30: OPERATIONS – IRRIGATION 58
TABLE 31: OPERATIONS – WETLANDS 59
TABLE 32: OPERATIONS – SOILS 60
TABLE 33: OPERATIONS – WASTE MANAGEMENT 62
TABLE 34: OPERATIONS – AIR QUALITY 64
TABLE 35: OPERATIONS – VISUAL 64
TABLE 36: DECOMMISSIONING AND REHABILITATION 65

LIST OF FIGURES

FIGURE 1: LOCALITY MAP 3
FIGURE 2: DIFFERENT PHASES OF THE PROJECT LIFE-CYCLE 4
FIGURE 3: DEMING CYCLE OF CONTINUING IMPROVEMENT 5
FIGURE 4: ADAPTED FROM THE DEMING CYCLE OF CONTINUING IMPROVEMENT 5
FIGURE 5: KEY PERSONNEL IN THE PROJECT TEAM – WITH REPORTING LINKAGES 12

APPENDICES

ANNEXURE A **SITE LAYOUT AND SENSITIVITY MAP**

ANNEXURE B **STORMWATER MANAGEMENT PLAN (GOLDER 11613755-11980-4)**

ANNEXURE C **PROCESS WELL DRILLING PROCEDURE (UCG PC 2073-1381)**

ANNEXURE D **BIOREMEDIATION OF HYDROCARBON CONTAMINATION SOIL (UCG WN 2073-15150)**

ANNEXURE E **GUIDELINES FOR POLLUTION PREVENTION AND REHABILITATION OF DISTURBED AREAS FOR DRILLING DEPARTMENT (UCG PC 2073-1392)**

ANNEXURE F **UCG REVISED WATER MONITORING PROGRAMME**

ANNEXURE G **WETLAND REHABILITATION PLAN (AS EXTRACTED FROM THE WETLAND SPECIALIST REPORT)**

GLOSSARY OF TERMS

ACCIDENT:

An unexpected event, that may result in loss or injury to a person and/or damage to property or the environment.

BUILDING AND DEMOLITION WASTE:

Building and demolition waste means waste, excluding hazardous waste, produced during the construction, alteration, repair or demolition of any structure, and includes rubble, earth, rock and wood displaced during that construction, alteration, repair or demolition.

CONTRACTOR:

Any provider of services, goods or people to Eskom sites, directly or indirectly, and includes: Contractors, sub-contractors, hired labour agency, suppliers, event contractors, consultants and contractors as traditionally defined.

DEGRADATION:

The lowering of the quality of the environment through human activities, e.g. river degradation, soil degradation, etc.

DOMESTIC WASTE:

Domestic waste means waste, excluding hazardous waste, that emanates from premises that are used wholly or mainly for residential, educational, health care, sport or recreation purposes (National Environmental Management: Waste Amendment Act (No 26 of 2014) Schedule 3: Category B – General Waste).

EMERGENCY:

An unplanned and uncontrolled condition that might threaten or negatively influence the environment or property.

ENVIRONMENT:

In terms of the National Environmental Management Act (NEMA) (No 107 of 1998)(as amended), "Environment" means the surroundings within which humans exist and that are made up of:

(i) the land, water and atmosphere of the earth;
(ii) micro-organisms, plants and animal life;
(iii) any part or combination of (i) of (ii) and the interrelationships among and between them; and
(iv) the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and wellbeing.

ENVIRONMENTAL CONTROL OFFICER (ECO):

An individual nominated through the Client to be present on site regularly to act on behalf of the Client in matters concerning the implementation and day to day monitoring of the EMPr, Environmental Authorisation, Waste Management License and Water Use License conditions stipulated by the authorities. The ECO will report independently to the authorities on a regular basis.

ENVIRONMENTAL OFFICER (EO):

An individual employed by Eskom who will be present on site at all times and who will ensure implementation of the EMPr, integrated Environmental Authorisation and Waste Management Licence and Water Use Licence conditions stipulated by the authorities.

ENVIRONMENTAL IMPACT:

A change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.

ENVIRONMENTAL MANAGEMENT PROGRAMME:

A detailed plan of action prepared to ensure that recommendations for enhancing or ensuring positive environmental impacts and limiting or preventing negative environmental impacts are implemented during the life-cycle of the project.

GENERAL WASTE:

Means waste that does not pose an immediate hazard or threat to health or to the environment, and includes –

(a) Domestic waste;

(b) Building waste and demolition waste;

(c) Business waste;

(d) Inert waste; or

(e) Any waste classified as non-hazardous waste in terms of the regulations made under section 69,

and includes non-hazardous substances, materials or objects within business, domestic, inert, building and demolition wastes as outlined in the National Environmental Management: Waste Amendment Act (No 26 of 2014) Schedule 3: Category B – General Waste.

HAZARDOUS WASTE:

Means any waste that contains organic or inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics of that waste, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, residue deposits and residue stockpiles as outlined in the National Environmental Management: Waste Amendment Act (No 26 of 2014).Schedule 3: Category A - Hazardous Waste.

IMPACT:

A description of the potential effect or consequence of an aspect of the development on a specified component of the biophysical, social or economic environment within a defined time and space.

INCIDENT:

An undesired event which may result in a significant environmental impact but can be managed through internal response.

MITIGATION:

Measures designed to avoid, reduce or remedy adverse impacts.

WASTE:

Any substance, material or object, that is unwanted, rejected, abandoned, discarded or disposed of, or that is intended or required to be discarded or disposed of, by the holder of that substance, material or object, whether or not such substance, material or object can be re-used, recycled or recovered and includes all wastes as defined in Schedule 3 of the National Environmental Management: Waste Amendment Act (No 26 of 2014).

WATERCOURSE:

a) a river or spring;

b) a natural channel or depression in which water flows regularly or intermittently;

c) a wetland, lake or dam into which, or from which, water flows; and

d) any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse as defined in the National Water Act, 1998 (Act No. 36 of 1998) and a reference to a watercourse includes, where relevant.

WETLAND:

land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

ACRONYMS

DEA – Department of Environmental Affairs

DMR – Department of Mineral Resources

DWA – Department of Water Affairs

EIA – Environmental Impact Assessment

EIAR – Environmental Impact Assessment Report

EMPr – Environmental Management Programme

ESS – Environmental Scoping Study

GTP – Gas Treatment Plant

I&AP – Interested and Affected Party

IWULA – Integrated Water Use License Application

IWWMP – Integrated Waste Water Management Plan

MDEDET - Mpumalanga Department of Economic Development, Environment and Tourism

NEM:AQA – National Environmental Management – Air Quality Act (Act No. 39 of 2004)

NEM:WA – National Environmental Management – Waste Act (Act No. 59 of 2008)

NEMA – National Environmental Management Act (Act No. 107 of 1998)

NHRA – National Heritage Resources Act (Act No. 25 of 1999)

QMS – Quality Management System

SAHRA – South African Heritage Resources Agency

UCG – Underground Coal Gasification

1 INTRODUCTION

Eskom Holdings SOC Limited (Eskom) is mandated by the South African Government to ensure the provision of reliable and affordable power to South Africa. Eskom currently generates approximately 95% of the electricity used in South Africa. Electricity cannot be stored in large quantities and must be used as it is generated. Therefore, electricity must be generated in accordance with supply-demand requirements. In addition, increasing economic growth and social development within Southern Africa is placing a growing demand on energy supply. Coupled with the rapid advancement in community development, is the growing awareness of environmental impact, climate change and the need for sustainable development.

Eskom's core business is in the generation, transmission (transport), trading, and, retail of electricity. In terms of the Energy Policy of South Africa "*energy is the life-blood of development*". Therefore, the reliable provision of electricity by Eskom is critical for industrial development and related employment and sustainable development in South Africa. Electricity production is still largely dependent on the reliable and cost effective supply of fuel, of which coal is the predominant feedstock for Eskom, in current years. Due to market forces, Eskom competes with other users and international markets for indigenous coal resources, so the price and availability thereof depends on the market.

Underground Coal Gasification (UCG), a process whereby coal is converted *in situ* into combustible gas that can be used for power generation, is one of the new clean coal technologies being developed for implementation by Eskom that intends to diversify Eskom's fuel supply. The technology has been through 12 years of intensive research by Eskom since 2001 to achieve a better understanding of the gasification process, and the nature of the gas produced. Eskom proposes the use of synthesis gas or "syngas"[1] *(*at a flow-rate of 15,000 Nm^3/hr) produced by the UCG process as a supplementary fuel source within a boiler at Majuba power station. The intent is for the 15,000 Nm^3/hr pilot plant to be scaled up to a 70,000 Nm^3/hr pilot and based on the outcomes of the 70000 Nm^3/hr plant, Eskom may in future investigate the option of a commercial size power plant based on UCG technology.

This Environmental Impact Assessment is for the UCG pilot project (70,000 Nm^3/hr) and associated infrastructure on the farm Roodekopjes 67 HS (Portions 1, 2, 3 and remaining extent), Portions 17 and 21 of the farm Bergvliet 65HS and Portions 4 and 5 of the farm Rietfontein 66HS, in support of the co-firing of syngas at the Majuba Power Station (refer to Figure 1). The UCG site is located within the southern portions of Mpumalanga Province, near the town of Amersfoort and opposite the Eskom Majuba Power Station. The area falls within the local administrative boundaries of Pixley ka Seme Local Municipality, which in turn is part of the Gert Sibande District Municipality.

The sensitivity map for the study area, as derived from the impact assessment process, is attached as **Annexure A**.

1.1 Applicable Documentation

The following environmental documentation is applicable for the project, and will be read in conjunction with this EMPr:

- Scoping and Environmental Impact Assessment Report for the Underground Coal Gasification Project and associated infrastructure in support of co-firing of gas at the Majuba Power Station, Amersfoort, Mpumalanga.
- Environmental Authorisation and Waste Management License from the Department of Environmental Affairs (*once issued*).

[1] Biofuel.org.uk/what-is-syngas.html – Syngas is the abbreviation for Synthesis gas. This is a gas mixture that comprises of carbon monoxide, carbon dioxide and hydrogen.

- Integrated Water Use License from the Department of Water Affairs (*once issued*).
- Mining Right (*once issued*).

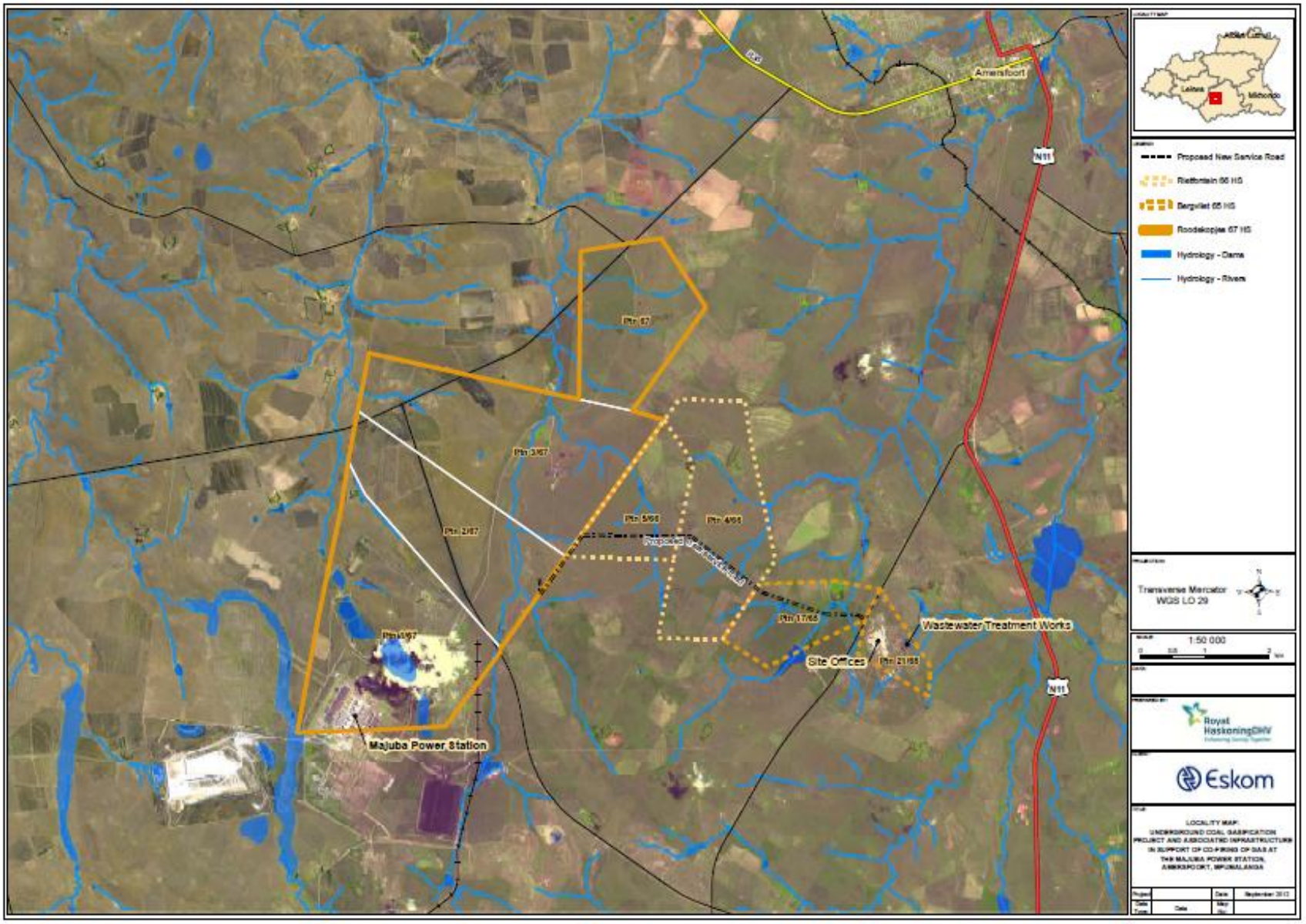


Figure 1: Locality map

1.2 Objectives of the EMPr

The EMPr has the following objectives:

- To outline functions and responsibilities of responsible persons;
- To state standards and guidelines, which are required to be achieved in terms of environmental legislation;
- To outline mitigation measures and environmental specifications, which are required to be implemented for all phases of the project in order to minimise the extent of environmental impacts, and to manage environmental impacts;
- To prevent long-term or permanent environmental degradation;
- Develop commitments register to address legal and other requirements;
- Ensure that all workers, subcontractors and other involved in the project meet legal and other requirements with regard to environmental management;
- Incorporate environmental management into project design and operating procedures;
- Address concerns and issues addressed in the EIA's stakeholder consultation process and those that will likely to continue to arise during the project's lifetime;
- Provide a framework for implementing project environmental commitments (i.e. mitigation measures identified in the EIA); and
- Prepare and maintain records of project environmental performance (i.e. monitoring, audits, non-compliance tracking).

An independent Environmental Control Officer (ECO) must be appointed (by the proponent: Eskom) to ensure compliance with the EMPr. The EMPr will be considered an extension of the Conditions of Approval as set forth by the Department of Environmental Affairs (DEA) and Department of Water Affairs (DWA).

Non-compliance with the EMPr will constitute non-compliance with said Conditions.

1.3 Structure of the EMPr

The EMPr provides mitigation and management measures for the following key phases of the project:

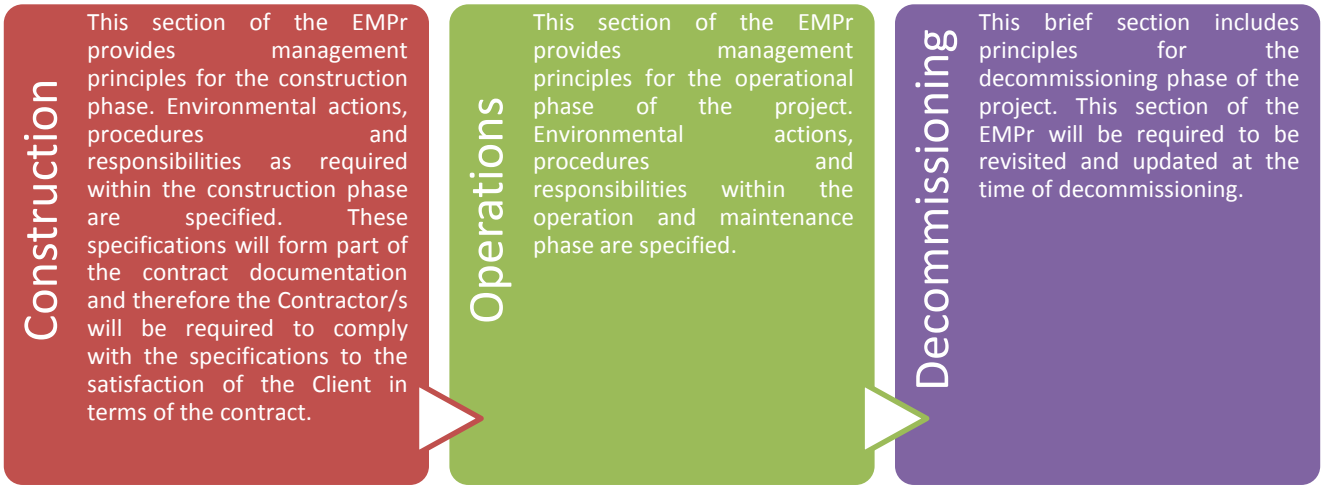


Figure 2: Different phases of the project life-cycle

1.4 EMPr as a "live" Document

The approach adopted for this EMPr is derived from the Deming Cycle (Figure 3), a cycle of continuous improvement that entails the reiterative actions of plan, do, check, act, and critically to then return to the planning phase. The cycle is followed through the research process, through the pilot and up to the demonstration scale.

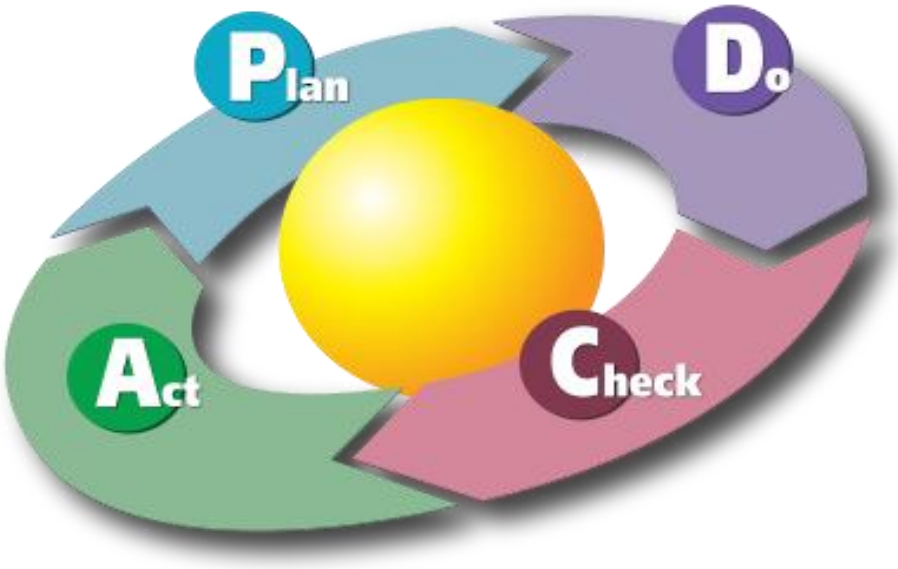


Figure 3: Deming cycle of continuing improvement

Each level achieves greater detail, and enables the Plan, Do, Check and Act (PDCA) cycle to tighten its range of uncertainty.

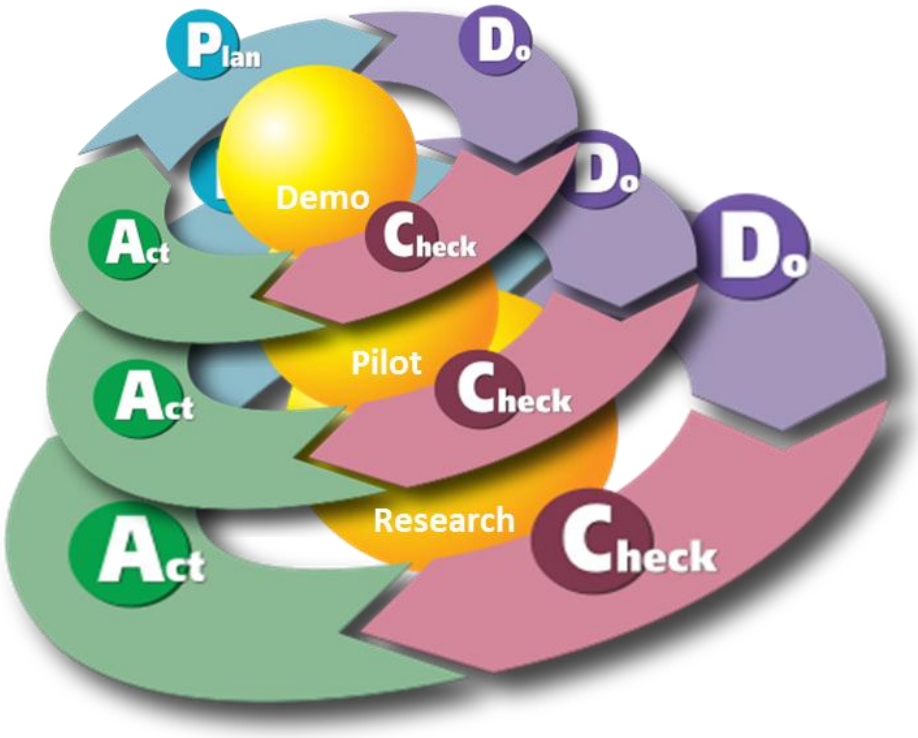


Figure 4: Adapted from the Deming cycle of continuing improvement

1.4.1 Plan

Project-specific planning for the proposed project involves consideration of the legal triggers, the specifics of the proposed development, and the nature of the receiving environment. This provides a starting point for targeted environmental management objectives. Environmental performance indicators are then determined with measurable targets prescribed to monitor the environmental performance of the project. Achieving the targets depends on compliance with this EMPr and the legislative requirements that underpin it.

1.4.2 Do

Throughout the development's life-span, the developer and operator will be required to develop and maintain a Quality Management System – designed to ensure that best management practices are implemented in day-to-day management. Such a QMS should at least include the following information:

- Location and extent of associated infrastructure;
- Associated activities, such as the transportation of people and equipment;
- Resources and experience required (staffing);
- Materials and equipment to be used;
- Management actions;
- Human resources used;
- Construction-monitoring activities;
- Emergency / disaster incident and reaction procedures; and
- Rehabilitation procedures for the impacted environment.

These topics will be cross-linked into the contracts related to the development and operational phases of the project.

1.4.3 Check

A system of assessing monitoring results has been developed to check the environmental management performance. Continuous assessment facilitates proactive management of the environmental issues. Mitigation measures can then be successfully implemented on an on-going basis to keep environmental indicators within their target thresholds. Moreover, the assessment system also enables the assessment of the efficacy of the EMPr. Regular auditing of environmental performance is prescribed to prove and preserve accountability.

1.4.4 Act

The assessments and monitoring of the results and findings of the regular audits must be documented within a reporting system. Precautionary mitigation measures and corrective actions will be prescribed and instructions will be given in order to implement these in the field. The findings of monitoring and auditing programmes can also be used to update the EMPr. Although the EMPr is a project-specific document, it is dynamic and should be updated regularly to address the changing circumstances of the scheme.

1.5 Details of the Environmental Assessment Practitioner

The particulars of the EAPs responsible for the compilation of this document are presented in Table 1 below:

Table 1: Details of EAP

Details	
Consultant:	Royal HaskoningDHV (formerly SSI Engineers and Environmental Consultants (Pty) Ltd)
Contact Persons:	Prashika Reddy and Malcolm Roods
Postal Address	PO Box 867 Gallo Manor 2052
Telephone:	012 367 5973 / 011 798 6442
Facsimile:	012 367 5878 / 011 798 6010
E-mail:	prashika.reddy@rhdhv.com / malcolm.roods@rhdhv.com
Expertise:	Prashika Reddy is a Senior Environmental Scientist (*Pr Sci Nat* 400133/10) with a BSc Honours in Geography. Ms Reddy has the necessary experience in various environmental fields including: environmental impact assessments, environmental management plans/programmes, public participation and environmental monitoring and auditing. Ms Reddy has extensive experience in compiling environmental reports (Screening, Scoping, EIA and *Status Quo* Reports). Ms Reddy is/has been part of numerous multi-faceted large–scale projects, including the establishment of linear developments (roads, and power lines); industrial plants; electricity generation plants and mining-related projects. Malcolm Roods is a Principal with RHDHV specializing in Environmental Impact Assessments (EIA) for electricity supply (generation, transmission and distribution), road infrastructure, residential developments as well as water management projects. This builds on a broad government background, which has made him particularly flexible. His past experiences include 6 years public service which included policy development, environmental law reform and EIA reviews. His experience also includes 5 years of environmental consulting in the field of Impact Assessment and Authorisation Applications, with a focus on legislative requirements and sector area management. He is also a certified Environmental Assessment Practitioner with the Interim Certification Board (ICB) for EAP of South Africa.

1.6 Department of Environmental Affairs EMPr Request

The DEA requires the following to be submitted as part of the EMPr:

Table 2: Additional request from DEA

Plans / Other Information	Relevant Section(s) of the EMPr
Plant rescue and protection	5.2
Open space management	5.3; 6.11; 7.9
Re-vegetation and habitat rehabilitation	6.10; 8
Alien invasive management	6.9; 7.8
Stormwater management	6.4; 6.5; 7.3; 7.5 and Annexure B
Monitoring system for the detection of leakage and spillage	6.3; 6.5; Annexure F
Erosion management	6.7; 7.7
Traffic management	6.18
Environmental sensitivity map	Annexure A
Measures to protect hydrological features such as streams, rivers, pans, wetlands, dams and their catchment and other environmental sensitive areas	6.2; 6.3; 6.4; 6.5; 7.2; 7.3; 7.4; 7.5; 7.7

2 ENVIRONMENTAL LEGISLATION, POLICIES AND GUIDELINES

All relevant environmental legislation pertaining to the project from cradle to grave is listed within Table 3 below. Eskom and the Contractor are required to comply with this legislation for all phases of the project. This list is intended to serve as a guideline only and is not exhaustive. Further, legislation is regularly amended or updated and as such some items may no longer be relevant, whilst others have been superseded. Additional aspects should be added once the Environmental Authorisation as well as other licenses listed in Section 1.1 is obtained and amended as construction commences.

Table 3: Relevant environmental legislation, guidelines and policies applicable to the project

LEGISLATION	SECTIONS	RELATES TO
The Constitution (Act No. 108 of 1996)	Chapter 2	Bill of Rights.
	Section 24	Environmental rights.
National Environmental Management Act (Act No. 107 of 1998 [as amended])	Section 2	Defines the strategic environmental management goals and objectives of the government. Applies throughout the Republic to the actions of all organs of state that may significantly affect the environment.
	Section 24	Provides for the prohibition, restriction and control of activities which are likely to have a detrimental effect on the environment.
	Section 28	The developer has a general duty to care for the environment and to institute such measures as may be needed to demonstrate such care.
EIA Regulations (2010) – Government Notice Regulation (GNR) 543 – 546	GN 543 – Sections 28, 31, 32, 33, 54	Content of scoping reports (Section 28), Environmental Impact Assessment reports (Section 31), specialist report and reports on specialised processes (Section 32), content of draft environmental management programmes (Section 33) and the public participation process (Section 54).
	GNR 544 – Listing Notice 1 and GN 922 – Amendment of Listing Notice 1	Activities requiring a Basic Assessment study to be undertaken.
	GNR 545 – Listing Notice 2 and GNR 923 – Amendment of Listing Notice 2	Activities requiring a Scoping and Impact Assessment study to be undertaken.
	GNR 546 – Listing Notice 3	Activities in special geographical areas requiring a Basic Assessment study to be undertaken.
National Environmental Management: Waste Act (Act No. 59 of 2008)	Section 19	A list of waste management activities (GN R.718) which have, or are likely to have a detrimental effect on the environmental have been published.
	GNR 921 – Category A	Activities requiring a Basic Assessment study to be undertaken as part of the waste management license application.
	GNR 921 – Category B	Activities requiring a Scoping and Impact Assessment study to be undertaken as part of the waste management license application.

LEGISLATION	SECTIONS	RELATES TO
	GNR 921 – Category C	Activities requiring compliance with the relevant requirement or standards: a) Norms and Standards for Storage of Waste, 2013; or b) Standard for Extraction, Flaring or Recovery of Landfill Gas, 2013 or c) Standards for Scrapping or Recovery of Motor Vehicles, 2013.
Environment Conservation Act (Act No. 73 of 1989) and Regulations	Sections 19 and 19A	Prevention of littering by employees and subcontractors during construction and the maintenance phases of the proposed project.
National Water Act (Act No. 36 of 1998)	Section 21	General principles for regulating water use.
National Heritage Resources Act (Act No. 25 of 1999) and regulations	Section 34	No person may alter or demolish any structure or part of a structure which is older than 60 years without a permit issued by the relevant provincial heritage resources authority.
	Section 35	No person may, without a permit issued by the responsible heritage resources authority destroy, damage, excavate, alter, deface or otherwise disturb any archaeological or palaeontological site.
	Section 36	No person may, without a permit issued by the South African Heritage Resource Agency (SAHRA) or a provincial heritage resources authority destroy, damage, alter, exhume, remove from its original position or otherwise disturb any grave or burial ground older than 60 years which is situated outside a formal cemetery administered by a local authority. “Grave” is widely defined in the Act to include the contents, headstone or other marker of such a place, and any other structure on or associated with such place.
	Section 38	This section provides for Heritage Impact Assessments (HIAs), which are not already covered under the ECA. Where they are covered under the ECA the provincial heritage resources authorities must be notified of a proposed project and must be consulted during the HIA process. The Heritage Impact Assessment (HIA) will be approved by the authorising body of the provincial directorate of environmental affairs, which is required to take the provincial heritage resources authorities’ comments into account prior to making a decision on the HIA.
National Environmental Management: Air Quality Act (Act No. 39 of 2004)	Section 33	Rehabilitation when mining operations cease.
	Section 34	Control of noise.
	Section 35	Control of offensive odours.
National Dust Control Regulations (GN R827 of November 2013)		Control of dust.

LEGISLATION	SECTIONS	RELATES TO
Minerals and Petroleum Resources Development Act (No 28 of 2002)	Section 22	Application for a mining right.
	Section 39	Environmental management programme and environmental management plan.
Conservation for Agricultural Resources Act (No 43 of 1983) and Regulations		Implementation of control measures for alien and invasive plant species. *Replaced by National Environmental Management Biodiversity Act (Act No. 10 of 2004) and regulations but listed here for completeness.*
National Environmental Management Biodiversity Act (Act No. 10 of 2004) and regulations: – **Threatened or protected species (GN 388)** – **Lists of species that are threatened or protected (GN 389)** – **Alien and invasive species regulations (GNR 506)** – **Publication of exempted alien species (GNR 509)** – **Publication of National list of invasive species (GNR 507)** – **Publication of prohibited alien species (GNR 508)**		Provide for the protection of species and ecosystems that warrant national protection and the sustainable use of indigenous biological resources. – Threatened or protected species. – Alien and invasive species management and control. – Exempted alien species. – National list of invasive species. – Prohibited alien species.
National Forests Act (Act No. 84 of 1998) and Regulations	Section 7	No person may cut, disturb, damage or destroy any indigenous, living tree in a natural forest, except in terms of a licence issued under section 7(4) or section 23; or an exemption from the provisions of this subsection published by the Minister in the Gazette.
	Sections 12 – 16	These sections deal with protected trees, with the Minister having the power to declare a particular tree, a group of trees, a particular woodland, or trees belonging to a certain species, to be a protected tree, group of trees, woodland or species. In terms of section 15, no person may cut, disturb, damage, destroy or remove any protected tree; or collect, remove, transport, export, purchase, sell, donate or in any other manner acquire of dispose of any protected tree, except under a licence granted by the Minister.
Occupational Health and Safety Act (No 85 of 1993)*	Section 8	General duties of employers to their employees.
	Section 9	General duties of employers and self-employed persons to persons other than their employees.
Hazardous Substances Act (Act No. 15 of 1973) and Regulations		Provides for the definition, classification, use, operation, modification, disposal or dumping of hazardous substances.
Fencing Act (Act No. 31 of 1963)	Section 17	Any person erecting a boundary fence may clean any bush along the line of the fence up to 1.5 meters on each side thereof and remove any tree standing in the immediate line

LEGISLATION	SECTIONS	RELATES TO
		of the fence. However, this provision must be read in conjunction with the environmental legal provisions relevant to protection of flora.
Mine Health and Safety Act (Act No. 29 of 1996)	Chapter 2	Health and safety at mines.
	Chapter 8	General provisions.
Mpumalanga Biodiversity Conservation Plan (2007)		
Road Transportation Act (No 74 of 1977)		
Mpumalanga Roads Act (No 1 of 2008)		
Gert Sibande District Municipality Spatial Development Framework (2009)		
Gert Sibande District Integrated Development Plan 2011/12 and 2013/14		
Pixley ka Seme Local Municipality Integrated Development Plan 2009 - 2012		
Pixley ka Seme Local Municipality Spatial Development Framework (2011)		
Other Local Municipality Bylaws		

*The UCG Site is governed by the Mine Health and Safety Act (MHSA), although the OHSA is used as best practice guideline in addition to the MHSA and in instances the MHSA does not govern.

3 MANAGEMENT AND MONITORING PROCEDURES

3.1 Organisational Structure and Responsibility

The key personnel from an environmental perspective are the Majuba UCG Site Manager, the Environmental Control Officer (ECO) and the Contractor.

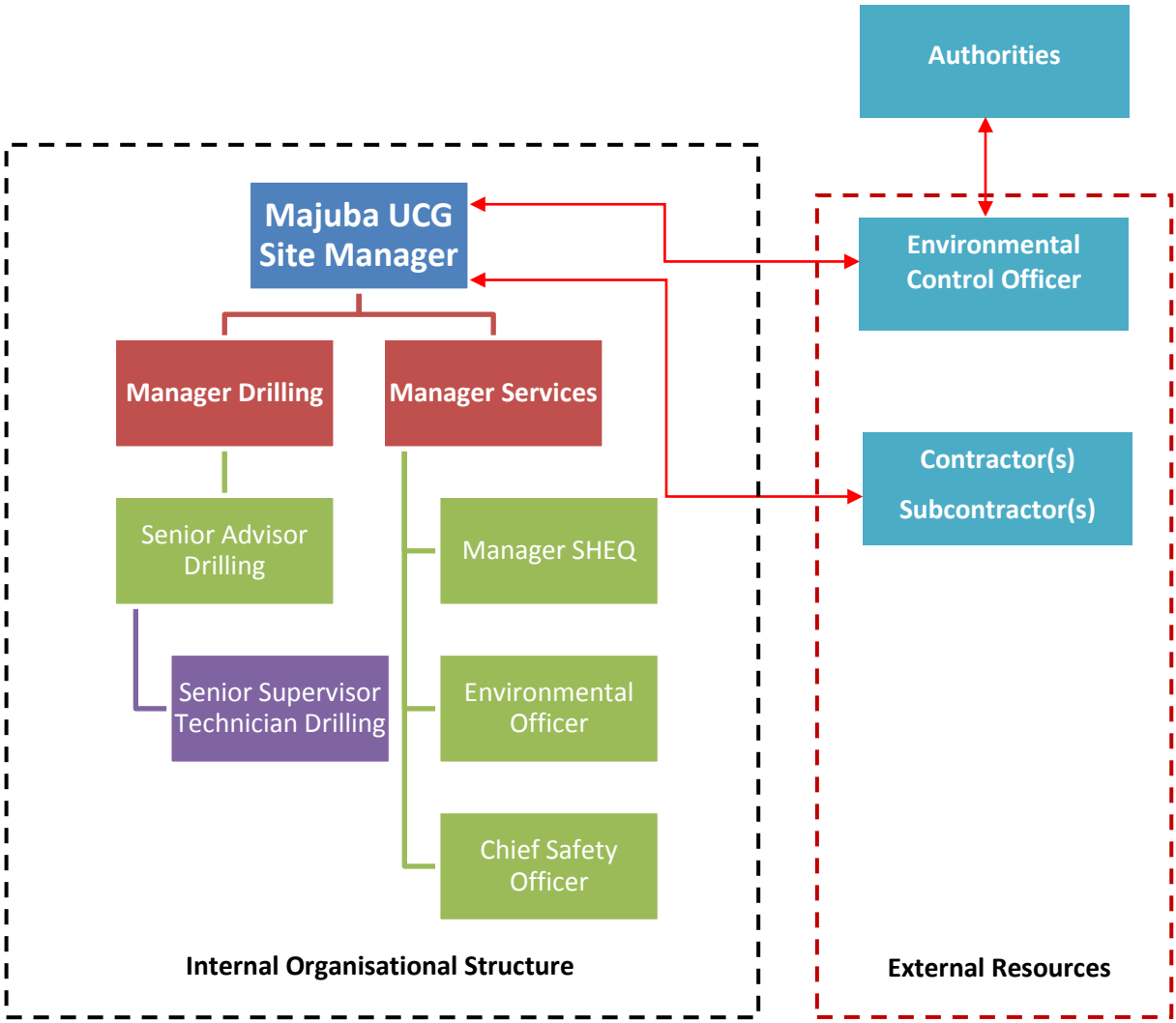


Figure 5: Key personnel in the project team – with reporting linkages

3.1.1 Majuba UCG Site Manager

The Majuba UCG Site Manager (SM) is responsible for overall management of the project. The following tasks will fall within his / her responsibilities:

- Be conversant with the findings of the Environmental Impact Assessment and Water Use Licensing process for the project, the conditions of the EA, and all relevant environmental legislation.
- Be familiar with the recommendations and mitigation measures of this EMPr, and ensure the EO and ECO are provided with the necessary tools / equipment / support to implement these measures.

- Ensure that the EO fulfils his duty in terms of having all stipulations within the EMPr communicated and adhered to by the Employees, Contractor(s) and its sub-contractor(s).
- Monitor the implementation of the EMPr throughout the project by means of site inspections and meetings. This will be documented as part of the management meeting minutes.
- Conduct internal audits of the construction site against the EMPr.
- Liaise with the Environmental Compliance Officer and Environmental Officer on matters concerning the environment.
- Be the lead in all negotiations required for any reason with the affected parties (including affected landowners), employees and the Contractor. No verbal agreements shall be made, that is, all agreements shall be recorded in writing and all parties shall co-sign the relevant documentation.
- Ensure that the affected parties are always kept informed about any changes to the construction programme if it should affect them.
- Prevent actions that will harm or may cause harm to the environment, and take steps to prevent pollution on the site.

The SM thus oversees the entire project, including both the construction team and the environmental oversight function to ensure compliance with the environmental decision reached by the authorities. Any of the tasks mentioned above may be delegated in writing.

3.1.2 Environmental Officer

The Environmental Officer is responsible for the implementation of the EMPr during the construction phase and liaison between the Eskom, the employees and the Contractor on environmental matters:

The EO will:

- Be fully conversant with the environmental documents as indicated in Section 1.1.
- Be fully conversant with the conditions of the Integrated Environmental Authorisation and Waste Management License and Water Use License.
- Be fully conversant with each EMPr applicable to each of the various environmental licences obtained.
- Be fully conversant with all relevant environmental legislation and Eskom environmental policies and procedures, and ensure compliance with them.
- Be familiar with the recommendations and mitigation measures of this EMPr, and implement these measures.
- Ensure that all stipulations within the EMPr are communicated and adhered to by the Employees, Contractor(s) and its sub-contractor(s).
- Confine the construction site to the demarcated area.
- Rectify transgressions through the implementation of corrective action after consultation with the SM.
- Ensure that periodic environmental performance audits are undertaken on the project implementation.
- Maintain the following on site:
  - A daily site register
  - A non-conformance register (NCR)
  - A public complaint register
  - A register of audits

- Undertake regular and comprehensive inspection of the site and surrounding areas in order to monitor compliance with the EMPr.
- Take appropriate action if the specifications contained in the EMPr are not followed.
- Monitor and verify that environmental impacts are kept to a minimum, as far as possible.
- Ensure that activities on site comply with all relevant environmental legislation.
- Compile progress reports on a regular basis, with input from the Site Manager, for submission to the relevant authorities, including a final post-construction audit carried out by an independent auditor/consultant.

3.1.3 Environmental Control Officer

The following tasks will fall within the independent Environmental Control Officer's (ECO) responsibilities:

- Be aware of the findings and conclusions of the Environmental Impact Assessment and Water Use Licensing process and the conditions stated within the environmental licenses.
- Be familiar with the recommendations and mitigation measures of this EMPr.
- Be conversant with relevant environmental legislation, policies and procedures, and ensure compliance with them.
- Undertake regular and comprehensive site inspections / audits of the construction site according to the EMPr and applicable licenses in order to monitor compliance with the EMPr.
- Educate the construction team about the management measures contained in the EMPr and environmental licenses.
- Monitor and verify that environmental impacts are not caused, or if inevitable kept to a minimum.
- In consultation with the Site Manager (SM), order the removal of person(s) and/or equipment which are in contravention of the specifications of the EMPr and/or environmental licenses.
- Ensure regular liaison with the construction team and the SM.
- Recommend corrective action for any non-compliance incidents on the construction site.
- Compile a regular report highlighting any non-compliance issues as well as satisfactory or exceptional compliance with the EMPr.
- Facilitate training for all personnel on the site – this may range from carrying out the training, to reviewing the training programmes of the Contractor and/or sub-contractors.
- The ECO thus oversees the environmental facets of the project, ensuring compliance with the environmental decision reached by the authorities. The ECO reports to the SM, but remains independent of the construction team so as to allow for impartial oversight and compliance auditing on all environmental and social issues / impacts for the development project.
- The ECO has authority to report directly to the relevant authorities regarding environmental matters on site.
- In case of non-compliances, the ECO must first communicate this to the SM, who has the power to ensure this matter is addressed. Should no action or insufficient action be taken, the ECO may report this matter to the authorities as non-compliance.

Further note, the ECO function is not limited to the construction phase alone, but is also an active role during the operational and later phases of the project.

3.1.4 Contractors

All Contractors, including sub-contractors and staff (of both contractors and sub-contractors), and all service providers to the site are ultimately responsible:

- To ensure the implementation and compliance with recommendations and conditions of the EMPr.
- Submit a Safety File as requested during the Tender process, which will include an environmental risk assessment. This document has to be approved by the SHEQ Manager / SM (if applicable).
- Adhere to any instructions issued by the Site Engineer and/or SM on the advice of the ECO.
- Submit a report indicating any incident which may occur prior to the end of shift on the prescribed form.
- Ensure that the list of transgressions issued by the ECO in the site office is available on request.
- Maintain an environmental register which keeps a record of all incidents which occur on the site during construction. These incidents may include:
  - Health and safety incidents.
  - Incidents involving hazardous materials stored on site.
  - Non-compliance incidents.
  - Arrange that all his/her employees and those of his/her sub-contractors receive appropriate training before the commencement of construction. Note that this may be facilitated or actually undertaken by the ECO.
- Ensure that suitable safety and health related measures are in place to limit potential harm to those on the site and those surrounding the site.
- Complying with the environmental management specifications where applicable.
- Adhering to any environmental instructions issued by the Site Manager on the advice of the Environmental Control Officer or Environmental Officer.

Most landowners/surrounding landowners (landowners) will see the construction period as an interference with their daily activities. As such the potential for a negative attitude towards the whole construction process is high. Landowners are always apprehensive toward changes they have no control over as well as the presence of people from outside of their area. For the above reason, the ECO shall monitor activities on site on a daily basis and report to the Contractor and EO.

As per the final responsibility, the necessary safety and health precautions shall be taken by the Contractor to safeguard the lives and property of the inhabitants and/or users thereof. The Contractor shall under no circumstances interfere with the property of landowners or nearby communities.

3.1.5 Independent Auditor

An independent, suitably qualified, auditor will need to be contracted to conduct an environmental audit during the construction phase of the project (e.g. on a construction period of 24 months, quarterly audits – Month 0, 4, 8, 12, 16, 20 and 24 of the construction programme) according to the provisions of the EMPr.

3.2 Roles and Responsibilities Summary

A summary of the roles and responsibilities is provided in Table 4 below for the proposed project across both the Construction and Operational phases.

Table 4: Responsible parties

Title	Party	Role During Construction	Role During Operation	Abbrev
Developer	Eskom	Assume ultimate responsibility	Assume ultimate responsibility	**ESKOM**
Majuba UCG Site Manager	Eskom	Overall management of the project and ensuring EMPr implementation during construction	Overall management of the project and ensuring EMPr implementation during operation	**SM**
Environmental Officer	Eskom	EMPr implementation and monitoring during construction	EMPr implementation and monitoring during operation	**EO**
Environmental Control Officer	To be appointed by Eskom	Two weekly to monthly audits. Reporting to authorities	Annual audits. Reporting to authorities	**ECO**
Main Contractor	TBA	Main Contractor	N/A	**MC**
Drilling Contractor	To be appointed by Eskom	Overseeing drilling activities during the lifetime of the project	Overseeing drilling activities during the lifetime of the project	**DC**
Engineering Team	To be appointed by Eskom	Technical process control relating to design	Technical process control relating to operation	**ET**
SHEQ Manager	To be appointed by Eskom	Overall management of Safety, Health, Environmental and Quality issues during construction	Overall management of Safety, Health, Environmental and Quality issues during operation	**SQM**

3.3 Environmental Monitoring

A monitoring programme will be implemented for the duration of the construction phase of the project. This programme will include:

- Two weekly to monthly audits will be conducted by the ECO across the duration of the construction phase. These audits can be conducted randomly and do not require prior arrangement with the SM.
- Compilation of an audit report per audit event with a rating of the compliance with the EMPr provided in the report. This report will be submitted to the relevant environmental authorities. The ECO shall keep a photographic record of any damage to areas outside the demarcated site area. The date, time of damage, type of damage and reason for the damage shall be recorded in full to ensure the responsible party is held liable.

All claims for compensation emanating from damage should be directed to the ECO for appraisal. The Contractor shall be held liable for all unnecessary damage to the environment. A register shall be kept of all complaints from the landowners and/or the local community. All complaints and/or claims shall be handled immediately to ensure timeous rectification and/or payment by the responsible party.

It should be noted that it is difficult to outline a formal monitoring protocol for specific environmental parameters and key impacts until such time as the detailed plant design and final alignment for the linked infrastructure (i.e. dam, ponds, road and pipelines) have been completed.

A formal monitoring protocol will be included within the revised EMPr once the detailed plant design and final positions for these linked infrastructure items have been completed.

The revised EMPr will also include all additional recommendations and conditions from the decision-making authority (DEA) once these have been received. Requirements from linked legislative processes will also be incorporated (as appropriate) into the revised EMPr.

A monitoring programme will be in place not only to ensure conformance with the EMPr, but also to monitor any environmental issues and impacts which have not been accounted for in the EMPr that are, or could result in significant environmental impacts for which corrective action is required.

The UCG project will stipulate the period and frequency of monitoring required. This will be determined in consultation with relevant stakeholders and authorities. The Site Manager will ensure that the monitoring is carried out. The Environmental Officer will ensure compliance with the EMP, and to carry out monitoring activities.

3.4 Compliance with the EMPr

Compliance with the EMPr will be ensured through the following mechanisms:

- A copy of the EMPr must be kept on site during the construction period at all times.
- The EMPr will be made binding on all Employees and Contractors operating on the site and must be included as Contractual Clauses in any contractual agreement between the Developer and any Contractor. It should be noted that those responsible for environmental damage must make provision for any costs associated with remedying pollution, environmental degradation and consequent adverse health effects and of preventing, controlling or minimising further pollution, environmental damage or adverse health impacts (i.e. “polluter pays principle”).
- All persons employed by the Contractor and/or his sub-contractors must abide by the requirements of the EMPr.
- Contract conditions to include measures to be taken in the event of a construction workforce found to be in breach of any of the specifications contained within the EMPr.
- The Contractor may not direct a person to undertake any activity which would place them in contravention of the specifications contained within the EMPr.
- Should the Contractor be in breach of any of the specifications contained in the EMPr, the SM in consultation with the ECO will, in writing, instruct the Contractor responsible for the incident of non-compliance of
  - the required corrective and/or remedial action(s),
  - specify a timeframe for implementation of these actions,
  - implement a penalty, and/or
  - indicate that work could be suspended should non-compliance continue.
- Should non-compliance continue, further written notification will be forwarded to the Contractor responsible for the incident of non-compliance outlining the required corrective and/or remedial action, the timeframe for implementation, penalties and/or work could be suspended as specified previously.

- Contract clauses are required with the Contractor to hold the Contractor responsible for the cost of any delays, corrective or remedial actions are required as a result of non-compliance with the specifications and clauses of the EMPr.
- An appropriate reporting schedule for frequent reporting (of compliance with the environmental license and EMPr) to the competent authority will be developed. The process to be followed for the auditing of the environmental license conditions and EMPr, as well as the reporting procedure to be followed, will be outlined in this document.
- The SM must notify the relevant authorities, in writing, within the time period specified by the environmental license, if any condition of the environmental license is not adhered to.
- Departmental officials must be given access to the property referred to in the environmental license for the purpose of assessing and/or monitoring compliance with the conditions contained in the environmental license, at all reasonable times. Standard safety requirements may be imposed on such officials so as to meet site-specific requirements.

3.4.1 Non-Conformance and Corrective Action

The Contractor will be deemed to not have complied with the EMPr if:

- Within the boundaries of the site, site extensions and haul/access roads there is evidence of contravention of clauses.
- If environmental damage ensues due to negligence.
- The Contractor fails to comply with corrective or other instructions issued by the SM / ECO within a specified time.
- The Contractor fails to respond adequately to complaints from the public.

The Developer will be deemed to not have complied with the EMPr if:

- Within the boundaries of the site there is evidence of contravention of clauses.
- If environmental damage ensues due to negligence.
- They fail to respond adequately to complaints from the public.

Responsibility for non-conformance and corrective actions will be a joint responsibility. That is, the onus is on all parties to ensure that non-compliances do not occur, that good records are kept, and if non-compliance(s) occur that they are rectified as soon as possible.

3.4.2 Penalties for Non-Compliance

Application of a penalty clause to the Contractor will apply for incidents of non-compliance. The penalty imposed will be per incident and will be deducted from the Contractor's monthly payment certificate.

Unless stated otherwise in the project specification, the penalties imposed per incident or violation will be determined in consultation with the relevant authorities and depending on the severity and/or regularity of the incidence occurring.

The following incidents will be finable:

- Failure to demarcate working servitudes.
- Working outside of the demarcated servitude.
- Failure to strip topsoil with intact vegetation (where applicable).
- Failure to stockpile topsoil correctly.

- Failure to protect topsoil from contamination.
- Failure to stockpile materials in designated areas.
- Pollution of water bodies (including. increased suspended solid loads).
- Failure to control stormwater run-off.
- Failure to provide adequate sanitation.
- Failure to remove waste off site to a registered waste disposal facility, and retain waste disposal certificates for the same.
- Failure to reinstate disturbed areas within the specified timeframe.
- Any other contravention of project specific specification.
- Poor housekeeping including water wastage, untidy site, etc.

3.5 Documentation and Reporting

The following documentation must be kept on site in order to record compliance with the EMPr and the related environmental licence:

- EMPr itself (latest version): It is accepted that the EMPr is a living document which can be updated to ensure for environmental best practice on site as well as to address actual and current construction activities as well as reporting lines. Such amended / revised EMPr must however be submitted to DEA for approval.
- Copy of the Integrated Environmental Authorisation and Waste Management License.
- Copy of the Water Use License and Mining License.
- Copy of relevant legislation.
- Environmental Policy of the Main Contractor.
- Environmental Method statements compiled by the Contractor.
- Environmental register, which shall include:
  - Communications Register – including records of Complaints, and, minutes and attendance registers of all environmental meetings.
  - Monitoring Results – including environmental monitoring reports, register of audits, non-conformance reports.
  - Incident book – including copies of notification of Emergencies and Incidents, this must be accompanied by a photographic record, flash reports and the minutes of SHEQ meetings outlining the outcome of the incident.
  - Waste manifests.

The Environmental Register as kept by the Contractor must maintain a formal record of the following items:

- Report incidents involving Contractor employees and/or the public that could potentially cause negative sentiment and perception towards the project and/or the Developer – that is, formal non-compliances or potential non-compliances during construction or operation.
- Report environmental complaints and correspondence received from the public or the construction workforce team(s), to the SM or the ECO.
- Record and report incidents that cause harm or may cause harm to the environment to the ECO.

- Record all hazardous materials used on site – this should include a summary of the inventory when deviations occur and a linkage to the where the full inventory can be found. The Material Safety Data Sheets for these materials should also be readily available.
- Maintain a record of all Waste Disposal Manifests detailing the nature of the waste disposed of, the waste classification, and, the location of the site to which such waste was sent.

The above records will form an integral part of the Contractors' records. These records will be kept with the EMPr, and will be made available for scrutiny if so requested by the SM, or his/ her delegate, and the ECO.

The ECO the must insure that every entry in the Environmental Register includes the following information:

- Name and contact details of person lodging the entry.
- Nature of complaint / incident.
- Causes of complaint / incident.
- Party/parties responsible for causing complaint / incident.
- Immediate actions undertaken to stop / reduce / contain the causes of the complaint / incident.
- Additional corrective or remedial action taken and/or to be taken to address and to prevent re-occurrence of the complaint / incident.
- Timeframes and the parties responsible for the implementation of the corrective or remedial actions.
- Procedures to be undertaken and/or penalties to be applied, if corrective or remedial actions are not implemented.
- Copies of all correspondence received regarding complaints / incidents.

3.5.1 Responsibility Matrix and Organogram

The Contractor must have a regularly updated Responsibility Matrix linked to an Organogram displayed in an appropriate location identifying responsible parties and how they may be contacted.

3.5.2 Environmental Inspections and Monitoring

The ECO shall undertake regular environmental monitoring. The audits will consider compliance with the EMPr and licence conditions. The EO shall constantly ensure that he / she is aware of the activities on site and tend to activities he / she is required to in terms of the relevant Eskom Procedures.

External auditing may take place at unspecified times by the authorities and/or other relevant authorities.

3.5.3 Weekly Reporting

The EO will be required to provide with a weekly report to the SM covering the events of the past week, highlighting key performance areas and providing feedback on corrective and/or preventive actions taken.

3.5.4 Non-Conformance Report

A Non-Conformance Report (NCR) will be issued to the employees and Contractors as a final step towards rectifying a failure in complying with a requirement of the EMPr. This will be issued by the SM to the Contractor in writing, as advised by the ECO. Preceding the issuing of an NCR, the employees and Contractors must be given an opportunity to rectify the issue.

Should the ECO, SM or his/her delegate assess an incident or issue and find it to be significant (e.g. non-repairable damage to the environment), it will be reported to the relevant authorities and immediately escalated to the level of an NCR. The following information should be recorded in the NCR:

- Details of non-conformance;
- Any plant or equipment involved;
- Any chemicals or hazardous substances involved;
- Work procedures not followed;
- Any other physical aspects.
- Nature of the risk.
- Actions agreed to by all parties following consultation to adequately address the non-conformance in terms of specific control measures and should take the hierarchy of controls into account.
- Agreed timeframe by which the actions documented in the NCR must be carried out.
- ECO should verify that the agreed actions have taken place by the agreed completion date, when completed satisfactorily; the ECO and Contractor should sign the Close-Out portion of the Non-Conformance Form and file it with the contract documentation.

3.5.5 Environmental Emergency Response

The Contractor's environmental emergency procedures must ensure appropriate responses to unexpected / accidental actions / incidents that could cause environmental impacts. Such incidents may include:

- Accidental discharges to water (i.e. into the watercourse) and land;
- Accidental spillage of hazardous substances (typically oil, petrol, and diesel);
- Accidental toxic emissions into the air; and
- Specific environmental and ecosystem effects from accidental releases or incidents.

The Environmental Emergency Response Plan is separate to the Health and Safety Plan as it is aimed at responding specifically to environmental incidents and must ensure and include the following:

- Construction employees shall be adequately trained in terms of incidents and emergency situations;
- Details of the organisation (i.e. manpower) and responsibilities, accountability and liability of personnel;
- A list of key personnel and contact numbers;
- Details of emergency services (e.g. the fire department / on-site fire detail, spill clean-up services) shall be listed;
- Internal and external communication plans, including prescribed reporting procedures;
- Actions to be taken in the event of different types of emergencies;
- Incident recording, progress reporting and remediation measures to be implemented; and
- Information on hazardous materials, including the potential impact associated with each, and measures to be taken in the event of accidental release (Material Safety Data Sheets and relevant procedures).

The Contractor and their sub-contractor(s) must comply with the environmental emergency preparedness and incident and accident-reporting requirements as per the relevant legal requirements.

3.5.6 Method Statements

It is a statutory requirement to ensure the wellbeing of employees and the environment. To allow the mitigation measures in this document to be implemented, task-specific method statements should be developed for each set of tasks.

A Method Statement details how a process will be carried out, detailing possible dangers/risks, and the methods of control required.

- Type of construction activity;
- Timing and location of the activity;
- Construction procedures;
- Materials and equipment to be used;
- Transportation of the equipment to / from site;
- How equipment / material will be moved while on site;
- Location and extent of construction site office and storage areas;
- Identification of impacts that might result from the construction activity;
- Methodology and/or specifications for impact prevention / containment;
- Methodology for environmental monitoring;
- Emergency/disaster incident and reaction procedures (required to be demonstrated); and
- Rehabilitation procedures and continued maintenance of the impacted environment.

The Contractor will be accountable for all actions taken in non-compliance of the approved Method Statements. The Contractor shall keep all the Method Statements and subsequent revisions on file, copies of which must be distributed to all relevant personnel for implementation.

As a minimum the following Method Statements will be required to be generated:

- Bunding;
- Construction site and office/yard establishment;
- Cement mixing / concrete batching / bentonite mixing;
- Contaminated water;
- Dust;
- Environmental awareness course(s);
- Environmental monitoring;
- Erosion control;
- Fire, hazardous and/or poisonous substances;
- Fuels and fuel spills (may form part of the item above);
- Personnel, public and animal safety;
- Rehabilitation of modified environment(s);
- Solid and liquid waste management;
- Air Quality Management;
- Sources of materials (including MSDSs);
- Top-soil management; and,
- Wash bay areas.

3.5.7 Public Communication and Liaison with I&APs

The Developer must ensure that the adjacent landowners and all I&APs are informed and updated throughout the construction and operational phases.

Sufficient signage should be erected around the site (including at the entrance), informing the public of the construction activities taking place. The signboards should include the following information:

- The name of the Contractor.

- The name and contact details of the site representative to be contacted in the event of emergencies or complaint registration.

4 ENVIRONMENTAL AWARENESS PLAN

Eskom is committed to promoting and implementing sustainability throughout their operations. As part of this commitment, the UCG team recognises the importance of making all employees aware of the potential environmental impacts that could result from conducting their jobs and how this potential can be minimised through effective training. Environmental awareness of the employees at the UCG project will be provided by implementing environmental awareness training in the following forums:

- SHEQ meetings (monthly);
- Induction courses (annually);
- Open days (*ad hoc*); and
- Environmental awareness courses (*ad hoc*).

Induction will ensure that all personnel are aware of the environment in which they operate and what environmental aspects require attention during their daily operations. Additionally *ad hoc* open days and training courses for personnel will be undertaken if and when required to strengthen the personnel's understanding of environmental issues.

The method and medium of communication during the environmental meetings will be determined by the site manager facilitating the meetings. The topics discussed in meetings will be recorded, with all employees present signing an attendance register.

As potential environmental impacts differ in each department of the operation, the environmental topics selected for discussion can either be:

- General topics that are applicable to the entire operation;
- Area specific topics as identified in the impacts assessment section of the EIAR, or
- Topics that can be "taken home" and implemented off-site.

4.1 General Topics

There are a number of environmental impacts resulting from the UCG project that are caused by more than one activity and are therefore considered to be general impacts that are applicable throughout the project. These topics should be discussed at all areas. General topics include, but are not limited to, the following:

- Water consumption and conservation;
- Potential for water pollution and the related impacts (including health-related);
- Dust generation related impacts (including health-related) ;
- Noise generation and related impact (including health-related);
- Waste minimised and recycling;
- Practical training regarding the clean-up of a major and minor hydrocarbon spills;
- Practical training on using a fire extinguisher; and
- Alien vegetation identification and removal, and the importance of indigenous vegetation.

4.2 Activity Specific Topics

Some departments may have environmental impacts that are unique to that area. These must be addressed in the SHEQ meetings. Area specific topics include, but are not limited to those impacts which are ranked as having a negative “medium” to “high significance” as determined in the EIA study. Some of these topics may be a repeat of those covered under general topics.

- Stormwater management;
- Identification and management of erosion;
- Water consumption and conservation;
- Vehicle emissions and related impacts (including health related)
- Practical training regarding the clean-up of a major and minor hydrocarbon spills;
- The importance of the waste management system and implementing good housekeeping; and
- Dust generation and why and how to reduce dust.

4.3 Take-home Topics

Environmental awareness should not stop at the work place. Many of the concepts learned at work can be applied to employees’ life style at home. Topics that can be covered under “take home topics” include, but are not limited to:

- Water consumption and conservation;
- Energy consumption and conservation “49M Remember your power”; and
- Waste minimisation and recycling - “Reduce, Reuse and Recycle”.

5 ENVIRONMENTAL MANAGEMENT PROGRAMME: PRE-CONSTRUCTION

Requirements for the pre-construction phase include:

- Proper, timeous, and continuous liaison between the developer, the Contractor and landowners to ensure all parties are appropriately informed at all times.
- The adjacent landowners must be informed of the starting date of construction as well as the phases in which the construction shall take place.
- The Contractor must adhere to all conditions of contract including the EMPr and environmental license conditions.
- Adequate planning of the construction programme to allow for disruptions due to rain and very wet conditions.
- Where existing private roads are in a bad state of repair, such roads' condition shall be documented before they are used for construction purposes. This will allow for easy assessment of any damage to the roads which may result from the construction process. If necessary some repairs should be done to prevent damage to equipment.
- All manmade as well as natural (vegetation) structures outside the boundary of the servitude shall be protected against damage at all times and any damage shall be rectified immediately.
- Proper documentation and record keeping of all complaints and actions taken.
- A formal communications protocol should be set up during this phase. The aim of the protocol should be to ensure that effective communication on key issues that may arise during construction be maintained between key parties such as the ECO, EO, SM and Contractor. The protocol should also ensure that concerns / issues raised by I&APs are formally recorded and considered and where necessary acted upon. If necessary, a forum for communicating with key stakeholders on a regular basis may need to be set up. This could be done through an Environmental Monitoring Committee that would meet on a regular basis. The communications protocol should be maintained throughout the construction phase.

5.1 General controls for pre-construction

Table 5: Pre-construction – general activities

ACTIVITY	ENVIRONMENTAL MEASURES AND CONTROLS	FREQUENCY	RESPONSIBLE PERSON(S)
Pre-construction	• The Employer must ensure that this EMPr forms part of any contractual agreements with a contractor(s) and sub-contractors for the execution of the proposed project. Local labour and contractors must be used wherever possible. • Appoint an independent ECO. • Before construction begins, all areas to be developed must be clearly demarcated with fencing.		SM MC & ECO
	• Confirm with ECO, suitable sites for the storage areas of materials. • Unskilled labourers should be drawn from the local market. • Training of site staff. • Environmental awareness training for construction staff, concerning the prevention of accidental spillage of hazardous chemicals and oil; pollution of water resources (both surface and groundwater), air pollution and litter control and identification of archaeological artefacts. • The SM shall ensure that the training and capabilities of the Contractor's site staff are adequate to carry out the designated tasks • Staff operating equipment (such as excavators, loaders, etc.) shall be adequately trained and sensitised to any potential hazards associated with their tasks. • No operator shall be permitted to operate critical items of mechanical equipment without having been trained by the Contractor and certified competent by the SM. • Staff should be educated as to the need to refrain from indiscriminate waste disposal and/or pollution of local soil and water resources and receive the necessary safety training.		ECO, SM

5.2 Plant and Animal Rescue and Protection

Table 6: Pre-construction – plant and animal rescue and protection activities

ACTIVITY	ENVIRONMENTAL MEASURES AND CONTROLS	FREQUENCY	RESPONSIBLE PERSON(S)
Pre-construction	• A plant / animal rescue and protection plan must be compiled by an Ecologist and implemented by the EO prior to construction. • An existing programme is in place where Sungazer lizards are located and removed to a suitable locality prior to the commencement of construction activities. This programme should be expanded to include other Red Data fauna and flora species (and those of provincial importance (Orange Data Species)) and relevant identification and location programmes should be launched in the summer period when these species are most prevalent. • Removal and disturbance of protected plants and animals is subject to permitting requirements from the relevant authorities.	Prior to and during construction	ECO, EO and Ecologist

5.3 Open Space Management

Table 7: Pre-construction – open space management

ACTIVITY	ENVIRONMENTAL MEASURES AND CONTROLS	FREQUENCY	RESPONSIBLE PERSON(S)

Pre-construction	• Determination of areas to be controlled as open space within the greater site. Such areas to ensure connectivity of areas of conservation importance (i.e. corridors, islands, and maintenance of large blocks of functional open space).
	• Determine level of impact that will be allowed per area of designated open space, as linked to the sensitivity mapping (**Annexure A**) process carried out.
	• Ensure ECO has knowledge of when specific access activities may trigger permitting processes outside of those already in hand.
	• Link controls to ensure that importance of open space areas are not compromised.
	  ○ Open space areas deemed "no go" – strict access controls, delineation required, fencing off from direct access, ensure agricultural species (e.g. cattle) excluded from such areas.
	  ▪ Determine an appropriate buffer area around such areas and indicate it on the site plans.
	  ▪ Note: deemed highly sensitive (species and ecosystem groupings), e.g. existing wetlands.
	  ○ Minimal access with pre-approval – limited access with pre-approval only, delineation but will not require formal fencing off, if cattle allowed in such areas then their impact should be monitored and removed if the quality of the vegetation is significantly impacted on.
	  ▪ Determine an appropriate buffer area around such areas and indicate it on the site plans.
	  ▪ Note: areas composed of virgin or close-to-virgin vegetation that although do not include Red Data species are considered to be good examples of the vegetation type e.g. grassland).
		Prior to and during construction	ECO and Ecologist

6 ENVIRONMENTAL MANAGEMENT PROGRAMME: CONSTRUCTION

6.1 Site Preparation, Construction Camp, Storage of Materials and Health & Safety

Table 8: Construction – Site preparation, construction camp, storage of materials, and, health and safety

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Site preparation activities	• Site clearing must take place in a phased matter, as and when required. • Areas which are not to be constructed on within two (2) months' time must not be cleared so as to reduce risk of erosion. • The area to be cleared must be clearly demarcated and this footprint strictly maintained. • The necessary erosion control measures must be implemented in areas where these risks are more prevalent. These include watercourses.	Weekly	MC
Storage of materials including hazardous materials: improper storage of material including hazardous materials have the potential to pollute groundwater and surface water resources as well as soils	• Choice of location for storage areas must take into account prevailing winds, distances to water bodies, general on site topography and water erosion potential of the soil. Impervious surfaces must be provided where necessary. • Storage areas must be designated, demarcated and fenced. • Storage areas should be secure so as to minimize the risk of crime. They should also be safe from access by animals etc. • Fire prevention facilities (e.g. fire extinguishers) must be present at all storage facilities. • Proper storage facilities for the storage of oils, paints, grease, fuels, chemicals and any hazardous materials to be used must be provided to prevent the migration of spillage into the ground and groundwater regime around the temporary storage area(s). These pollution prevention measures for storage should include a bund wall high enough to contain at least 110% of any stored volume, and this should be sited away from drainage lines in a site set with the approval of the SM and ECO. • Any water that collects in the bund must not be allowed to stand and must be removed immediately and disposed of according to the stormwater management plan (**Annexure B)**. • All fuel storage tanks (temporary or permanent) and associated facilities must be designed and installed in accordance with the relevant oil industry standards, National codes and other relevant requirements. • Areas for storage of fuels and other flammable materials must comply with standard fire safety regulations and may require the approval of the relevant Fire and Rescue Officer.	Weekly - Biweekly	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	• Flammable fuel and gas must be well separated from all welding workshops, assembly plants and loading bays where ignition of gas by an accidental spark may cause an explosion or fire. • Symbolic safety signs depicting “No Smoking”, “No Naked Flames” and “Danger” are to be prominently displayed in and around the fuel storage area. • The capacity of the tank must be clearly displayed and the product contained within the tank clearly identified. • There must be adequate fire-fighting equipment (e.g. fire extinguishers) at the fuel storage and dispensing area or areas. • The rated capacity of tanks must provide sufficient capacity to permit expansion of the product contained therein by the rise in temperature during storage. • Any electrical or petrol-driven pump must be equipped and positioned so as not to cause any danger of ignition of the product. • If fuel is dispensed from 200 litre drums, the proper dispensing equipment must be used. The drum must not be tipped in order to dispense fuel. The dispensing mechanism of the fuel storage tank must be stored in a waterproof container when not in use. • These storage facilities (including any tanks) must be on an impermeable surface that is protected from the ingress of stormwater from surrounding areas in order to ensure that accidental spillage does not pollute local soil or water resources. • Clear signage must be placed at all storage areas containing hazardous substances / materials. • Material Safety Data Sheets (MSDSs) shall be readily available on site for all chemicals and hazardous substances to be used on site. Where possible the available, MSDSs should additionally include information on ecological impacts and measures to minimise negative environmental impacts during accidental releases or escapes. • Storage areas containing hazardous substances / materials must be clearly signed. • Staff dealing with these materials / substances must be aware of their potential impacts and follow the appropriate safety measures. • A suitable Waste Disposal Contractor must be employed to remove waste oil. These wastes should only be disposed of at a licensed landfill site designed to handle hazardous wastes. • The Contractor must ensure that its staff is made aware of the health risks associated with any hazardous substances used and has been provided with the appropriate protective clothing / equipment in case of spillages or accidents and have received the necessary training.		

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	• All excess cement and concrete mixes are to be contained on the construction site contained in a bund wall, prior to usage for road maintenance and rehabilitation. • Any spillage, which may occur, shall be investigated and immediate action must be taken. This must also be reported to the ECO and DEA as soon as reasonably possible, but within 24 hours. • Keep written records detailing the type of spill, the corrective and remedial measures implemented in the stopping or reduction of the spill, and the cleanup of the spill. Such progress reporting is important for monitoring and auditing purposes and the written reports may afterwards be used for training purposes in an effort to prevent similar future occurrences.		
Construction: Health and Safety of construction workers and site staff	• The Health and Safety Plan needs to be developed for the project in respect of construction worker safety and this plan must be adhered to at all times. • The Contractor must adhere to the prescriptions of the relevant health and safety legislation and standards. The contractor must familiarise himself and his employees with the contents of the aforementioned legislation. • First Aid facilities must be on hand at all times in accordance with international practice (e.g. First Aid Boxes containing necessary equipment). • The Contractor must implement adequate and mandatory safety precautions relating to all aspects of the construction. Such safety measures and work procedures/instructions must be communicated to construction workers. • The wearing of PPE on site is mandatory for all personnel and construction team members. Minimum requirements must include the wearing of an approved safety helmet, safety boots and dust masks, ear plugs, etc. where appropriate and as identified by the Baseline Risk Assessment for the specific task. • PPE signs should be erected on site at the areas where it is required and the integrity and availability of the signs must be maintained. • All personnel must be trained in basic site safety procedures. • The construction staff handling chemicals or hazardous materials must be trained in the use of the substances and the environmental, health and safety consequences of incidents. • The Contractor must design, test/exercise appropriate emergency preparedness programmes (plans, schedules, procedures and methods) for addressing environmental accidents, incidents and events such as spills of fuel, oil or lubricants; fires etc. • Smoking will only be allowed at designated areas.	Weekly	MC, SM and SO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	• Overloading of equipment and construction vehicles is strictly prohibited to avoid accidents. Eskom specification/policy on transport of personnel to be adhered to. • Safety files must be compiled and signed off by SM prior to commencement of construction. • Adequate provision of ablutions for construction employees.		

6.2 Drilling of Wells

Table 9: Construction – Drilling of wells (i.e. gasifiers)

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Drilling of wells: construction of injection and production wells into the coal seam resulting in the disturbance of soil cover including possible impacts to fauna and flora; possible collapse of wells.	• Development of a mining methodology / plan that will describe the specifications (i.e. depth, size, distance between wells), sequencing and location of wells. • Drilling to be done in accordance with the Process Well Drilling Procedure (UCG PC 2073-1381) – **Annexure C**. • Proper surface casing, marking thereof and rehabilitation of surrounding land to be done after moving from the site • All wells must be sealed all the way into the coal seam and grouted with cement. • A lot of care should be taken during well construction to ensure that there are no air voids and no contacts points with the upper aquifer. • Drilling cuttings collected and used for road maintenance, natural resource so not hazardous.	Weekly	DC & ET

6.3 Hydrogeology

Table 10: Construction – Hydrogeology

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Construction activities related to shallow groundwater contamination: • **Spillage of fuels, lubricants and other chemicals.** • **Construction equipment, vehicles, workshop and wash bay areas will be a likely source of pollution as a non-point source.** • **Lack of provision of ablutions that may lead to the creation of informal ablutions.**	• Chemicals to be stored in bunded areas. • Adequate provision of ablutions for construction employees. • Groundwater monitoring to confirm any impacts. • Clean-up of spills as soon as they occur and maintain an incident register. • Any spillage, which may occur, shall be investigated and immediate action must be taken. This must also be reported to the ECO and DEA as soon as reasonably possible, but within 24 hours. • Keep MSDS records of chemicals in use up to date. • Implement appropriate actions and measures to reduce or prevent contamination of the ground and surface water as a result of a spill of potentially hazardous substances. • Keep written records detailing the type of spill, the corrective and remedial measures implemented in the stopping or reduction of the spill, and the clean-up of the spillage. Such progress reporting is important for monitoring and auditing purposes and the written reports may afterwards be used for training purposes in an effort to prevent similar future occurrences. • Groundwater monitoring both during and after operations will be required in order to ensure that there is a minimal impact to groundwater from the UCG operation.	Weekly	MC & ECO

6.4 Hydrology & Freshwater Resources

Table 11: Construction – Hydrology and Freshwater resources

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
• **Spillage of fuels, lubricants and other chemicals;** • **Inadequate stormwater management around the site; the dumping of construction material, including fill**	• Bunded areas should be used to store chemicals. • Bund capacity to be a minimum of 110% of total capacity stored. • Clean-up of spills as soon as they occur. • Clean-up methods to be appropriate to the nature of the spill.	Daily – Weekly	MC & ECO Ecologist

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
or excavated material into, or close to surface water features that may then be washed into these features; • **Construction-related activities such as cement batching;** • **Construction equipment, vehicles and workshop areas will be a likely source of pollution as a non-point source; and** • **Lack of provision of ablutions that may lead to the creation of 'informal ablutions' within or close to a surface water resource.** **The above aspects could potentially lead to contaminated run-off having a negative effect on water resources.**	• Waste material generated post-spill to be stored in such a way that it does not cause further damage to the environment and be bioremediated and ultimately rehabilitated. • Keep construction activities away from the Geelklipspruit – the buffer area from the watercourse shall be a minimum of 50 m from the watercourse and depending on the their sensitivity either 50 m; 100 or 200 m from wetlands, and may be set at a greater distance on consultation with the ecologist. • Adequate provision of ablutions for construction employees at a minimum ratio of 1:15, and at a reasonable accessible distance from the active working areas. • Ablution facilities to be carefully positions so as to not be close to preferential stormwater flow paths to watercourses or wetland areas. • Access to ablution facilities for service purposes to be integrated into the stormwater control plan. • In order to ensure that the medium to high impacts are mitigated, the stormwater management plan (**Annexure B**) must be complied with.		
Water quality impairment: • **In a direct sense, water quality impacts by construction equipment, vehicles and material will be a likely water quality impairment point source.** • **From an indirect and non-point source, run-off of building materials (e.g. cement) into the river during construction of the hard surface development structures / bridge is also possible.**	• Run-off from the construction site should be prevented from directly entering the Geelklipspruit River Catchment as far as possible by implementing features such as the use of applicable prevention measures. • Construction should also preferably take place during the drier months when run-off is low.	During construction and operation the surface water monitoring programme (four surface water monitoring points on site) must be kept in place and kept going until after decommissioning. Monitoring should be done on a monthly basis for all the parameters that are currently being undertaken and any further that would be written into a water use licence.	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Groundwater influx during construction that could affect groundwater quality which could manifest in surface water sources.	• Ensure that UCG has limited connectivity with other water resources. • Shutdown procedures must be followed. The gasification zone must be allowed to cool slowly, while continued gas extraction takes place until the gasification process stops completely. • Post-gasification reactor flushing - It may be advantageous to pump water from the reactor post gasification for two reasons; firstly it ensures that groundwater flow is maintained towards the reactor by lowering the local hydrostatic pressure and secondly, it removes contaminants from the reactor so that they may be treated and disposed of at the surface; • Monitoring borehole design and construction as well as continued groundwater monitoring after closure. • No infrastructure should encroach into any major drainage lines. • Restrict construction activities to the drier winter months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development.	Weekly	MC & ECO
Construction activities resulting in: • **Impaired water quality.** • **Impact on riparian vegetation.** • **Build up of contaminants in sediment leading to the creation of a sediment sink and chronic source of potential water contamination.** • **Increased turbidity of water.**	• Very clear and well managed clean and dirty water separation must take place; • Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of clean water runoff areas and the concomitant recharge of streams in the area. • Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project. • All hazardous chemicals must be stored on bunded surfaces. • Ensure that all spills are immediately cleaned up.	Weekly & then on-going aquatic ecological monitoring must take place on a 6 monthly basis	MC & ECO & Aquatic Assessor
• **Earthworks in the vicinity of drainage systems leading to increased run-off and erosion and altered run-off patterns.** • **Construction of the service road**	• Limit the footprint area of the construction activity to what is absolutely essential in order to minimise the loss of aquatic habitats in the area. • Keep all demarcated sensitive zones outside of the construction area off limits during the construction phase of the project;	Weekly & then on-going aquatic ecological monitoring must take place on a 6 monthly basis	MC & ECO & Aquatic Assessor

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
altering stream flow patterns and water velocities. • **Construction of bridge crossings altering stream flow patterns and water velocities.** • **Placement of infrastructure within riverine features with special mention of road crossings and bridges.** **The following potential impacts may occur:** • **Erosion and incision of riparian zone.** • **Sedimentation and loss of natural substrates.** • **Altered stream channel flows.** • **Increased turbidity of water.** • **Loss of aquatic refugia.** • **Altered substrate conditions due to the deposition of silt.** • **Altered depth and flow regimes in the major drainage systems.** • **Loss of flow sensitive and water quality sensitive macroinvertebrates and fish.** • **Loss of riparian vegetation species.** • **Alien vegetation proliferation.**	• Permit only essential construction personnel within 32 m of all riparian systems. • No infrastructure should encroach into any major drainage lines. • Restrict construction activities to the drier winter months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development and aim for completion in early spring at which time re-vegetation should take place allowing for a full summer growing season to become established.		

6.5 Wetlands

Table 12: Construction – Wetlands

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON/S

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON/S
Construction activities across or within wetlands: • **Irresponsible construction practices could lead to the pollution of wetlands and rivers (e.g. faecal contamination, or pollution of surface water through hydrocarbons).** • **Poor stormwater management could lead to the siltation (pollution) of surface waters.** • **Temporary accesses across wetlands / rivers could cause hydrological and morphological impacts and degrade the resource quality.**	• Very sensitive wetlands and their catchments must be avoided. No UCG mining should occur within the stipulated buffer areas i.e. no undermining should occur in the buffer. The following buffers are applicable: – Very High wetland sensitivity – 200 m buffer should be included as part of the buffer. – High wetland sensitivity – a 100 m buffer beyond the boundaries of the wetland. – Moderately High to Moderate wetland sensitivity – a 50 m buffer beyond the boundaries of the wetland. • No storage areas for hazardous materials (such as fuel), parking areas for vehicles or any temporary toilets should be located within a 50 m zone beyond the buffer (i.e. 150 m from a high sensitivity wetland, 100 m from a moderate high to moderate sensitivity wetland). • No batching or chemical / fuel storage areas to be located within any surface water feature or associated buffer. • A construction stormwater management plan (linked to **Annexure B**) to be devised to prevent silt ingress into surface water features. • Pipeline/road-related construction must occur in the drier winter months. At this time the predominantly vertic soils will be drier in many parts of the wetland, and less likely to be compacted by machinery. Vegetation is also dormant and less likely to be damaged. • A form of running track should be constructed through wetlands adjacent to the pipeline/road alignment, especially if heavy tracked machinery is going to access the wetland to undertake construction. The running track would protect underlying soils and vegetation, especially in wetter parts of the wetland, and would facilitate the access of heavy machinery in these areas • Pipeline / road design should take into account the potential for flooding and spate flows in wetlands, especially within valley bottom wetlands and along riverine corridors. Due to the nature of runoff in the study area, high flow peaks are likely to occur in most of the valley bottom wetlands in the study area. It is recommended that design be undertaken to withstand a 1:100 year flood. • Alignment of pipelines/roads should aim to cross wetlands perpendicularly to the direction of flow in the wetland, as this is usually the shortest route across the wetland. • Alignment of pipelines/roads should aim to cross wetlands at their narrowest point, where possible, as wetlands are often channelised at these points, making a single span that does not physically affect the wetlands possible. • No temporary construction accesses to be constructed through any surface water feature and no machinery to enter any wetland unless authorised under the EMPr by the ECO as part of a construction activity.	Weekly	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON/S
	• The dumping of construction material, including fill or excavated material into, or close to surface water features that may then be washed into these features.		

6.6 Soils

Table 13: Construction – Soils

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Drilling of holes and associated vehicle movement.	• Vehicle movement has to be restricted to existing roads in order to prevent degradation of any additional land or parts of land. • Vehicle movement has to be restricted to an absolute minimum that is required for the mining exercise. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to an increased erosion risk. • Drill rigs should remain stationary for as long a time as possible without unnecessary movement. • Drill rig is fitted with landing legs and baseplates to prevent it from sinking into the soil. Tyres are sometimes lifted into the air.	Weekly	DC
Construction of manifold system, pipes and other infrastructure.	• Vehicle movement has to be restricted to existing roads in order to prevent degradation of any additional land or parts of land. • Vehicle movement has to be restricted to an absolute minimum that is required for the mining exercise. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to an increased erosion risk.	Weekly	MC
Soil stripping, removal and stockpiling.	• The Contractor should, prior to the commencement of earthworks determine the average depth of topsoil, and agree on this with the ECO. The full depth of topsoil should be stripped from areas affected by construction and related activities prior to the commencement of major earthworks. This should include the building footprints, working areas and storage areas. Topsoil must be reused where possible to rehabilitate disturbed areas. • Care must be taken not to mix topsoil and subsoil during stripping. • Removed polluted topsoil should be bioremediated on site • Remove and store topsoil separately in areas where excavation/degradation takes place. Topsoil should be used for rehabilitation purposes in order to facilitate re-growth of species that occur naturally in the area. • No soil stripping must take place on areas within the site that the Contractor does not require	Weekly	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	for construction works or areas of retained vegetation. • Subsoil and overburden should, in all construction and lay down areas, be stockpiled separately to be returned for backfilling in the correct soil horizon order. • Stockpiles should not be situated such that they obstruct natural water pathways and drainage channels. • If stockpiles are exposed to windy conditions or heavy rain, they should be covered by vegetation local to the area. • Where contamination of soil is expected, analysis must be done prior to disposal of excess soil to determine the appropriate disposal route.		
Vehicles operation on site: spillage of lubricants, cement and petroleum products.	• Vehicles and machinery must be properly maintained to keep oil and diesel leaks in check. • Depending on the nature and extent of the spill, contaminated soil must be either excavated or treated on-site. • Contaminated soils will be bio-remediated as per Bioremediation of Hydrocarbon Contaminated Soil, Work Instruction Unique Identifier: UCG WN 2073 – 15150 – **Annexure D.** • No vehicles transporting concrete to the site may be washed on site. • If a batching plant is necessary, run-off should be managed effectively to avoid contamination of other areas of the site. Untreated run-off from the batch plant must not be allowed to get into the stormwater system or any rivers, streams, wetlands or existing erosion channels / dongas.	Weekly	MC

6.7 Erosion Management and Control

Table 14: Construction – Erosion management and control

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Vegetation removal and exposed soils: owing to the nature of the soils in the study area (i.e. generally shallow with thin soil profiles overlying weathered rock or distinctly higher clay content sub-soils) the soils tend to hold limited quantities of water and due to the poor drainage, are very susceptible to erosion.	• Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in areas of existing erosion. • No vehicles should be allowed to cross rivers or streams in any area other than an approved crossing, taking care to prevent any impact (particularly erosion) in a surrounding habitat. • Disturbed areas of natural vegetation as well as cut and fills must be rehabilitated immediately to prevent soil erosion. • The use of erosion control measures must be implemented in areas that are susceptible to erosion. • Other erosion control measures that can be implemented are: – Brush packing with cleared vegetation; – Mulch, stone chip packing; – Planting of vegetation; or – Hydroseeding / hand sowing. • Sensitive areas need to be identified prior to construction so that the necessary precautions can be implemented. • All erosion control mechanisms need to be regularly maintained. • Sealing of topsoil and subsoil stockpiles to prevent wind and water erosion of soil surfaces. • Retention of vegetation where possible to avoid soil erosion. • Vegetation clearance should be phased to ensure that the minimum area of soil is exposed to potential erosion at any one time. • Where possible re-vegetation of disturbed surfaces should occur immediately after construction activities are completed. • No impediment to the natural water flow other than approved erosion control works is permitted. • Stockpiles not used in three (3) months after stripping must be seeded to prevent dust and erosion. • Vehicle movement has to be restricted to an absolute minimum that is required for the mining exercise. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to an increased erosion risk.	Weekly initially – Bi-weekly	MC & ECO

6.8 Fauna and Flora

Table 15: Construction – Fauna and flora

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Clearing of study area for construction of infrastructure: destruction of conservation important flora taxa.	• Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in areas that might be conducive to soil erosion, such as the destabilizing of substrate in areas of high slopes, riparian zones, etc. • Demarcate construction areas in order to control movement of personnel, vehicles and provide boundaries for construction sites in order to limit spread of impacts. • Disturbance of vegetation must be limited only to areas of construction. • The removal or picking of any protected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with, unless agreed to by the ECO. • Removal and disturbance of protected plants and animals is subject to permitting requirements from the relevant authorities. • Limit construction, maintenance and inspection activities to dry periods when Red Data species of the area are most likely to be absent or hibernating, limiting potential impacts to a large extent. • Limit loss of endangered (Sowetan Highveld Grassland) and vulnerable grassland vegetation (Amersfoort Clay Highveld Grassland). • The use of natural vegetation for fire making purposes is strictly prohibited.	Weekly	MC & ECO
Construction impacts on conservation important fauna species: the presence of Red Data fauna species was confirmed during the site investigations.	• Implement a relocation plan for the location and removal of Sungazer Lizards, but only from sites that will be directly affected. Individuals present nearby activity sites should be conserved in situ. • Limit construction, maintenance and inspection activities to dry periods when Red Data species of the area are most likely to be absent or hibernating, limiting potential impacts to a large extent. • Removal and disturbance of protected plants and animals is subject to permitting requirements from the relevant authorities.	Weekly - Biweekly	SM, MC, ECO, Ecologist
Destruction of sensitive/pristine habitat types – extensive parts of the study area are regarded highly sensitive and are highly likely	• Demarcate construction areas in order to control movement of personnel, vehicles, providing boundaries for construction sites in order to limit spread of impacts. • Disturbance of vegetation must be limited only to areas of construction. • Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in areas that might be conducive to soil erosion,	Weekly - Biweekly	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
to be occupied by a diverse species composition as well as flora and fauna species of conservation importance.	such as the destabilizing of substrate in areas of high slopes, riparian zones. • Limit construction, maintenance and inspection activities to dry periods when Red Data species of the area are most likely to be absent or hibernating, limiting potential impacts to a large extent.		
Construction impacts on common fauna species and faunal interactions with structures, servitudes and personnel.	• No animal may be hunted, trapped or killed for any purpose whatsoever. • In the event that animals are present that may pose a risk to human safety, a suitable animal handler must be requested to remove the animal in an environmentally responsible manner. This specifically refers to snakes and scorpions. • Demarcate construction areas in order to control movement of personnel, vehicles and provide boundaries for construction sites in order to limit spread of impacts.	Weekly	MC & ECO

6.9 Alien Invasive Vegetation Management

Table 16: Construction – Alien invasive vegetation management

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Alien invasive vegetation establishment.	• Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Environmental monitoring should be conducted at least twice per year (Summer, Winter). • The establishment and regrowth of invasive and alien vegetation must be controlled after the removal of grass. • All declared aliens must be identified and managed in accordance with the National Environmental Management Biodiversity Act (Act No. 10 of 2004) and Regulations. Weed control methods should be confirmed with the Eskom Environmental Officer to prevent any undesirable secondary impacts. • Monitoring the potential spread of declared weeds and invasive alien vegetation to neighbouring land and protecting the agricultural resources and soil conservation works are regulated by the National Environmental Management Biodiversity Act (Act No. 10 of 2004) and Regulations should be addressed on a continual basis. • Remove invasive and alien vegetation, particularly in vicinity of riparian zones where alien and invasive trees are known to occur. The implementation of a monitoring programme in this regard is recommended, being the responsibility of the ECO / ecologist.	Biweekly - Monthly	ECO & Ecologist

6.10 Re-vegetation and Rehabilitation Plan

Table 17: Construction – Re-vegetation and rehabilitation plan

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Re-vegetation and rehabilitation of areas utilised during construction.	• Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Environmental monitoring should be conducted at least twice per year (summer, winter). • Ensure proper surface restoration and re-sloping in order to prevent erosion, taking cognisance of local contours and landscaping. • Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation. • The re-vegetated areas (where possible), should be temporarily fenced to prevent damage by grazing animals. • Re-vegetated areas showing inadequate surface coverage (less than 30 % within eight months after re-vegetation) should be prepared and re-vegetated from scratch. • Damage to re-vegetated areas shall be repaired promptly. • Exotic weeds and invasive species that establish on the re-vegetated areas should be controlled to allow the grasses to properly establish.	Re-vegetated areas should be monitored every four months for the first 12 months and once a year thereafter for the maintenance period.	ECO

6.11 Open Space Management

Table 18: Construction – Open space management

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)

Impact / access to open space areas associated with the greater site.	• Level of control as per the classified open space areas (as per Table 7), to be complied with.
	  ○ Open space areas deemed “no go”:
	  ▪ Strict site specific access controls shall be complied with and linked to the determined delineated area. No access without pre-approval from the ECO and ecologist, and linked to a formal motivation for the need to access such area.
	  ▪ Appropriate “exclusion” mechanism e.g. fencing off from direct access (e.g. to ensure agricultural species (e.g. cattle) excluded from such areas), closure of access roads into such areas, ripping of existing footpaths and ensuring these paths are not re-established.
		Biweekly – Monthly, and prior to any requested access	ECO & ecologist

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	▪ Establish the approved buffer area around such areas and indicate it on the site plans. Link inappropriate access to such areas to the fine and penalty requirements in place on the site. ○ Minimal access with pre-approval: ▪ Limited-access controls shall be complied with and linked to the determined delineated area. Access with pre-approval only, delineation but will not require formal fencing off, if cattle allowed in such areas then their impact should be monitored and removed if the quality of the vegetation is significantly impacted on. ▪ Establish the approved buffer area around such areas and indicate it on the site plans. Link inappropriate access to such areas to the fine and penalty requirements in place on the site.		

6.12 New Service Road

Table 19: Construction – New service road specific

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Clearing of study area for construction of the new service road: destruction of conservation important flora taxa.	• Limit construction, maintenance and inspection activities to dry periods in order to curb occurrence/ augmentation of erosion in areas that might be conducive to soil erosion, such as the destabilizing of substrate in areas of high slopes, riparian zones, etc. • Demarcate construction areas in order to control movement of personnel, vehicles and provide boundaries for construction sites in order to limit spread of impacts. • Disturbance of vegetation must be limited only to areas of construction. • The removal or picking of any protected or unprotected plants shall not be permitted and no horticultural specimens (even within the demarcated working area) shall be removed, damaged or tampered with unless agreed to by the ECO. • Limit construction, maintenance and inspection activities to dry periods when Red Data species of the area are most likely to be absent or hibernating, limiting potential impacts to a large extent.	Weekly	MC & ECO
Construction impacts on conservation important fauna species: the presence of Red Data fauna species was	• Implement a relocation plan for the location and removal of Sungazer lizards, but only from sites that will be directly affected. Individuals present nearby activity sites should be conserved in situ. • Limit construction, maintenance and inspection activities to dry periods when Red Data	Weekly - Biweekly	SM, MC, ECO, Ecologist

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
confirmed during the site investigations.	species of the area are most likely to be absent or hibernating, limiting potential impacts to a large extent.		
Destruction of sensitive/pristine habitat types - wetlands.	• Existing access roads and tracks across wetlands must be used as far as possible, as these are typically associated with an existing impact on a wetland / stream. It is preferable for existing drifts / causeways to be upgraded rather than new road structures built into an un-impacted section of the wetland. • Where wetlands cannot be spanned by bridges, road design must incorporate a sufficient number and volume of culverts to allow flow within the wetland to pass under the road in as natural a manner as possible; i.e. flow within wetlands should be kept as diffuse as possible where diffuse flow occurs. • Road construction through wetlands must occur in the drier winter months. At this time the predominantly vertic soils will be drier in many parts of the wetland, and less likely to be compacted by machinery. Vegetation is also dormant and less likely to be damaged. There is likely to be less surface flow that could potentially carry silt and pollutants into the wetland, and which could act as an erosive force. • Road design should take into account the potential for flooding and spate flows in wetlands, especially within valley bottom wetlands and along riverine corridors. Due to the nature of runoff in the study area, high flow peaks are likely to occur in most of the valley bottom wetlands in the study area. It is recommended that design be undertaken to withstand a 1:100 year flood. • Alignment of roads should aim to cross wetlands perpendicularly to the direction of flow in the wetland, as this is usually the shortest route across the wetland. • Alignment of roads should aim to cross wetlands at their narrowest point, where possible, as wetlands are often channelised at these points. A smaller area of wetland would thus potentially be affected.	Weekly - Biweekly	MC & ECO

6.13 Waste Management

Table 20: Construction – Waste management

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Contamination of the surface and site with general and hazardous waste.	• An adequate number of general waste receptacles, including bins must be arranged around the site to collect all domestic refuse, and to minimise littering.	Weekly	MC, EO & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
General waste produced on site includes: • **Office waste (e.g. food waste, paper, plastic);** • **Operational waste (clean steel, wood, glass); and** • **General domestic waste (food, cardboards, paper, bottles, tins).** **Hazardous waste produced on site includes:** • **Waste sludge;** • **Spent activated carbon;** • **Oil and other lubricants, diesel, paints, solvent;** • **Containers that contained chemicals, oils or greases; and** • **Equipment, steel, other material (rags), soils, gravel and water contaminated by hazardous substances (oil, fuel, grease, chemicals or bitumen).**	• Bins should be clearly marked and lined for efficient control and safe disposal of waste. • A fenced area must be allocated for waste sorting and disposal on the site. • General waste produced on site is to be collected in skips for disposal at the Majuba Power Station or local municipal waste site. Hazardous waste is not to be mixed or combined with general waste earmarked for disposal at the municipal landfill site. • Under no circumstances is waste to be burnt or buried on site. • Waste bins should be cleaned out on a regular basis to prevent any windblown waste and/or visual disturbance. • All general waste must be removed from the site at regular intervals and disposed of in suitable waste receptacle. • Hazardous waste is to be disposed at a Permitted Hazardous Waste Landfill Site. The ECO must have as part of his/her records the waste manifest for each batch based disposal. • Hazardous waste bins must be clearly marked, stored in a contained area (or have a drip tray) and covered (either stored under a roof or the top of the container must be covered with a lid). • A hazardous waste disposal certificate must be obtained from the waste removal company as evidence of correct disposal. • In the case of a spill of hydrocarbons, chemicals or bituminous, the spill should be contained and cleaned up and the material together with any contaminated soil collected and bioremediated.		

6.14 Social

Table 21: Construction – Social issues

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Arrival of construction workers.	• Raise awareness amongst construction workers about local traditions and practices. • Inform local businesses that construction workers will move into the area to enable local businesses to plan for the extra demand. • Ensure that the local communities communicate their expectations of construction workers'	Weekly	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	behaviour with them.		
Possible inflow of unemployed job seekers.	• Ensure that employment procedures/polices are communicated to local stakeholders, especially community representative organisations and ward councillors. • Have clear rules and regulations for access to the construction site to control loitering. Consult with the local SAPS to establish standard operating procedures for the control and/or removal of loiterers at the construction site. • Construction workers should be clearly identifiable by wearing proper construction uniforms displaying the logo of the construction company. Construction workers could also be issued with identification tags. • The contractor should monitor areas where people gather in the field on a regular basis as this is normally the first indication that (informal) settlement might be established in the area. These people should be removed in co-operation with the local SAPS to prevent the formation and/or expansion of informal settlements in the area.	Weekly	SM
Change in community infrastructure (additional demand on services).	• Construction workers should be made aware of the limited capacity of the municipal services network. • Negotiations with the affected local municipalities must be conducted and a “demand-side management” should be implemented. • Sufficient portable chemical toilets should be provided on site (if applicable).	Monthly	SM, MC & ECO
Dissimilarity in social practises and alteration in family structure.	• Consult with the local municipality to establish a partnership as outlined in the municipality’s IDP (2009-2013). • An aggressive STI and HIV/AIDS awareness campaign should be launched, which is not only directed at construction workers but also at the community as a whole. • Access at the construction site should be controlled to prevent sex workers from either visiting and/or loitering at the construction village or the construction sites. • Local women should be empowered. This could be achieved by employing them to work on the project, which in turn would decrease their (financial) vulnerability.	Monthly	MC

6.15 Air Quality

Table 22: Construction – Air quality

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Dust and emissions	• Dust must be suppressed on the construction site and during the transportation of material	Daily	MC & ECO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
during construction generated by debris handling and debris piles, truck transport, bulldozing, general construction.	during dry periods by the regular application of water. Water used for this purpose must be used in quantities that will not result in the generation of run-off. • Loads could be covered to avoid loss of material in transport, especially if material is transported off site. • A speed limit of 30 km/hr should be set for all vehicles travelling over exposed areas. • During the transfer of materials, drop heights should be minimised to control the dispersion of mater being transferred. • Equipment used by the contractor must be maintained in good working order to prevent smoke emissions.		

6.16 Heritage, Archaeology and Palaeontology

Table 23: Construction – Heritage, archaeology and palaeontology

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON/S
Impact on identified farmsteads and homesteads, cemeteries, burial grounds and other features identified in the study area (old bridge, hunting blinds).	• Mitigation should take the form of isolating known sites and declare them as no-go zones with sufficient large buffer zones around them for protection. In exceptional cases mitigation can be implemented after required procedures have been followed. • The Contractors and workers should be notified that archaeological sites might be exposed during the construction activities. • Should any heritage artefacts be exposed during excavation, work on the area where the artefacts were discovered, shall cease immediately and the ECO shall be notified as soon as possible. • All discoveries shall be reported immediately to a heritage practitioner so that an investigation and evaluation of the finds can be made. Acting upon advice from these specialists, the ECO will advise the necessary actions to be taken. • Under no circumstances shall any artefacts be removed, destroyed or interfered with by anyone on the site. • Contractors and workers shall be advised of the penalties associated with the unlawful removal of cultural, historical, archaeological or palaeontological artefacts, as set out in the National Heritage Resources Act (Act No. 25 of 1999), Section 51. (1). • It is recommended that a responsible person (geologist, environmental officer, or other) regularly monitors the excavations, removes and collects fossil material that is found. The	Weekly	MC & ECO Archaeologist

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON/S
	fossils should then be given to an institute that is recognized by SAHRA as a repository for fossils. As there is no such repository in Mpumalanga the material could go to the Ditsong Museum or Council for Geosciences in Pretoria or the Bernard Price Institute for Palaeontological Research, University of the Witwatersrand in Johannesburg.		

6.17 Noise

Table 24: Construction – Noise

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Noise generation during construction.	• Provide all equipment with standard silencers. Maintain silencer units in vehicles and equipment in good working order. • Construction staff working in area where the 8-hour ambient noise levels exceed 85 dBA must have the appropriate Personal Protective Equipment (PPE). • Compliance with the provisions of SANS 10103 (rural areas) is required.	Weekly	MC & Safety Officer (SO)

6.18 Traffic Management and Transportation

Table 25: Construction – Traffic management and transportation

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Traffic and Transportation during construction.	• As per Eskom Policy, no person is allowed to drive more than 60 km/h on a gravel road. This is applicable only to the access roads on site. All areas within the site itself, has a reduced speed limit of 30 km/h due to the danger of driving into the pipeline. This is communicated to all persons by means of National Speed Signs. • All vehicles entering the UCG site are to be roadworthy. • Seatbelts are to be worn at all times. • When using heavy or large vehicles / equipment, “spotters” are to be present to assist the driver with his blind spots. • Pedestrians: – All pedestrians are to wear reflective vests when in the vicinity of moving machinery and vehicles (as per MHSA requirements). – Pedestrians are to avoid wherever possible moving over the vehicle routes.	Weekly	MC & SO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	– Pedestrians to be aware of their surroundings. • No person is allowed to transport any persons on the back of a LDV or Double Cab. • No unauthorised persons to operate Eskom vehicles. • Persons are to be authorised for the specific vehicle they are operating in terms of an Eskom Licence. • All vehicles have checklists that have to be completed before operation of the equipment commences. • Due to the UCG site being a Mining Site as per the Mine, Health and Safety Act, reverse parking is encouraged. • Any accident or damage to a vehicle are to be reported immediately as per Eskom Policies and Procedures.		

6.19 Visual

Table 26: Construction – Visual

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Excavation for permanent structures associated with the proposed development (e.g. the Gas Treatment Plant) could create temporary un-vegetated areas in the landscape that could create a visual contrast with the natural vegetation.	• Avoid unnecessary excavations / clearing of land and keep the construction footprint to a minimum. • Rehabilitate cleared areas as soon as possible.	Weekly	MC & ECO

7 ENVIRONMENTAL MANAGEMENT PROGRAMME: OPERATIONS

7.1 Geology

Table 27: Operations – Geology

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Production of syngas through the gasification process: impacts include: • **Subsidence and goafing.** • **High concentration gas accumulation in gasification chamber leading to underground explosions.**	• Ensure mining is done in accordance with the Mining Work Programme and the Environmental Management Programme. • Subsidence beacons will be installed to verify baseline information with regards to any movement of the ground surface area in and around the gasification area prior to any events. • The gasification process will be linked to specially designed process software to ensure early detection of upset/emergency conditions underground. • During the operational phase the gasification can be controlled and the flow of air into the well can be stopped thereby stopping the gasification process. • Ongoing geological and rock monitoring programmes are required to ensure that a high level of geological certainty, reliability and assurance is achieved and maintained. The existing geological database should be continuously updated when new geological data is acquired. Record should be kept of all changes that are made over time.	Daily Operator Logs	UCG Engineering Team & Geologist

7.2 Hydrogeology

Table 28: Operations – Hydrogeology

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Gasification activities and the impact on groundwater resources: • **Potential lowering of the shallow groundwater level in farmers' boreholes.** • **Contamination of the shallow groundwater.** • **Leaks of untreated water from pipelines may occur and impact on the shallow groundwater quality.**	• According to the current understanding of the hydrogeology, the B5 dolerite sill acts as a hydraulic barrier and no impact on the shallow groundwater levels is expected. The important aspect that will determine the potential impact is the stability of the rocks above the roof of the gasifier/cavity that will determine if goafing and/or subsidence will occur. The major mitigation measure is to develop the gasifier panels in such a way to ensure that subsidence does not occur. • Groundwater monitoring is important to identify potential impacts. Groundwater monitoring to be done as per *UCG: Revised Water Monitoring Programme (2013)* – **Annexure F**. • Any leaks should be fixed immediately and areas rehabilitated as needed.	Daily	SM & Hydrogeologist
Failure of production borehole casings.	• Ensure casing and grouting specifications are adhered to. • Groundwater monitoring is important to identify potential impacts. Operation pressure and temperature monitoring is critical in identifying potential casing failures. Groundwater monitoring to be done as per UCG: Revised Water Monitoring Programme (2013) – **Annexure F**. • In the event of UCG production borehole leaks: – Immediate actions for remediation of a leaking UCG production well include: ▪ Ensuring all operational staff are trained in the detection and response to the presence of UCG gas. ▪ Following an alert to a possible gas leak ensure the safety of all UCG staff, contractors, clients and associated bodies before entering the suspected gas leakage area. Consider the possible risks of exposure to leaking gas and exposure or contact with condensates. ▪ Confirm the presence of UCG gas with hand-held gas analysers. ▪ Establish the likely source of contamination, the likely duration of leak, the flow rates and the safe perimeter around the source beyond which personnel will not be exposure to unsafe level of	Daily Operator Logs	SM; UCG Engineering Team; UCG technology provider

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	contamination. ▪ Record date of and or duration period of product leak, as well as source and flow rate of contamination. ▪ Report the incident to the responsible line manager, who must initiate reporting as per Eskom's SHE procedures. ▪ Report the incident to the responsible hydrogeologist, and UCG technology provider. ▪ Barricade the perimeter of the contamination area by means of barrier tape, and install signage forbidding entry with the necessary Personal Protection Equipment (PPE). ▪ Inspect the source of contamination, and report findings to an ad-hoc technical committee appointed by the Site Manager or alternatively the Site Engineer. This committee will review the findings and recommend immediate actions to monitor the situation and prevent any further contamination of the identified area. The ad-hoc committee must recommend one or all of the remediation strategies listed below, as required. – Remediation measures, in the case of well casing failures or any other underground process contamination. These measures must be conducted in sequence as follows, with monitoring of gas leakage and condensate plume spread via monitoring wells: ▪ Hydraulic containment – water must be drawn into the UCG cavity to have it running at a substantially lower pressure than the surroundings. ▪ Pump-and-remove – wells within the contaminated area has to be pumped on a regular basis and the water removed for treatment. ▪ Bio-remediation – water with bio-remediation agent has to be introduced into the UCG well network. ▪ Air sparging – air has to be permeated through the leaking well into the surrounding strata, which assists in the natural breakdown of contaminants and accelerates the action of the bioremediation agent. ▪ Sweeping of the UCG Cavity and underground water bodies – by continuing the UCG process, albeit in a gradually reducing extent		

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	required for a controlled shutdown, contaminants are drawn back into the UCG cavity and swept to surface. – Longer term actions: ▪ Map out the surface area and record it in the form of a site lay out sketch. Calculate the area coverage in square meters. Take photographs where possible indicating the spread of contamination. ▪ The ad-hoc technical committee must initiate appropriate water sampling from the hydrogeology monitoring network. ▪ The ad-hoc technical committee, in conjunction with the responsible hydrogeologist and UCG technology provider must consider recommending a controlled shutdown of the UCG underground production cavity, if the risk of contamination spread is confirmed. This involves the de-pressurisation of the cavity, and commencement of the gradual sweeping and cleaning of the cavity. The estimated duration of this process is at least 12 months. ▪ The implication of this step implies loss of UCG production and interruption of UCG research, with further cost and time implications. The ad-hoc technical committee, in conjunction with the responsible hydrogeologist and UCG technology provider, must therefore prepare a detailed report of the situation, the implications and their recommendations. This report must be reported to the correct Eskom Executive manager, and determined by the prevailing Delegation of Authority according to the implications of the decision. ▪ The correct Eskom Executive manager will consider the report, implications and recommendations, and make an informed decision regarding the next action. – Closing Investigation: ▪ Irrespective of the final actions, Eskom will commence a detailed investigation into the root cause of the incident. This will include interaction with local and international experts, possible drilling of further monitoring boreholes, diagnostics, sampling, analyses and engineering design audits. Once the root cause has been identified, it will be rectified and steps taken to ensure no further occurrence. In		

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	the interim no new UCG processes will be initiated until this reassurance has been received. All other UCG engineering studies and designs will be informed by the findings of this investigation.		
The gasification process may impact on the quality of the coal seam groundwater.	• Mitigation measures during closure may include flushing of the gasifier and/or treatment of the gasifier water.	Daily Operator Logs	SM & Hydrogeologist
Overflow from contaminated storage dams causing an impact on the shallow groundwater quality.	• As a safety precaution, a dam with sufficient capacity will be constructed to specifically cater for down-time of the water treatment plant. • It is therefore essential to have adequately sized infrastructure (pond) to contain the contaminated water. In addition infrastructure (pond) should not be in the 1:50 flood line.	Weekly	SM & EO

7.3 Hydrology & Freshwater Resources

Table 29: Operations – Hydrology and freshwater resources

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Run-off from dirty areas such as: • **Workshop areas;** • **Chemical storage areas; and** • **Access roads.**	• Adequate stormwater management around the site to comply with GN704. This will mean that clean run-off from the site will be diverted away from dirty areas to the river and that run-off from dirty areas will be contained in an adequately sized (1:50) pollution control dam for evaporation and reuse. • Chemical storage areas to be bunded so that if a spill occurs the chemical will be contained. • Compliance with the Stormwater Management Plan (**Annexure B**).	Weekly inspections	SM
• **Discharge of treated effluent from the wastewater treatment works.** • **Discharge of poor quality effluent to a small stream like the Geelklipspruit may cause pollution to downstream water users.**	• In line with Eskom's no discharge policy, no treated wastewater is expected to be discharged from the plant and associated infrastructure into the adjacent environment unless a failure of the WWTW occurs. • Ongoing operational and maintenance resources must be in place to ensure that the plant operates optimally.	Monthly inspections	SM
Water quality impairment.	• During the operation of the proposed development, water quality must be	Every 6	SM &

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	continually monitored as part of the proposed development risk response management (early detection system). • Hazardous waste handling must be in line with the EMPr mitigation and monitoring measures as indicated in section 6.1 (Storage of materials).	months	Hydrogeologist
UCG operations resulting in potential: • **Groundwater influx during operations.** • **Root shear and vegetation death at the tensile strains of the curvature of the subsidence surface.** • **Changes in drainage features and surface water flow.** • **Creating a connection between the cavity and overlying aquifers such that water ingress into the cavity increases.** • **Loss of flow sensitive macroinvertebrates and fish.** • **Loss of aquatic habitats for aquatic macroinvertebrates and fish.** • **Alien vegetation encroachment.**	• Ensure that UCG has limited connectivity with other water resources. • Shutdown procedures must be followed. The gasification zone must be allowed to cool slowly, while continued gas extraction takes place until the gasification process stops completely. • Post gasification reactor flushing - It may be advantageous to pump water from the reactor post gasification for two reasons; firstly it ensures that groundwater flow is maintained towards the reactor by lowering the local hydrostatic pressure and secondly, it removes contaminants from the reactor so that they may be treated and disposed of at the surface; • Monitoring borehole design and construction as well as continued groundwater monitoring after closure. • No infrastructure should encroach into any major drainage lines. • Restrict construction activities to the drier winter months, if possible, to avoid sedimentation and siltation of riparian features in the vicinity of the proposed development. • Buffer areas should be allocated to all wetland, riparian and surface infrastructure to avoid deliberate undermining as far as possible; • Sites should be actively monitored to determine the rate and extent of surface subsidence. • No infrastructure should encroach into any major drainage lines.		

7.4 Irrigation

Table 30: Operations – Irrigation

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Irrigation: • **Irrigation of treated condensate and potential impact on shallow groundwater quality.** • **Treated condensate may cause run-off of contaminated water into the river if treatment is not done adequately.** • **Impact on soils.** • **Impact on vegetation.** • **Impact on wetlands.**	• Irrigation should be done according to the Management Plan proposed by the Report, GAA Report No. 11613755/11857/2 (see **Appendix S of the main report)**. It is recommended that irrigation be limited to that parcels 4; 5 8 – 15 are considered for irrigation due to parcels 1 and 2 being located within the buffer of a high sensitivity wetland, or within the high sensitivity wetland. No irrigation must occur within the wetland or within the buffer of the wetland. • Eskom's stated preferred method of irrigation is by water tanker fitted with an appropriate spray bar. • It is essential that the speed of the water tanker be calibrated with the discharge rate of the spray bar, such that the application rate does not exceed 5 mm/hr. • It is recommended that a system be devised where the water tanker start irrigating each load where the previous load ended so that the full 150 ha receive the same amount of irrigation water. This will ensure an even spread of the irrigation water and the problematic inorganic compounds contained therein, and limit compaction of the soil by the tanker wheels. • The applied volumes of irrigation water must be adjusted to the needs of the crop throughout the year and the water holding capacity of the soil to prevent excessive leaching into the groundwater system. • To limit run-off of the irrigation water, no irrigation should take place during particularly wet periods. This will require a collection dam of sufficient capacity to store water for a number of weeks. • As a safety precaution, a dam with sufficient capacity will be constructed in order to cater for down-time of the water treatment plant. It is envisaged that for the option of supplying the water for irrigation purposes, the plant will consist of solid sludge filtration, followed by the removal of organic compounds with the use of activated carbon. The resulting largely organic free condensate will pass through a micro-filtration unit after which it will be made available for irrigation purposes. • Irrigation areas need to be assessed for suitability considering the wetlands on the site. • Soils that are waterlogged and/or displaying signs of wetness must be avoided. • It is recommended that during the detail soil survey of the irrigable area of 150 ha at least 15 sampling points (fixed points) are identified and samples taken at a depth of 0-300 mm and	Weekly	SM

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	300-600 mm to establish the baseline values in the soil profile of the organic and inorganic compounds contained in the irrigation water. Photographs of the areas surrounding the sampling points must be taken and any crop abnormalities and waterlogging conditions documented. • Bi-annual sampling of the 15 sampling points at a depth of 0-300 mm and 300-600 mm must take place and the results of analysis compared with the baseline established under the point above. Photographs must be taken of the areas surrounding the sampling points and compared with the baseline photographs to identify any changes to the crop abnormalities and waterlogging conditions. • Water used for irrigation purposes should not be allowed to enter any riparian or wetland related habitat as it could lead to the contamination of natural water resources. • Further conditions stipulated in the WUL need to be complied with.		

7.5 Wetlands

Table 31: Operations – Wetlands

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Gasification impact on wetlands: • **Gasification activities could lead to the subsidence of parts of the wetland catchment that are undermined, causing parts of the outer catchment to be lower than the inner catchment, significantly impacting surface and sub-surface (including groundwater) flows into the wetland.** • **Spills of any pollutants such as hydrocarbons due to leakage of infrastructure may cause pollution of nearby surface water features.**	• Gasification (sinking of wells) should be designed in such a way that subsidence is greatly limited or does not occur. • If the above is not possible, undermining of entire wetland unit catchments to ensure even subsidence across the catchment and not disrupt surface flows and sub-surface flows from the catchment into the wetlands should be considered. • Leakage detection system to be implemented to ensure that leaked hydrocarbons do not enter wetlands. • Leakage rehabilitation and clean up procedures to be put in place. • The following 10 steps of the Incident Management Process will be practiced: – Identify incident. – Initiate emergency response. – Notify relevant parties.	Weekly inspections	SM & EO

	– Respond to incident. – Record and classify incident. – Prioritise management protocols. – Investigate incident record. – Implement and monitor appropriate action. – Close-out incident.		
Pipeline leaks / failures within wetlands or their catchments could pollute the wetland with hydrocarbons.	• Strict control of machinery access into wetlands for maintenance purposes. • Leakage detection system to be implemented to ensure that leaked hydrocarbons do not enter wetlands. • Leakage rehabilitation and clean up procedures to be put in place.	Weekly inspections	SM & EO

7.6 Soils

Table 32: Operations – Soils

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Operation and gas extraction.	• Vehicle movement has to be restricted to a distinct grid in order to prevent degradation of any additional land or parts of land. • Vehicle movement has to be restricted to an absolute minimum that is required for the mining exercise. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to an increased erosion risk.	Weekly	SM & EO
Vehicles operation on site: • **Spillage of lubricants and petroleum products.**	• Vehicles and machinery must be properly maintained to keep oil and diesel leaks in check. • Depending on the nature and extent of the spill, contaminated soil must be either excavated or treated on-site. • Excavation of contaminated soil must involve careful removal of soil using appropriate tools/machinery to storage containers until treated or disposed of at a licensed hazardous landfill site. • Contaminated soils will be bio-remediated as per Bioremediation of Hydrocarbon Contaminated Soil, Work Instruction Unique Identifier: UCG WN 2073 – 15150 – **Annexure D.**	Weekly	SM & EO

7.7 Erosion Management and Control

The environmental measures and controls specified during the construction phase (section 1.1, Table 14) must be carried forwarded into the Operations phase for the impacts relating to erosion.

7.8 Alien Invasive Vegetation Management

The environmental measures and controls specified during the construction phase (section 6.9, Table 16) must be carried forwarded into the Operations phase for the impacts relating to alien invasive vegetation management.

7.9 Open Space Management

The environmental measures and controls specified during the construction phase (section 6.9, Table 18) must be carried forwarded into the Operations phase for the impacts relating to alien invasive vegetation management.

7.10 Waste Management

Table 33: Operations – Waste management

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Leakage of gasification condensate onto land along pipeline route.	• Implement operation inspection protocol of gasfield pipe network. • Regular groundwater monitoring programme. • Institute clean up protocol should there be a local leakage. • Ongoing raw gas transfer pressure measurement with pressure change alarm signal control.	Daily	SM & UCG Engineering Team
Untreated water discharge into environment.	• Evaporation pond represents a safety feature should there be a failure with the treatment plant. • The water treatment plant shall have a proactive service and maintenance plan in place to ensure high availability. • Contaminated wastewater including hydrocarbon contaminated water must not enter any watercourse and must be managed by the site manager to ensure that the existing water resources on and off site are not polluted by the development. • Institute clean up protocol should there be accidental release of untreated water.	Daily	SM & EO
UCG condensate treatment and proposed handling - the UCG condensate would have to be treated such that it can be considered for reuse, discharge into the environment or irrigation.	• Contaminated wastewater including hydrocarbon contaminated water must not enter any watercourse and must be managed by the site manager to ensure that the existing water resources on and off site are not polluted by the development. • Continuous sampling and analysis of surface water quality in the targeted application area, including upstream and downstream. • Continue sampling and analysis of the treated condensate stream for the target range of pollutants and water quality parameters. • Irrigation to be undertaken according to an informed irrigation plan that takes into account soil moisture levels, soil salinity levels and interaction with ground water and wetland systems. • Material Safety Data Sheet (MSDS) for the condensate be readily available. MSDS's should include information pertaining to environmental impacts and measures to minimise and mitigate against any potential environmental impacts which may result from a spill. • Ongoing monitoring of the inputs and outputs of the treatment plant. Monthly reports on removal efficiencies of the pollutants of concern such as phenol and PAH.	Monthly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Leakage of hydrocarbons in the gas treatment plant.	• Contaminated wastewater including hydrocarbon contaminated water must not enter any watercourse and must be managed by the site manager to ensure that the existing water resources on and off site are not polluted by the development. • Measure volume of sludge removed from site and maintain a waste manifest in terms of its ultimate disposal. The sludge shall be analysed monthly for pH, total solids, organics, ammonia and ash content. • Measure volume of brine removed from site and maintain a waste manifest in terms of its ultimate disposal. • Maintain a log of solids removed and monitor regularly the qualitative parameters in the solids. Waste manifest for solids to be documented. • Waste manifest for activated carbon to be documented.	Monthly	SM & EO
Improper disposal of admin-based wastewater, brine, solid sludge and particulates and spent activated carbon.	• Contaminated wastewater including hydrocarbon contaminated water must not enter any watercourse and must be managed by the site manager to ensure that the existing water resources on and off site are not polluted by the development. • Measure volume of sludge removed from site and maintain a waste manifest in terms of its ultimate disposal. The sludge shall be analysed monthly for but not limited to pH, total solids, organics, ammonia and ash content. • Measure volume of brine removed from site and maintain a waste manifest in terms of its ultimate disposal. • Maintain a log of solids removed and monitor regularly the qualitative parameters in the solids. Waste manifest for solids to be documented. • Waste manifest for activated carbon to be documented.	Monthly	SM & EO

7.11 Air Quality

Table 34: Operations – Air Quality

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Emergency incidents when the transport of syngas to the Majuba Power Station is interrupted and the syngas needs to be flared.	• High efficiency combustion of gases according to manufacturer's specifications should be achieved to limit the release of pollutants into the atmosphere.	Under emergency conditions	SM & UCG Engineering Team

7.12 Visual

Table 35: Operations – Visual

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Gas Treatment Plant and emergency stack with flare: • **The height of the stack (9 m) would make it visible from a wide around within, and surrounding the site.** • **Emergency flaring could cause the stack to become a visual focal point, especially at night when it could become a nuisance factor.**	• Avoid flaring as much as possible, especially at night time.	Under emergency conditions	SM & UCG Engineering Team
Gasifier Units	• All cleared / disturbed areas in the footprint of gasifier units to be rehabilitated with natural vegetation as soon as infrastructure has been dismantled.	Monthly	SM & UCG Engineering Team
The proposed service road runs close to one receptor location (Skaapkraal farmstead), and could thus be responsible for a visual impact, especially relating to the light pollution (vehicle lights at night).	• • Reduce night time traffic on the service road as much as possible.	Once-off Monthly	SM

8 ENVIRONMENTAL MANAGEMENT PROGRAMME: DECOMMISSIONING & REHABILITATION

Table 36: Decommissioning and Rehabilitation

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
Closure of injection and production boreholes.	• Well heads to be removed and stored or disposed of as per Management decision in line with Eskom policies. • Rehabilitation to be done in accordance with the Guidelines for pollution prevention and rehabilitation of disturbed areas for Drilling Department (UCG PC 2073-1392) – **Annexure E**. • All drilled holes must be properly closed up with caps and marked for future use and referencing. • Wells that have not been cemented to bottom of the hole but merely plugged at the top, to be drilled open to the bottom of the hole and closed completely with cement. • Surface casing to be cut off at ground level to ensure no 'sticking out' of the ground. • Drilling site must be fenced off with appropriate danger signs displayed conspicuously on the fencing. • Soil pollution must be prevented by the use of drip trays under drill rig. In the event of an oil spillage, polluted soil must be removed and disposed of at an area identified by the Environmental Officer. • The area must be fertilised if necessary to allow vegetation to establish rapidly. The site must be seeded with a local or adapted indigenous seed mix in order to spread the locally or regionally occurring flora.	Weekly	SM & EO
The gasification process may impact on the quality of the coal seam groundwater that will remain after closure.	• Mitigation measures during closure may include flushing of the gasifier and/or treatment of the gasifier water.	Monthly	SM & ET
Pollution of water resources due to infrastructure decommissioning: • **Decommissioning of infrastructure such as buildings in the workshop and plant area would contain materials which could potentially act**	• Proper post-operation rehabilitation, removal and disposal of any material that could cause pollution of water resources through seepage or stormwater run-off is important. • Post-operation groundwater and surface water quality data analysis and reporting should be completed every 6 months. This will allow reporting on the status of the water system half yearly and will allow Eskom to respond to	Every 6 months	Hydrologist, SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
as pollutants to surface water resources, including fuel/hydrocarbon storage tanks or wastewater storage dams. • **The risk of this impact depends on the proximity of infrastructure to surface water receptors, and to links between groundwater and surface water resources in the case of seepage of pollutants into the ground that may pollute groundwater.** • **Residual impacts of mining activities such as development of soil erosion or improperly maintained roads may result in secondary impacts on water resources through the extension of erosion into the wetland or other surface water resources resulting in silt deposition.**	the recommendations, so as to implement the necessary controlling measures.		
Ingress of upper groundwater into combustion void with consequent build-up of contaminants of concern (oils, salts and metals).	• Implement post-combustion chamber monitoring in terms of water quality and pressure status. • Contaminated groundwater from the combustion void must be pumped out and sent to the water treatment plant. This stream shall be quantified in terms of flow and water quality parameters. • Pump-out to cease once acceptable groundwater quality objectives have been met.	Every 6 months	SM & EO & Hydrogeologist
Wetlands: • **Removal of pipelines from wetland (crossings) could result in spillage of pipeline contents (hydrocarbons) into wetlands, thus pollution of the wetland would result.** • **Entrance of machinery into wetlands could damage wetlands, affecting the**	• Decommissioning to be guided by Eskom guidelines for construction / decommissioning. • Decommissioning to be monitored by the SM and or EO according to the stipulations of the EMPr. • No temporary accesses to be constructed through any surface water feature and no machinery to enter any wetland unless authorised under the EMPr by the EO as part of a decommissioning activity. • The recommendations of the Wetland Rehabilitation Plan for existing	Weekly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
resource quality. • **Irresponsible and uncontrolled decommissioning (construction) practices could cause pollution of the wetland.**	crossings (**Annexure G**) must be adhered to.		
Soils: • **Capping and sealing of boreholes.** • **Removal of manifold system and pipes.** • **Rehabilitation of access roads and drill areas.**	• Vehicle movement has to be restricted to a distinct grid in order to prevent degradation of any additional land or parts of land. • Vehicle movement has to be restricted to an absolute minimum that is required for the decommissioning. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to an increased erosion risk. • Boreholes should be rehabilitated once all infrastructure has been removed. Soil erosion mitigation measures should be implemented on each of the borehole sites to ensure minimal land degradation once mining has ceased.	Monthly	SM & EO
Waste: **Contamination of the surface and site with general and hazardous waste.** **General waste produced on site includes:** • **Office waste (e.g. food waste, paper, plastic);** • **Operational waste (clean steel, wood, glass); and** • **General domestic waste (food, cardboards, paper, bottles, tins).** **Hazardous waste produced on site includes:** • **Waste sludge;** • **Spent activated carbon;** • **Oil and other lubricants, diesel, paints, solvent;** • **Containers that contained chemicals, oils or greases; and** • **Equipment, steel, other material**	• An adequate number of general waste receptacles, including bins must be arranged around the site to collect all domestic refuse, and to minimise littering. • Bins should be clearly marked and lined for efficient control and safe disposal of waste. • Different waste bins, for different waste streams must be provided to ensure correct waste separation. • A fenced area must be allocated for waste sorting and disposal on the site. • General waste produced on site is to be collected in skips for disposal at the local municipal waste site. Hazardous waste is not to be mixed or combined with general waste earmarked for disposal at the municipal landfill site. • Under no circumstances is waste to be burnt or buried on site. • Waste bins should be cleaned out on a regular basis to prevent any windblown waste and/or visual disturbance. • All general waste must be removed from the site at regular intervals and disposed of in suitable waste receptacle. • Hazardous waste is to be disposed at a Permitted Hazardous Waste Landfill Site. The EO must have as part of his/her records the waste manifest for each batch based disposal.	Weekly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
(rags), soils, gravel and water contaminated by hazardous substances (oil, fuel, grease, chemicals or bitumen).	• Hazardous waste bins must be clearly marked, stored in a contained area (or have a drip tray) and covered (either stored under a roof or the top of the container must be covered with a lid). • A hazardous waste disposal certificate must be obtained from the waste removal company as evidence of correct disposal. • In the case of a spill of hydrocarbons, chemicals or bituminous, the spill should be contained and cleaned up and the material together with any contaminated soil collected and disposed of as hazardous waste to minimize pollution risk.		
Dust and emissions during decommissioning generated by debris handling and debris piles, truck transport, bulldozing, general decommissioning activities.	• Dust must be suppressed on the construction site and during the transportation of material during dry periods by the regular application of water. Water used for this purpose must be used in quantities that will not result in the generation of run-off. • Loads could be covered to avoid loss of material in transport, especially if material is transported off site. • Dust and mud should be controlled at vehicle exit and entry points to prevent the dispersion of dust and mud beyond the site boundary. Facilities for the washing of vehicles should be provided at the entry and exit points. • A speed limit of 40 km/hr should be set for all vehicles travelling over exposed areas. • During the transfer of materials, drop heights should be minimised to control the dispersion of mater being transferred. • Equipment used by the contractor must be maintained in good working order to prevent smoke emissions.	Daily	SM & EO
During the decommissioning phase there is likely to be an increase in noise pollution from construction vehicles and construction staff.	• Provide all equipment with standard silencers. Maintain silencer units in vehicles and equipment in good working order. • Construction staff working in area where the 8-hour ambient noise levels exceed 85 dBA must have the appropriate Personal Protective Equipment (PPE).	Weekly	SM & SO
During decommissioning, there is likely to be an increase in traffic from construction vehicles.	• As per Eskom Policy, no person is allowed to drive more than 60 km/h on a gravel road. This is applicable only to the access roads on site. All areas within the site itself, has a reduced speed limit of 30 km/h due to the danger of driving into the pipeline/ other infrastructure. This is communicated to all	Weekly	SM & SO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	persons by means of National Speed Signs. • All vehicles entering the UCG site are to be roadworthy. • Seatbelts are to be worn at all times. • When using heavy or large vehicles / equipment, "spotters" are to be present to assist the driver with his blind spots. • Pedestrians: – All pedestrians are to wear reflective vests when in the vicinity of moving machinery and vehicles. – Pedestrians are to avoid wherever possible moving over the vehicle routes. – Pedestrians to be aware of their surroundings. • No person is allowed to transport any persons on the back of a LDV or Double Cab. • No unauthorised persons to operate Eskom vehicles. • Persons are to be authorised for the specific vehicle they are operating in terms of an Eskom Licence. • All vehicles have checklists that have to be completed before operation of the equipment commences. • Due to the UCG site being a Mining Site as per the Mine, Health and Safety Act, reverse parking is encouraged. • Any accident or damage to a vehicle are to be reported immediately as per Eskom Policies and Procedures.		
Impact similar to construction – clearing of infrastructure could create bare, un-vegetated areas that would create a visual contrast with the natural vegetation. Stockpiling of rubble / cleared infrastructure that is not removed could create a contrast with the aesthetics of the natural environment.	• Decommissioning to be monitored by the EO according to the stipulations of the EMPr. • All rubble and cleared infrastructure to be properly removed and not left in situ. • All cleared areas / areas within the footprint of the UCG operation to be fully rehabilitated to their pre-construction state.	Weekly	SM & EO
Removal of access and gasifier roads.	• All access roads made specifically for the mining activities and access to site should be rehabilitated. • The site layout shall include access points for deliveries and services, and	Weekly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	future works. Minimizing disturbance to neighbours shall be considered at all times. • Vehicle movement has to be restricted to a distinct grid in order to prevent degradation of any additional land or parts of land. • Vehicle movement has to be restricted to an absolute minimum that is required for the decommissioning. Unnecessary movement of vehicles will increase the degradation of paths and dirt roads leading to an increased erosion risk. • Access roads should be rehabilitated by ripping the surface crust to ensure the regrowth of vegetation. • Vehicles with excessive emission will be noted in a book and reported to the contractor. The same vehicle will be not allowed back onto the property until the vehicle has been serviced. • All structures built for the purpose of the crossing (e.g. silt traps, etc.) shall be decommissioned and reinstated. • Excess material used for or generated from the crossing activity will be removed from the site, and will not obstruct the water flow. Material removed from banks of watercourses shall be stockpiled within the work space provided adjacent to the watercourse crossing, from where it can be recovered to restore the banks to their original condition. • Banks and contours of the watercourse shall be re-constructed to the original. • Erosion control and other geotechnical measures shall be implemented to achieve bank conditions suitably stable, to resist erosion while settlement of the fill occurs. • Bio-restoration works will consist of the uniform seeding and fertilization of all areas where topsoil has been stripped and re-spread. • An environment monitoring program shall be implemented while reinstatement activities are being performed, in order to identify any needs for intervention / maintenance post-reinstatement (e.g. early signs of erosion, siltation or weed invasion), and implement appropriate works. • The recommendations of the Wetland Rehabilitation Plan (**Annexure G**) must be adhered to.		
Dismantling of pipework on site.	• Decommissioning to be guided by Eskom guidelines for construction	Weekly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	/decommissioning. • Purging of pipeline prior to decommissioning. • Decommissioning to be monitored by the SM and or EO according to the stipulations of the EMPr. • Pipes to be disassembled and removed. Plinths and support structures for the pipes have to be removed and disposed of appropriately. • Any holes / foundation areas for the plinths and support structures to be filled up and re-vegetated.		
Decommissioning of the evaporation pond.	• Ensure environmental approvals are in place for the decommissioning of the evaporation pond • The existing pond, sludge, lining, fence and associated infrastructure must be dismantled, removed and disposed of at a licensed hazardous waste disposal site. • Soils excavated must be tested and if it is established that there is contamination, the soils should be disposed of properly by a reputable waste management company at a licensed hazardous waste disposal site. • Rehabilitation of the existing dam site: – Rehabilitate disturbed areas with natural vegetation. – Exposed areas must be rehabilitated immediately to prevent soil erosion. – Ensure proper surface restoration and re-sloping in order to prevent erosion, taking cognisance of local contours and landscaping. – Damage to re-vegetated areas shall be repaired promptly.	Weekly	SM & EO
Decommissioning of the water treatment plant.	• Ensure that the decommissioning of the water treatment plant have the necessary environmental approvals. • All electrical installations are to be removed by a qualified electrician. • All plant components to be disposed of at a licensed hazardous waste disposal facility. • Cement floor / foundation to be broken up and all rubble disposed of. • Should the removal of the foundation cause an irregular ground level in relation to the natural slope of the land, this has to be filled up and returned to the natural slope of the land. • Rehabilitation of the existing water treatment plant site:	Weekly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	– Rehabilitate disturbed areas with natural vegetation. – Exposed areas must be rehabilitated immediately to prevent soil erosion. – Ensure proper surface restoration and re-sloping in order to prevent erosion, taking cognisance of local contours and landscaping. – Damage to re-vegetated areas shall be repaired promptly.		
Decommissioning of the raw water dam.	• Ensure that the decommissioning of the raw water dam have the necessary environmental approvals. • The dam can either be emptied or no further water should be pumped in by letting evaporation empty the dam. After the dam is emptied, the HDPE lining has to be removed, ensuring that no waste or other potentially dangerous sludge that accrued on the lining comes into contact with the soil below. • HDPE lining to be removed and soil to be tested for any contamination. • Rehabilitation of the existing dam site: – Rehabilitate disturbed areas with natural vegetation. – Exposed areas must be rehabilitated immediately to prevent soil erosion. – Compile and implement environmental monitoring programme, the aim of which should be ensuring long-term success of rehabilitation and prevention of environmental degradation. Environmental monitoring should be conducted at least twice per year (i.e. Summer, Winter). – Ensure proper surface restoration and re-sloping in order to prevent erosion, taking cognisance of local contours and landscaping. – Exposed areas with slopes less than 1:3 should be rehabilitated with a grass mix that blends in with the surrounding vegetation. – Re-vegetated areas showing inadequate surface coverage (less than 30% within eight (8) months after re-vegetation) should be prepared and re-vegetated from scratch. – Damage to re-vegetated areas shall be repaired promptly.	Weekly	SM & EO
Decommissioning of the gas treatment plant.	• All movable parts (i.e. pipes and spoils) to be removed in a safe manner and stored or disposed of at a licensed facility. • Gas bullet and flare stack to be removed with extreme caution.	Weekly	SM & EO

ASPECT & ASSOCIATED IMPACTS	ENVIRONMENTAL MEASURES AND CONTROLS	MONITORING FREQUENCY	RESPONSIBLE PERSON(S)
	• All electrical installations are to be removed by a qualified electrician. • Structures are to be taken apart in an environmentally safe manner as per a preapproved plan (to be compiled by the contractor / department tasked with the disassembly). • Cement floor / bund wall / foundation and stands/supports to be broken up and all rubble disposed of at registered waste disposal site. • Should the removal of the foundation cause an irregular ground level in relation to the natural slope of the land, this has to be filled up and returned to the natural slope of the land. • Rehabilitation of the gas treatment plant site: – Rehabilitate disturbed areas with natural vegetation. – Exposed areas must be rehabilitated immediately to prevent soil erosion. – Ensure proper surface restoration and re-sloping in order to prevent erosion, taking cognisance of local contours and landscaping. – Damage to re-vegetated areas shall be repaired promptly.		
Deconstruction/demolition of stores, workshops, offices, carports and other buildings.	• All items in the stores and workshops are to be removed and either stored at another location or disposed of. • The carports at the farmhouse will have to be removed. • All electrical installations are to • • • Should the removal of the foundation cause an irregular ground level in relation to the natural slope of the land, this has to be filled up and returned to the natural slope of the land. • Gravel to be removed (if necessary) and area revegetated. • Rehabilitate disturbed areas with natural vegetation. • Exposed areas must be rehabilitated immediately to prevent soil erosion. • Ensure proper surface restoration and re-sloping in order to prevent erosion, taking cognisance of local contours and landscaping. • Damage to re-vegetated areas shall be repaired promptly.	Weekly	SM & EO

ANNEXURE A:
SITE LAYOUT AND SENSITIVITY MAP

Extract from Land Surveyor's Co-ordinates

Survey System WG 29
Constants - Nil

A	-81125.32	2991492.31
B	-81823.02	2992549.00
C	-80643.64	2994196.29
D	-81161.70	2994317.30
E	-77754.02	2999076.55
F	-75437.75	2999176.45
G	-76568.85	2993243.86
H	-79657.94	2993965.90
J	-79878.14	2991675.71

The area A-B-C-D-E-F-G-H-J being the Mining Right Application Area represents 2359.5688 hectares

Components:
1. Remainder of the farm Roodekopjes No 67 Vide diagram S.G. No A.161
2. Portion 3 of the farm Roodekopjes No 67 Vide diagram S.G. No A. 164/18
3. Portion 2 of the farm Roodekopjes No 67 Vide diagram S.G. No A. 163/18
4. Portion 1 of the farm Roodekopjes No 67 Vide diagram S.G. No A. 162/18

Locality Plan
Scale 1:75000

KOPPIESKRAAL No.56
WEILAND No.59
RIETFONTEIN No.66
BERGVLIET No.65
RIETPOORT No.83
ROODEKOPJES No.67
Application Area
To Amersfoort
To Standerton
Majuba Power Station
Old Majuba Colliery Underground workings
Access Road
R35 To Volksrust

KOPPIESKRAAL No.56
VLAKPLAATS No.58
WEILAND No.59
JAPTRAP No.115
PALMIETSPRUIT No 68
ROODEKOPJES No.67
RIETFONTEIN No.66
KLEIN RIEFONTEIN No.117

PROPOSED GASIFIER No 1
PROPOSED GASIFIER No 2
PROPOSED GASIFIER No 3
PROPOSED GASIFIER No 4
PROPOSED GASIFIER No 5
PROPOSED GASIFIER No 6
PROPOSED GASIFIER No 7
PROPOSED GASIFIER No 8
PROPOSED GASIFIER No 9

Offices and Workshops
Offices and Control Room
Condensate Dam
Compressor Station
Proposed powerplant area
GTP Plant
Water tanks
Proposed dam
Airfield
Majuba Power Station
Proposed new service road
Road Servitude
Railway Servitude
Railway Siding
Railway
CL of 7m Wide Water Pipeline Servitude
CL of 27.5m Wide Electric Powerline on Both Sides
600mm Gas Pipe
11 KV Powerline
To Volksrust
To Standerton
To Amersfoort

Plan compiled by:
J C Fourie - Professional Mine Surveyor
8 January 2012

ESKOM HOLDINGS SOC Ltd

MINING RIGHTS APPLICATION PLAN
REG 2(2)

Survey System
WGS84 Spheriod WG29

Scale 1:15000

SIGNED

D.L. MAROKANE for Eskom Holdings SOC Ltd — Date

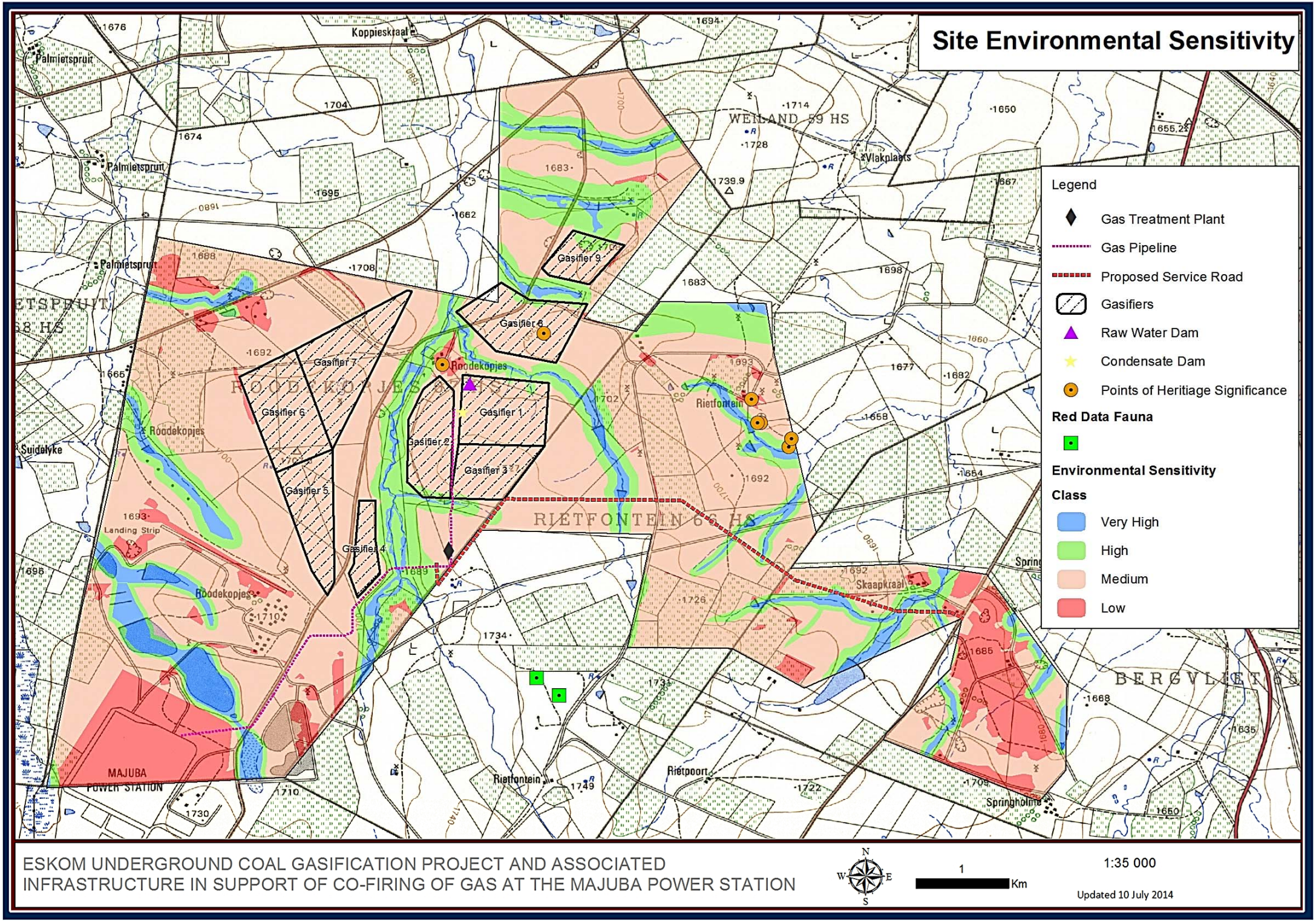
Surveyor JC Fourie (PMS0101) — Date

Regional Manager Mpumalanga — Date

For official use

Scale 1:15000
Metres
0 200 400 600 800 1000 1200 1400 1600 1800 2000

N
W E
S


Site Environmental Sensitivity
Legend
Gas Treatment Plant
Gas Pipeline
Proposed Service Road
Gasifiers
Raw Water Dam
Condensate Dam
Points of Heritiage Significance
Red Data Fauna
Environmental Sensitivity
Class
Very High
High
Medium
Low
Gasifier 1
Gasifier 2
Gasifier 3
Gasifier 4
Gasifier 5
Gasifier 6
Gasifier 7
Gasifier 8
Gasifier 9
Raw Water Dam
Roodekopjes
Rietfontein
Skaapkraal
Springholme
Rietpoort
Palmietspruit
Koppieskraal
Vlakplaats
Suidelyke
Landing Strip
MAJUBA
POWER STATION
WEILAND 59 HS
RIETFONTEIN 66 HS
BERGVLEI 65
ESKOM UNDERGROUND COAL GASIFICATION PROJECT AND ASSOCIATED
INFRASTRUCTURE IN SUPPORT OF CO-FIRING OF GAS AT THE MAJUBA POWER STATION
N
W
E
S
1
Km
1:35 000
Updated 10 July 2014

ANNEXURE B:
STORMWATER MANAGEMENT PLAN

March 2013

ESKOM HOLDINGS LIMITED

Majuba Underground Coal Gasification: Storm Water Management Plan

Submitted to:
Eskom Holding Limited
Majuba Underground Coal Gasification (UCG)
Amersfoort
Mpumalanga

REPORT

Report Number. 11613755-11980-4

Distribution:

1 x Copy Eskom Holdings Limited
1 x Copy GAA project folder
1 x Copy GAA Library

Golder Associates

Table of Contents

1.0 INTRODUCTION **1**

2.0 PROJECT OBJECTIVES **1**

3.0 SITE DESCRIPTION **1**

4.0 RAINFALL **2**

5.0 STORMWATER MANAGEMENT SYSTEM **4**

5.1 Clean and dirty water subcatchments 4

5.2 Description of proposed storm water management system 4

6.0 MODELLING STORMWATER MANAGEMENT PLAN **7**

6.1 Subcatchment Characteristics 7

6.2 Channel Characteristics 7

7.0 RECOMMENDATIONS **9**

8.0 CONCLUSIONS **9**

9.0 REFERENCES **10**

TABLES

Table 1: Details of Rietpoort rainfall station and Mean Annual Precipitation (MAP) 2

Table 2: 24 Hour storm rainfall depths (mm) 2

Table 3: Catchment parameters used in the modelling of the overall storm water management plan 7

Table 4: Dimensions of the clean and dirty water runoff diversion channels for the 1:50 year return period flood peak 8

Table 5: Computed total runoff volumes (m^3) entering the Witbankspruit via the dirty water channels 9

FIGURES

Figure 1: Plant site showing minimal above ground operations 2

Figure 2: Map showing location of UCG trial site in quaternary C11J 3

Figure 3: The clean and dirty water subcatchments 5

Figure 4: The proposed storm water management system layout 6

APPENDICES

APPENDIX A
Document Limitations

APPENDIX B
Photos

1.0 INTRODUCTION

Golder Associates Africa (Pty) Ltd (GAA) was requested to develop a storm water management plan for the Eskom Majuba Underground Coal Gasification (UCG) Site. Department of Water Affairs (DWA) requires that all mines and mining activity sites design, construct, maintain and operate independent clean and dirty water systems so that they are not likely to spill more than once in 50 years (National Water Act, 1998) into the environment.

The following was undertaken during the investigation:

- The site was visited;
- The clean and dirty water areas were identified and marked on a map;
- The PC SWMM model was setup for the site. The model applied was to develop a storm water system to ensure separation of the runoff from the clean and dirty areas and to size the channels needed to comply with Regulation 704.

2.0 PROJECT OBJECTIVES

The project objectives are based on the request from the DWA to address the following:

- Develop a Storm Water Management Plan for the Majuba UCG site.
- To implement the clean and dirty water separation on site to meet Regulation 704;
- The report proposes a storm water system to meet the above objectives. A storm water layout and sizing of the recommended channels has been undertaken. The results presented are not at a detailed design level. Further hydraulic and geotechnical work will be required for a detailed design and the development of specifications for construction.

3.0 SITE DESCRIPTION

The Majuba UCG trial site is located in Mpumalanga, approximately 10 km south-west of the town of Amersfoort and 35 km north north-west of the town of Volksrust. The UCG site is 5km north-east of Eskom's Majuba Power Station.

The Majuba UCG trial site covers an area of approximately 60 ha on the eastern bank of the Witbankspruit located in quaternary catchment C11J in the Upper Vaal Water Management Area (see Figure 2). The Witbankspruit flows south to north and is located to the west of the site. An unnamed tributary flows east to west past the northern part of the site. The confluence of the two watercourses lies directly north of the site, flowing to the Geelklipspruit and then onto the Vaal River.

The topography of the area is characterised by rolling steep-sided hills formed by erosion of the underlying Karoo sediments and dolerite sill. The Majuba UCG lies at an altitude of approximately 1710 mamsl.

The UCG process is a reaction that takes place in an underground void. This process is potentially a cleaner method of coal-based power generation and allows for almost all of the operations to occur underground without affecting the ground surface. The unusual nature of this process means that the UCG site is predominantly grassland with raised pipelines running across open fields that allow for overland runoff to pass beneath them as can be seen in Figure 1 below. The site consists of three potentially dirty areas: one area for offices, a warehouse and a workshop set up in an old farmhouse; an area where the bulk network of pipework is set up, alongside two raised lined earth dams (one for waste water and the other for raw water) and a lower section that currently has no infrastructure on it but has disturbed ground and the potential to have the Gas Treatment Plant in that location. The condense dam (waste water dam), the raw water dam and the area with disturbed ground can be seen in figures B1 – B3 in Appendix B. These areas could contaminate the clean runoff water by an increase in sedimentation, by any form of waste water leak from the pipelines or from contact with oil or rust from the machinery in the warehouse or workshop.

Figure 1: Plant site showing minimal above ground operations

4.0 RAINFALL

The Rainfall Depths were extracted from the closest weather station obtained from the Design Rainfall Estimation Program (details given in Table 1) (Design Rainfall Estimation Program, 2002). The selection of station 0406607_W (Rietpoort) is based on the fact that this is the closest station to the study area and it has the most reliable record. The rainfall distribution on site is classified as a type 3 design rainfall distribution (Schulze, 1995).

Table 1: Details of Rietpoort rainfall station and Mean Annual Precipitation (MAP)

Name of rainfall station	Rainfall station number	Distance from site (km)	Latitude (°)(‘)	Longitude (°)(‘)	Record length (Years)	MAP (mm)
Rietpoort	0406607_W	7.6	27° 7’	29° 51’	93	760

The 24 hour storm rainfall depths for the 1 in 2, 1 in 5, 1 in 10, 1 in 20 and 1 in 50 year recurrence intervals at the SAWS Station 0406607_W (Rietpoort Station) was abstracted from the database. The depths are presented in Table 2.

Table 2: 24 Hour storm rainfall depths (mm)

Return Period (Years)	1 in 2	1 in 5	1 in 10	1 in 20	1 in 50
Rainfall Depth (mm)	60	79	93	107	126

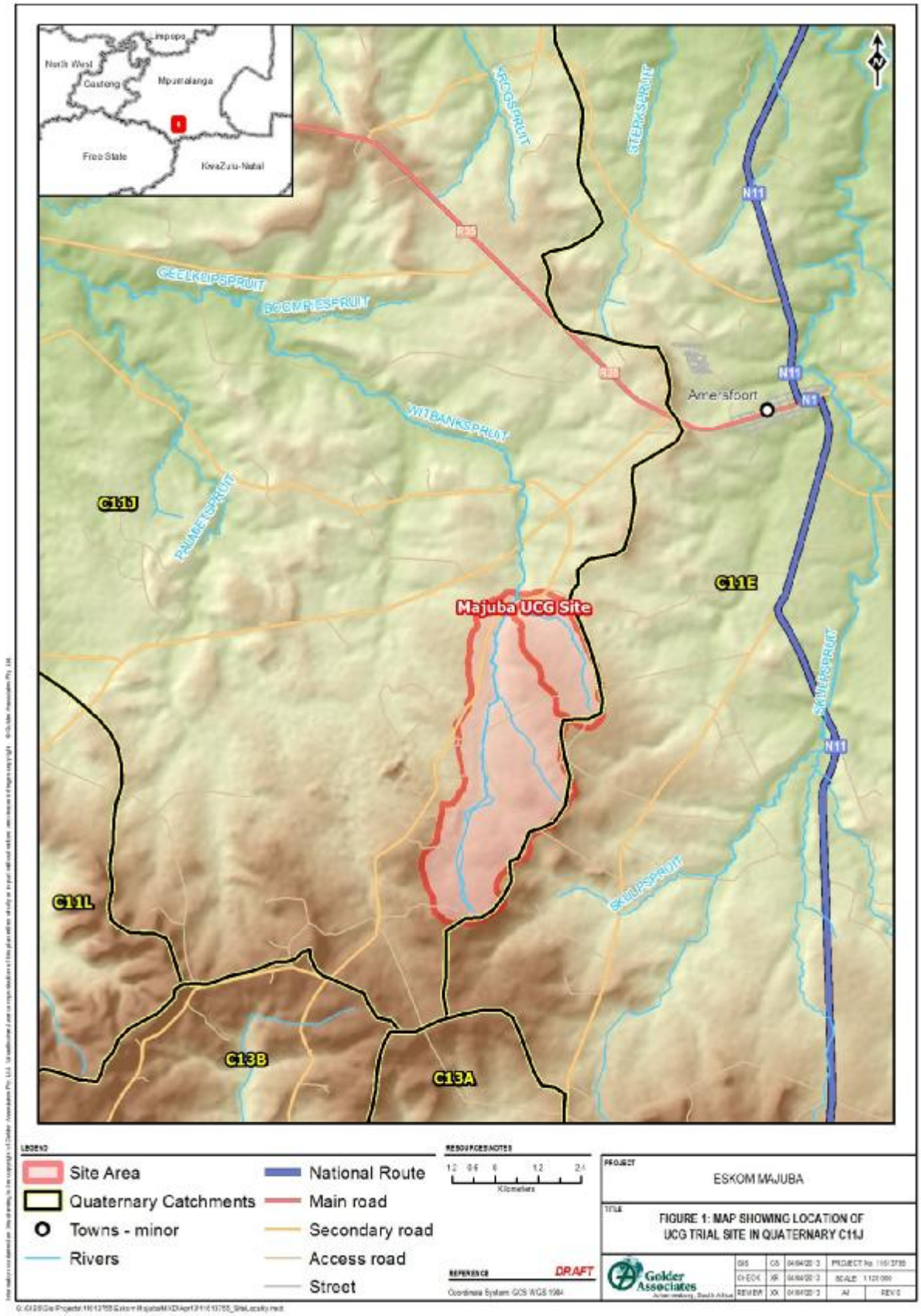


Figure 2: Map showing location of UCG trial site in quaternary C11J

5.0 STORMWATER MANAGEMENT SYSTEM

5.1 Clean and dirty water subcatchments

DWA requires that all activities involving mined resources design, construct, maintain and operate independent clean and dirty water systems so that they are not likely to spill more than once in 50 years (National Water Act, 1998). Therefore the Majuba UCG site area was discretised into subcatchments based on the topography of the region and on areas where clean water was potentially contaminated. These subcatchments were then classified as either clean or dirty water catchments based on the land usage. The Majuba UCG site is unique in that it has minimal above ground operations. The dirty water areas are therefore classified as those that have been disturbed by the UCG operation or those with the potential for further development. The dirty water could potentially be clean enough to release into the environment, but to be conservative, the potentially dirty water areas have been grouped and the runoff has been channelled to a single release point that can be monitored for further investigation. The extent of the clean and dirty water areas is shown in Figure 3.

5.2 Description of proposed storm water management system

The site is predominantly made up of open grass fields with a sealed gas and wastewater pipeline system. This means that most of the clean water will runoff into the two rivers without passing through the disturbed areas or office buildings. The clean water runoff from the upslope clean water catchments will be diverted away from the area producing dirty water as shown in Figure 4. The storm water management plan does not require the containment of the dirty water runoff due to the fact that the dirty water is only contaminated by sediment from the disturbed areas, with the potential of contamination depending on the future development of the Gas Treatment Plant (GTP). The dirty water is routed to several points where it is discharged into the river. It is recommended that monitoring stations be set up at these points to assess whether the dirty water runoff is fit to be released into the environment.

The proposed system is described below:

- The clean water runoff generated in the catchments uphill of the office and site area (CAT3 and CAT4 for the offices and CAT6 and CAT7 for the lower site area) will be diverted by means of a cut-off trench (CH3 and CH4 for the top site and CH6 and CH7 for the bottom end of the site) and routed to discharge into the environment. This reduces clean water entering into the dirty water system.
- The dirty water runoff generated from within the office area and site workings will be diverted by vegetation lined trenches (CH1, CH2_1 and CH2_2) into the Witbankspruit. It is recommended that a monitoring point be set up here to assess the quality of the dirty water generated as runoff from the offices and storage facilities.
- Monitoring stations should be set up at the points where the two dirty water channels discharge into the Witbankspruit River. A station is proposed at the end of CH1 and CH2_2 and another at the end of CH5. This would allow for an assessment of the actual quality of the dirty water, as it may be clean due to the operations existing largely underground with minimal infrastructure (consisting of offices and storage units) above ground.
- A sediment trap is recommended in CH5 as the runoff from CAT5 will potentially have high sediment concentrations due to the disturbed nature of CAT5, which could lead to a build-up of sediment in the Witbankspruit River.

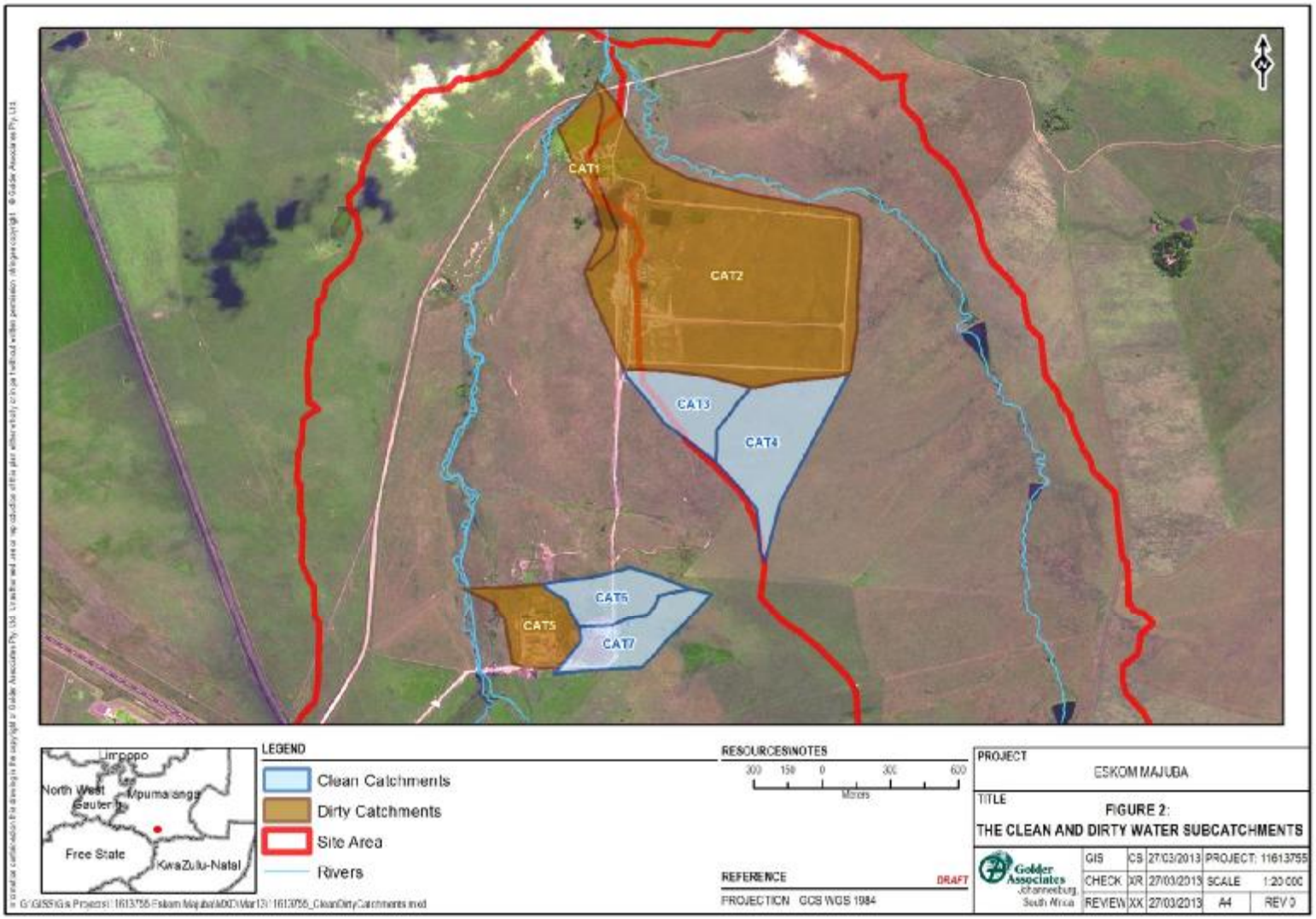


Figure 3: The clean and dirty water subcatchments

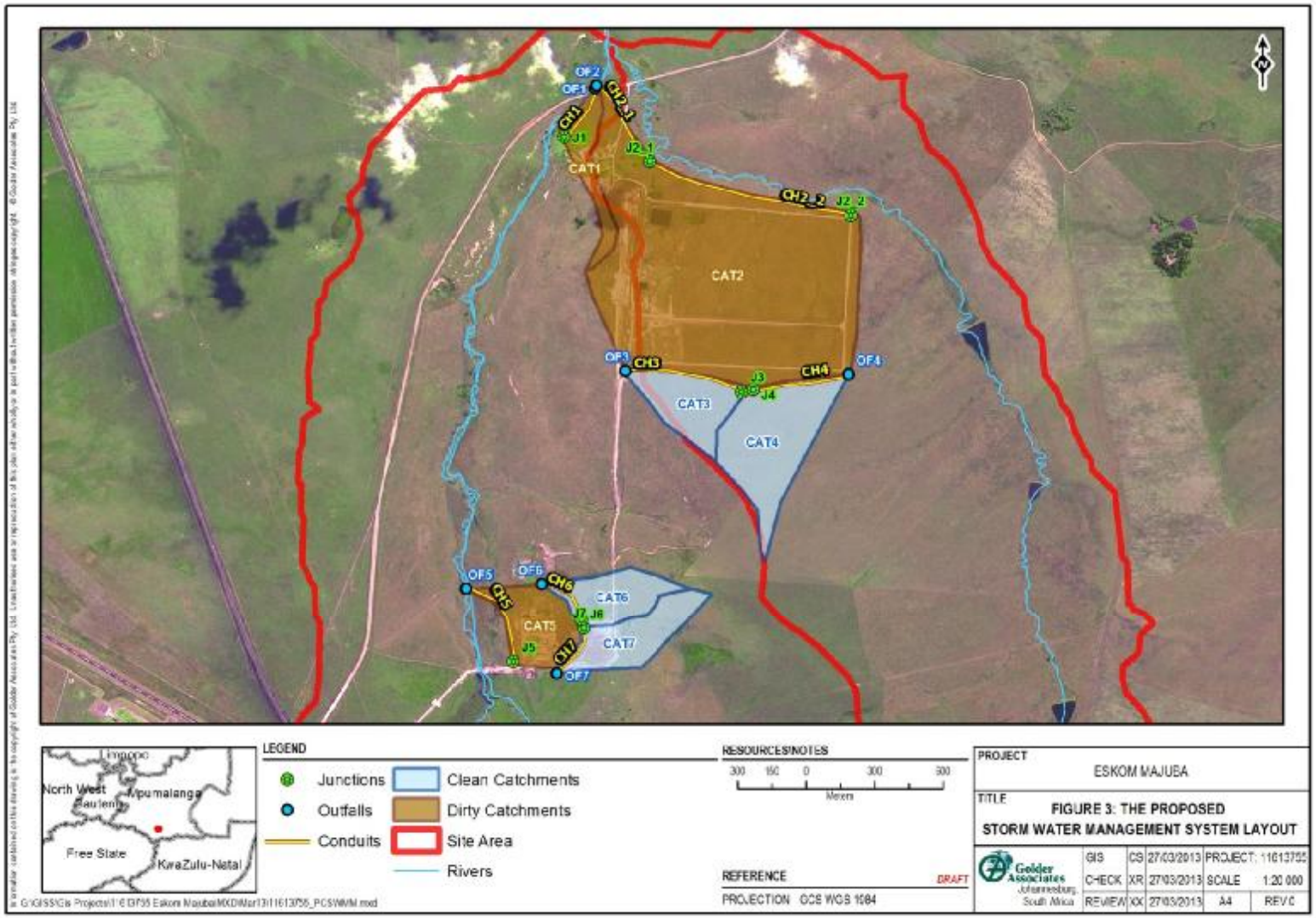


Figure 4: The proposed storm water management system layout

6.0 MODELLING STORMWATER MANAGEMENT PLAN

The PCSWMM model was used as the flood analysis model. PCSWMM is a dynamic rainfall-runoff simulation model used for single event or long-term simulation of runoff quantity. This model was set up for the site and used to size the conveyance structures for separation of clean and dirty storm water runoff.

6.1 Subcatchment Characteristics

The discretization into subcatchments is based on the topography of the Majuba UCG site area. The parameters used to model the overland and channel flow are shown in Table 3. Manning's 'n' coefficient used in the model for the impervious areas and pervious areas were 0.01 and 0.15 respectively due to the catchment areas being predominantly prairie grass lands as can be seen in figure B4 in Appendix B.

The soils were identified as being in the loam group. The model uses these criteria to incorporate infiltration into the analysis using the Green-Ampt infiltration method. The typical infiltration parameters for the loam group are a Suction Head of 88.9 mm, a Hydraulic Conductivity of 13.2 mm/hr and an Initial Deficit of 0.346 for input into the model (Maidment, 1993). The catchment parameters are listed in Table 3. Simulated runoff volumes are summarized Table 3 for the 50 year recurrence interval 24 hour storm event.

Table 3: Catchment parameters used in the modelling of the overall storm water management plan

Name	Description	Area (ha)	Flow Length (m)	Slope (%)	Suction Head (mm)	Conductivity (mm/hr)	Initial Deficit (frac.)	Runoff Volume (ML)
CAT1	Dirty	5.9	248.1	7	88.9	13.2	0.346	3.66
CAT2	Dirty	86.4	736.5	3.4	88.9	13.2	0.346	42.78
CAT3	Clean	9.5	258.3	2.1	88.9	13.2	0.346	5.46
CAT4	Clean	19.1	545.8	3.1	88.9	13.2	0.346	9.96
CAT5	Dirty	9.5	188.1	14	88.9	13.2	0.346	6.14
CAT6	Clean	8.3	346.8	5	88.9	13.2	0.346	4.82
CAT7	Clean	9.7	399.0	4.7	88.9	13.2	0.346	5.55

6.2 Channel Characteristics

All diversion channels have been sized to divert the clean and dirty water runoff for the 50 year return period flood peak as per Regulation 704 of the National Water Act. A freeboard of 0.3 m was included in the channel depth. Sizes of the structures are given in Table 4. The proposed clean and dirty water diversion channel layout can be seen in Figure 4.

The Manning's roughness assumed for the channels were 0.035-0.04 (Vegetation lined channels) (Hicks et al. 1998). The channel (CH2_1 and CH2_2) in subcatchment S2 must be vegetated in order to reduce the average velocity in the channel to below 3m/s to limit erosion.

Table 4: Dimensions of the clean and dirty water runoff diversion channels for the 1:50 year return period flood peak.

Name	Description	Length (m)	Manning's n	Cross-Section	Height (m)	Bottom Width (m)	Left Slope (1:H)	Right Slope (1:H)	Slope of conduit (m/m)	50 yr Flood Peak Flow (m^3/s)	Maximum Velocity (m/s)
CH1	Dirty	243.97	0.035	TRAPEZOIDAL	1	1	2	2	0.0164	1.76	1.73
CH2_1	Dirty	396.84	0.04	TRAPEZOIDAL	1.3	2	2	2	0.02773	10.43	2.9
CH2_2	Dirty	831.27	0.04	TRAPEZOIDAL	1.3	2	2	2	0.01444	10.658	2.65
CH3	Clean	469.74	0.035	TRAPEZOIDAL	1	1	2	2	0.00319	1.858	1.02
CH4	Clean	380.14	0.035	TRAPEZOIDAL	1	1	2	2	0.01973	2.795	2.05
CH5	Dirty	403.24	0.035	TRAPEZOIDAL	1	1	2	2	0.0124	3.685	1.94
CH6	Clean	234.75	0.035	TRAPEZOIDAL	1	1	2	2	0.02642	1.886	2.06
CH7	Clean	246.31	0.035	TRAPEZOIDAL	1	1	2	2	0.01624	2.006	1.79

The volume of water entering the Witbankspruit via channel CH2, CH2_1, CH2_2 and CH5 is given below in Table 5. The volumes listed are for a 24 hour storm with various recurrence intervals. The locations of the channel outfalls (OF) are shown in Figure 4.

Table 5: Computed total runoff volumes (m^3) entering the Witbankspruit via the dirty water channels

	Volumes (m^3) from dirty water channels		
Storm Recurrence Interval	**OF1**	**OF2**	**OF5**
1 in 2	1105	10049	1998
1 in 5	1799	18155	3140
1 in 10	2327	24835	3996
1 in 20	2877	32092	4882
1 in 50	3658	42739	6136

7.0 RECOMMENDATIONS

The proposed storm water management plan presented in this report is based on the assumption that the existing dirty water dam (used for collection of the waste water by product) is designed to accommodate the 50 year recurrence interval storm event, and its levels are maintained and managed according to this design. A storm water channel cleaning program should also be implemented as a standard operating procedure in order to avoid any collection of debris in the channels. As a minimum the sediment should be removed from the channels during the dry season and at least once during the wet season. This maintenance program would improve the efficiency of the proposed system by reducing the probability of spills as well as maintaining compliance with Regulation 704.

It is recommended that two monitoring stations are positioned at the point of discharge from the dirty water channels into the Witbankspruit River (At the outfalls OF1, OF2 and OF5). These monitoring stations would be able to assess the quality of the water released from the dirty water areas into the environment and allow for further decisions and storm water management plans to be developed based on this knowledge. It would also be advisable to install a sediment trap along the channel (CH5) of subcatchment S5. This site is currently disturbed earth, which might cause sedimentation of the Witbankspruit River. There is potential for the site to be developed into the Gas Treatment Plant, in which case the recommended monitoring station at the end of channel CH5 would be used to assess the quality of the dirty water runoff for this plant.

8.0 CONCLUSIONS

The UCG trial site is open grassland with infrastructure consisting of two gas pipelines and a waste water pipeline raised above the natural ground level and a warehouse and offices set up in the old farmhouse. Due to the relatively undeveloped nature of the site, the dirty water systems may not be contaminated to a level that would require the water to be contained in the system. Monitoring of water arising within dirty water areas and flowing into the Witbankspruit is recommended for a wet season in order to assess the degree of contamination of the runoff from the small site areas. If the water quality from these monitoring stations is not of a good standard, the storm water management plan will need to be readdressed. From this reassessment either a pollution control dam would need to be designed, or a system in which the dirty water was stored and treated along with the waste water from the UCG process, before it is released into the environment.

The storm water management plan described in this report has been developed to meet the requirements of Regulation 704 of the National Water Act by:

- Confinement of any unpolluted water to a clean water system away from possible contamination;
- Sizing of both the clean and dirty water systems so that it conveys the 1 in 50 year flood peaks.
- The design of the proposed storm water system has been carried out at a conceptual level. A detailed design process should be followed which involves further hydraulic analysis, geotechnical work,

identification of infrastructure such as pipes and cables that could be impacted on by the proposed system, specification and tender documents developed to allow for the construction tender process.

9.0 REFERENCES

- Design Rainfall Estimation Program (2002). Smithers, J.C. and Schulze, R.E. Rainfall Statistics for Design Flood Estimation in South Africa, WRC Project K5/1060
- Hicks, D.M. and Mason, P.D. 1991. Roughness characteristics of New Zealand Rivers, Water Resources Survey Paper, DSIR, 1-13.
- James, W. Rossman, L.E. and James, W.R.C. (2010). Users guide to SWMM5 13th edition. CHI Press. South Africa
- Maidment, D.R. (1993). Handbook of Hydrology. McGraw Hill Inc. New York
- Males, R., White, A., Lake, Cessford, F. (2004). Regulation GN 704 Audit and Conceptual Design of Surface Water Management Controls. Report No. 329851/2.
- Schulze, R.E. (1995), Hydrology and Agrohydrology: A text to accompany the ACRU 3.0 Agrohydrological Modelling System. Water Research Commission, Pretoria, Report TT69/95, 1995.

GOLDER ASSOCIATES AFRICA (PTY) LTD.

Xanthe Roux
Water Resource Engineer

Trevor Coleman
Senior Water Resource Engineer

XR/TJC/ptk

Reg. No. 2002/007104/07
Directors: FR Sutherland, AM van Niekerk, SAP Brown, L Greyling

g:\projects\11613755 - eskom hydrogeological services\4_reports\11613755_11980_4_swmp\11613755_11980_4_majuba_swmp.docx

APPENDIX A

Document Limitations

DOCUMENT LIMITATIONS

This Document has been provided by Golder Associates Africa Pty Ltd ("Golder") subject to the following limitations:

i) This Document has been prepared for the particular purpose outlined in Golder's proposal and no responsibility is accepted for the use of this Document, in whole or in part, in other contexts or for any other purpose.

ii) The scope and the period of Golder's Services are as described in Golder's proposal, and are subject to restrictions and limitations. Golder did not perform a complete assessment of all possible conditions or circumstances that may exist at the site referenced in the Document. If a service is not expressly indicated, do not assume it has been provided. If a matter is not addressed, do not assume that any determination has been made by Golder in regards to it.

iii) Conditions may exist which were undetectable given the limited nature of the enquiry Golder was retained to undertake with respect to the site. Variations in conditions may occur between investigatory locations, and there may be special conditions pertaining to the site which have not been revealed by the investigation and which have not therefore been taken into account in the Document. Accordingly, additional studies and actions may be required.

iv) In addition, it is recognised that the passage of time affects the information and assessment provided in this Document. Golder's opinions are based upon information that existed at the time of the production of the Document. It is understood that the Services provided allowed Golder to form no more than an opinion of the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings, or any laws or regulations.

v) Any assessments made in this Document are based on the conditions indicated from published sources and the investigation described. No warranty is included, either express or implied, that the actual conditions will conform exactly to the assessments contained in this Document.

vi) Where data supplied by the client or other external sources, including previous site investigation data, have been used, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Golder for incomplete or inaccurate data supplied by others.

vii) The Client acknowledges that Golder may have retained sub-consultants affiliated with Golder to provide Services for the benefit of Golder. Golder will be fully responsible to the Client for the Services and work done by all of its sub-consultants and subcontractors. The Client agrees that it will only assert claims against and seek to recover losses, damages or other liabilities from Golder and not Golder's affiliated companies. To the maximum extent allowed by law, the Client acknowledges and agrees it will not have any legal recourse, and waives any expense, loss, claim, demand, or cause of action, against Golder's affiliated companies, and their employees, officers and directors.

viii) This Document is provided for sole use by the Client and is confidential to it and its professional advisers. No responsibility whatsoever for the contents of this Document will be accepted to any person other than the Client. Any use which a third party makes of this Document, or any reliance on or decisions to be made based on it, is the responsibility of such third parties. Golder accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this Document.

GOLDER ASSOCIATES AFRICA (PTY) LTD

APPENDIX B

Photos

Figure B.1: Raised, lined earthen condense dam (for waste water from UCG process)

Figure B.2: Raised, lined earthen raw water dam

Figure B.3: Disturbed earth at lower site where Gas Treatment Plant might be built

Figure B.4: Catchment type is predominantly grass lands

At Golder Associates we strive to be the most respected global company providing consulting, design, and construction services in earth, environment, and related areas of energy. Employee owned since our formation in 1960, our focus, unique culture and operating environment offer opportunities and the freedom to excel, which attracts the leading specialists in our fields. Golder professionals take the time to build an understanding of client needs and of the specific environments in which they operate. We continue to expand our technical capabilities and have experienced steady growth with employees who operate from offices located throughout Africa, Asia, Australasia, Europe, North America, and South America.

Africa	+ 27 11 254 4800
Asia	+ 86 21 6258 5522
Australasia	+ 61 3 8862 3500
Europe	+ 356 21 42 30 20
North America	+ 1 800 275 3281
South America	+ 55 21 3095 9500

solutions@golder.com
www.golder.com

Golder Associates Africa (Pty) Ltd.
PO Box 6001
Halfway House, 1685
Thandanani Park
Matuka Close
Halfway Gardens
Midrand
South Africa
T: [+27] (11) 254 4800

Golder Associates

ANNEXURE C:
PROCESS WELL DRILLING PROCEDURE (UCG PC 2073-1381)

Eskom	DRILLING PROCEDURE	Majuba UCG Site

Title:	**PROCESS WELL DRILLING PROCEDURE**	Unique Identifier:	**UCG PC 2073-1381**
		Alternative Reference Number:	
		Area of Applicability:	**UCG**
		Documentation Type:	**PC**
		Revision:	**0**
		Total Pages:	**13**
		Next Review Date:	**FEBRUARY 2016**
		Disclosure Classification:	**CONTROLLED DISCLOSURE**

Compiled by	Functional Responsibility	Authorized by
P Lamberth	**M Beeslaar**	**L Duvenage**
Drilling & Completion Specialist	**Specialist Consultant**	**Site Manager**
Date: 20 feb 2013	Date: 25/2/2013	Date: 20/2/2013

CONTENTS

Page

1. INTRODUCTION 4

2. SUPPORTING CLAUSES 4

2.1 SCOPE 4
2.1.1 Purpose 4
2.1.2 Applicability 4
2.2 NORMATIVE/INFORMATIVE REFERENCES 4
2.2.1 Normative 4
2.2.2 Informative 4
2.3 DEFINITIONS 5
2.3.1 Classification 5
2.4 ABBREVIATIONS 6
2.5 ROLES AND RESPONSIBILITIES 6
2.6 PROCESS FOR MONITORING 6
2.7 RELATED/SUPPORTING DOCUMENTS 6

3. DOCUMENT CONTENT 7

DRILLING OPERATIONS 7

3.1 LOGISTICS 7
3.1.1 Permitting, Licenses and Registration 7
3.1.2 Access and Security 7
3.1.3 Site Safety 7
3.1.4 Site Preparation, and Well Installation 7
3.1.4.1 Site Inspection 7
3.1.4.2 Utility Clearances 7
3.1.4.3 Equipment 7
3.1.4.4 Borehole/well Requirements 7
3.1.4.5 Well Installation Schedule 8
3.1.4.6 Rehabilitation 8
3.2 DRILLING METHODOLOGY 8
3.2.1 Objectives 8
3.2.2 Rotary Air Percussion drilling using a Down Hole Hammer 8
3.2.2.1 Prior to Drilling 8
3.2.2.2 General Operating Principles 9
3.2.2.3 Turning on the Air 9
3.2.2.4 Starting Rotation 9
3.2.2.5 Lowering the Bit 9
3.2.2.6 Drilling with water 10
3.2.2.7 Lubrication 10
3.2.3 Foam Drilling 10
3.2.3.1 Purpose 10
3.2.4 Bit Inspection 11
3.2.4.1 Sharpening 11
3.2.5 Hammer Storage 11
3.3 TANKS AND SUMPS 12
3.4 SURFACE RUNOFF 12
3.5 DRILLING FLUIDS 12
3.6 SAMPLING 12

4. AUTHORIZATION 12

5. REVISIONS 12

6. DEVELOPMENT TEAM 13

7. ACKNOWLEDGEMENTS 13

1. INTRODUCTION

This document provides the protocols and recommended procedures for the proper design and construction of process wells. These wells must comply with the underground gasification process in such a manner that they can produce a syngas without compromising safety and the environment.

2. SUPPORTING CLAUSES

2.1 SCOPE

The drilling of UCG process wells

2.1.1 Purpose

The purpose of this procedure is to ensure that UCG production and exploration drilling is conducted in accordance with good drilling practice, and that the environment, health and safety hazards and risks involved in undertaking operations are eliminated or minimised so far as is practicable.

2.1.2 Applicability

This document shall apply throughout Eskom Majuba UCG Project and Contractors.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] ISO 14000 Environment Management Systems.

[3] Operations & Maintenance Procedure

[4] Mine Health and Safety Act number 29 of 1996, as amended.

2.2.2 Informative

[5] EN 791 Drill Rig Safety

[6] IADC SHE Guidelines.

[7] SRD 5000 Operating Manual

[8] Drilling Manual Australian Drilling Industry Training Committee

[9] Diamond Drilling Handbook W.F. Heinz

2.3 DEFINITIONS

2.3.1 Classification

a. **Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

b. **Blow out**: An uncontrolled flow of steam, water, gas or rock material at the ground surface either inside the well or escaping from the well at depth.

c. **BOP**: Blow out Preventor.

d. **Bore**: See Well.

e. **Conductor pipe**: The large diameter, very shallow pipe sometimes installed before drilling commences, used to retain surface material against collapse or washout, and to elevate returning drilling fluid to above ground level.

f. **Diverter**: A well control device consisting of sealing elements compressed in a cylindrical body mounted on a well and operated by hydraulically or air activated cylinders, with piping to direct the discharge from a well at a safe distance during drilling operations.

g. **Drilling**: Includes workovers and all well site activities associated with rigging up and rigging down.

h. **Intermediate casing:** Casing installed where required by subsurface conditions to enable target depth to be reached for that stage of the well.

i. **LCM:** Lost circulation material.

j. **Liner:** A casing having openings for the production or injection of fluids, and installed in the drilled hole to prevent collapse of the formation or entry of debris into the well.

k. **Master valve**: The primary containment valve on the well.

l. **NRV**: Non-return valve.

m. **Pressure**: Gauge pressure (that is, pressure above ambient) unless specified otherwise.

n. **Production casing**: The deepest cemented casing extending to the surface.

o. **Production liner**: A casing string installed to protect the hole or other casings from the corrosive or erosive effects of fluid flow.

p. **Injection well**: A well that is drilled for the purpose of re-injecting geothermal fluids into the ground.

q. **Surface casing**: The first casing installed in the well which supports a drilling wellhead.

r. **Well**: A fully- or partially-lined hole in the ground.

s. **Wellhead**: A set of valves and other pressure-rated components, connected to the top of the well and used to contain the well fluids.

t. **Workover**: Maintenance or repair in an existing well.

2.4 ABBREVIATIONS

Abbreviation	Description
API	American Petroleum Institute
D&C	Majuba UCG Drilling and Completion Section
DTH	Down hole hammer
ISO	International Organisation for Standardisation
m	Metre
mm	Mille metre
POOH	Pull out of hole
RIH	Run In Hole
SHEQ	Safety Health Environmental and Quality
UCG	Underground Coal Gasification
WOC	Wait on Cement

2.5 ROLES AND RESPONSIBILITIES

Drilling Manager (DM): Responsible for the implementation of this procedure and to ensure that the operators of the drilling rigs are working according to this procedure.

Drilling Engineer (DE): Ensure that this procedure is according to the manufacturer recommendations.

Drilling Supervisor (DS): Ensure that the operators of the drilling rigs are working according to this procedure.

Mine Manager (MM): Accountable for the implementation of this procedure and other relevant procedures.

Engineering Manager (EM): Ensure compliance with all engineering and SHEQ standards procedures as far as the implementation of this procedure goes.

2.6 PROCESS FOR MONITORING

Daily Drilling shift report – UCG FM 2073-13026

Pre–use Checklist for Drill rig – UCG FM 2073-13066

Inspection and test plan Drilling – UCG FM 2073-13028

Risk assessment and Toolbox talk – UCG FM 2073-13093

2.7 RELATED/SUPPORTING DOCUMENTS

Not applicable.

3. DOCUMENT CONTENT

DRILLING OPERATIONS

All materials and equipment for drilling and installing any given well are available and are onsite prior to commencing drilling activities.

3.1 LOGISTICS

3.1.1 Permitting, Licenses and Registration

All applicable permits, licenses, registration, rights-of-entry, applicable legislation, and local regulatory procedures for drilling, well installation, and well abandonment (to include any requirements for the submission of well logs, samples, etc) must be in place prior to any drilling

3.1.2 Access and Security

The need for any rights-of-entry must be specified in a mine plan along with the person(s) responsible. All security policies on site must be adhered to.

3.1.3 Site Safety

Safety precautions must be implemented for any drilling operation. The supervisor or designated safety person is responsible for the safety of the drilling team during all drilling activities. All personnel involved with drilling activities must be qualified in proper drilling and safety procedures.

3.1.4 Site Preparation, and Well Installation

3.1.4.1 Site Inspection

Site inspections must be made prior to drilling activities to evaluate physical conditions and equipment and logistical requirements. Particular interests include site access, proximal utilities, barriers and hindrances to movement of equipment, potential hazards, and geographical locations of support facilities (i.e., drilling supplies, drilling water, and emergency facilities). Site modifications and adaptations to drilling plans should be made accordingly and as is practical.

3.1.4.2 Utility Clearances

Prior to drilling, the supervisor must coordinate with the appropriate utility locator services to identify and locate all underground utilities and other subsurface features that could obstruct or be damaged by such activities. Overhead utilities and structures must also be considered with respect to clearance space required by the drilling equipment.

3.1.4.3 Equipment

All equipment must have been properly inspected, serviced, maintained, and tested prior to relocation to the site to ensure that it is in proper working condition. Sufficient replacement or repair equipment and supplies shall be kept on hand or readily available in the event of mechanical failures or malfunctions.

3.1.4.4 Borehole/well Requirements

The borehole shall be drilled and constructed so as to:

1) allow for the proper construction of a process well;
2) monitor the parameters of interest and;
3) meet the objectives of the Underground Coal Gasification program.

The borehole shall be drilled as close to vertical as possible. The depth and volume of the borehole should be calculated such that appropriate quantities of materials are acquired and installed during well construction. Surface casing should have an inside diameter (I.D.) sufficient to allow the installation of the prescribed diameter production string.

3.1.4.5 Well Installation Schedule

Well installation must begin immediately after drilling completion. Once installation has begun, no breaks in the installation process should be made until the well has been sealed.

3.1.4.6 Rehabilitation

All work areas around the wells must be restored to a condition equivalent to that prior to installation. This includes the disposal of drilling cuttings.

3.2 DRILLING METHODOLOGY

3.2.1 Objectives

The objectives of selecting a drilling method for a process well installation are to use that technique which:

- Provides representative data and samples consistent with project objectives;
- Eliminates or minimizes the potential for subsurface contamination and/or cross-contamination; and
- Minimizes drilling costs.

3.2.2 Rotary Air Percussion drilling using a Down Hole Hammer

Operating a down-hole hammer safely and efficiently requires a thorough understanding of the principles of drilling. The following is designed to assist drillers in the operation of down hole hammers.

3.2.2.1 Prior to Drilling

A down-hole hammer relies on a supply of clean lubricated air to operate reliably. Failure to ensure that a clean lubricated air supply is being provided may result in overheating, material pick-up, seizure or failure. Hose ends may be accidentally contaminated prior to connection and drill strings may be contaminated during storage. Even new hoses and drill string parts could be contaminated from the factory. All hoses, piping and drill string components must be plumbed to the compressors prior to connecting the hammer. Then, air must be blown through the system to reduce the possibilities of contaminants entering the hammer. Once the air supply system is flushed the hammer can be connected.

3.2.2.2 General Operating Principles

Regardless of the bit type being used, always follow the following sequence for proper operation of down hole hammers.

3.2.2.3 Turning on the Air

With the bit “off bottom” in the “stop action mode”, turn on the air. Air will blow straight through the hammer without cycling the piston.

NOTE: Failure to turn the air on prior to lowering the hammer on bottom or into a wet hole could result in plugging the bit exhaust holes or contaminants entering the bottom of the hammer. The same air that initiates the percussive action of the hammer exhausts through holes in the bit face to clean the hole.

3.2.2.4 Starting Rotation

Start rotating slowly. Please note that a general rule of thumb for rotation speed is 1.5 times the penetration rate in metres per hour.

The primary reasons for correct rotation is to index the carbide inserts to fresh unbroken rock between impact and to keep the hammer joints tightened. Excessive rotation speed will only generate premature carbide insert and bit body wear.

NOTE: The hammer should always be rotated in a clockwise direction. Operating the hammer without rotation or in a counter clockwise direction could cause the hammer joints to become loose and may result in loss of the hammer or damage to the threaded connections.

3.2.2.5 Lowering the Bit

Lower the bit to "bottom". The bit will move into the work position and the hammer will begin to operate. Adjust the weight on bit to attain smooth operation and optimum performance from the hammer. The general rule of thumb for a starting weight on bit is as follows: 9 kg per mm of bit diameter

140mm bit = 1,250kg weight on bit

219mm = 2000kg

254mm = 2300kg

311mm = 2800kg

In a wet-hole or unconsolidated material, it will be necessary to feed the hammer slowly to sufficiently clean the hole as the hammer is advanced. Care must be taken to limit the power developed by the hammer when drilling in these conditions.

When the edge of a boulder is encountered and rotation becomes erratic or stalls; raise the drill enough to clear the edge of the boulder and slowly feed until the edge is drilled off. Repeat the process until the rotation becomes smooth.

When a solid formation is encountered, the rotation will stabilize and the hammer will sound strong and smooth. Adjust the rotation speed and weight on bit accordingly. Stay alert to the possibility that the solid formation may be a large boulder with loose material below. As soon as the hammer sound changes or the rotation torque fluctuates, lift the hammer and bit off bottom. Keep the rotation on, and lower carefully to continue drilling.

Apply good practice to monitor the hole, flushing. It may be necessary to lift the hammer off bottom periodically to flush the hole until all the cuttings have been removed. Maintain rotation during this procedure.

Upon completion of the hole, lift the bit off bottom and flush the hole for several minutes to ensure no suspended material falls back on top of the hammer and drill bit. Maintain rotation during this procedure. It may be necessary, in difficult drilling conditions, to continue flushing the hole and rotating until the bit is at ground level.

NOTE: If a hole cannot be completed during a shift, remove the drill string from the hole. Holes can fill with water and foreign material overnight and contaminate the hammer.

3.2.2.6 Drilling with water

While drilling, water injection serves two general purposes. Keeping the internal hammer components cool, and reduces dust (dust suppression). In moist formations, mud rings develop and hinder hole, cleaning. These mud rings can become severe enough to cause hammers and bits to become stuck in the hole. Water injection will cause the cuttings to become liquefied and reduce the possibilities of mud rings

3.2.2.7 Lubrication

Downhole hammers require a continuous flow of rock drill oil during operation. Failure to supply a continuous flow of rock drill oil for only a short period of time will cause un-repairable damage. Heat cracks formed in the surface of the piston during this period propagate through continued usage and often initiate a failure at an unrelated time.

3.2.3 Foam Drilling

3.2.3.1 Purpose

Foam is used as additives in air flush drilling operations to improve or supplement the capabilities of air as a flushing media. The texture of the foam issuing from the borehole and therefore its usefulness depends on a number of factors and will vary from a "mist" of foam and water to thick, viscous, shaving cream type foam.

3.2.3.2 The Foam Injection System

The foaming solution consists of water containing usually 0.25-3% of foam concentrate. This solution is injected into the main airline by an injection pump and issues from the hammer ports as foam. The foam thus formed moves up the annulus of the hole carrying drilled solids to the surface. The injection pump may be either air operated or hydraulically operated. The use of a non-return valve in the main airline is essential to prevent foam from being blown into the compressor. The use of a needle valve and a gate valve to control the flow of foaming solution into the airline is desirable but not essential. Two valves are desirable so that the rate of injection, as governed by the needle valve, need not be altered when making a connection. It is recommended that two separate tanks or containers be used to hold the foaming solution as this allows greater control of injection rate and foam strength. Normal open top 210 litre drums are more than adequate as foam tanks.

3.2.3.3 The Foam/Contaminant relationship

Foam is merely a mixture of air and liquid -the air being in the form of bubbles the walls of which consist of thin liquid films. Generally, good foam stability and carrying capacity is associated with a tough bubble wall and small bubble size. Foam will collapse or resist formation for various reasons:-

- Drainage of liquid from the bubble wall
- Evaporation of liquid from the bubble

- Mechanical shock
- The presence of contaminants in the injection water or influx water.

Many otherwise good foaming agents are rendered poor due to the presence of one or more contaminants in the formation or influx water. In particular, salt, calcium and hydrocarbons (diesel or oil) are harsh on many foaming agents. Good drilling foam will be resistant to such contaminants.

3.2.3.4 Foam Concentration and injection rate

The foaming solution consists of water containing 0.25 - 3% of foam concentrate. The concentration necessary depends on the desired foam texture and the nature of the formation being penetrated. For example, if misting, 1/4- 1/2% foam concentrate is necessary while if stiff foam is desired, up to 2% concentrate may be used. If influx water is excessive, up to 5% concentrate may be necessary to successfully foam the influx water out of the hole. Similarly, the rate of injection of foaming solution depends on a number of factors. The injection rate may vary from 1 litre/min to 20 litre/min but should always be as low as possible while ensuring a continuous return of foam at the surface. If conditions are very poor, a foam stabilizer may be used to increase bubble stability and carrying capacity. Any one of a number of stabilizers may be used but the two most common ones are Guar gum and Polyacrylamide. The stabilizer is added to the injection water prior to the addition of the foam concentrate. Recommended dosage is as follows:-

GUAR GUM 100- 300 g/100 litre

POLYACRYAMIDE 30- 100 ml/100 litre

3.2.4 Bit Inspection

3.2.4.1 Sharpening

Carbide inserts should be sharpened when the buttons exhibit flats equal to 1/3 the diameter of the insert

Original Carbide Diameter	Sharpen When Carbide Reaches
1/2" (12.7 mm)	5/32" (4.0 mm)
9/16" (14.3 mm)	3/16" (4.8 mm)
5/8" (15.9 mm)	7/32" (5.6 mm)
3/4" (19.1 mm)	1/4" (6.4 mm)

3.2.5 Hammer Storage

If a hammer is to be stored or unused for any period of time the following procedure should be followed:

1) While connected to the drill string, blow dry lubricated air through the hammer for a period of ten (10) minutes. This will remove any water that has been used in the drilling process and lubricate the internal hammer.
2) Remove the hammer from the drill string and cap both ends.
3) Store the hammer in a horizontal position.
4) Prior to usage, pour rock drill oil into the backhead to insure immediate lubrication.

3.3 TANKS AND SUMPS

Portable recirculation tanks should be used for mud or water rotary operations and similar functions. The use of dug sumps or pits (lined or unlined) are expressly prohibited to minimize cross-contamination and to optimize both personal safety and work area restoration.

3.4 SURFACE RUNOFF

Surface runoff, e.g., precipitation, wasted or spilled drilling fluid, and miscellaneous spills and leaks, should not enter any boring or well either during or after construction. To help avoid such entry, the use of temporary casing, recirculation tanks, and or berms around the borehole must be considered.

3.5 DRILLING FLUIDS

To the extent practical, the use of water during drilling, and any other water used during well installation and completion, should be held to a minimum.

If there is a suitable source of approved water onsite, the source should be used. If no onsite approved water is available, a potential source must be located and approved prior to any drilling.

3.6 SAMPLING

A sufficient number of soil or rock samples should be collected and evaluated by the project geologist. The purpose of this collection is to provide a sound basis for the design of the production system. A “sufficient number of samples” is dependent on project-specific objectives, and should be described in the drilling plan.

4. AUTHORIZATION

This document has been seen and accepted by:

Name	Designation
L Duvenage	Site Manager
M Beeslaar	Technology Manager
S Maphumulo	Site Engineer
PK Lamberth	Drilling and Completion Specialist
J Du Plessis	Acting Drilling Supervisor
T Brink	Document Control Clerk

5. REVISIONS

Date	Rev.	Compiler	Remarks
September 2010	0 draft 1	PK Lamberth	Initial Compilation
May 2012	0	T Brink	Formatting and editing
February 2013		T Brink	New identifiers

6. DEVELOPMENT TEAM

P.K. Lamberth

T.R. Netshidongolowe

7. ACKNOWLEDGEMENTS

N/A

ANNEXURE D:
BIOREMEDIATION OF HYDROCARBON CONTAMINATED SOIL, WORK INSTRUCTION UNIQUE IDENTIFIER (UCG WN 2073-15150

Instruction for Bioremediation of hydrocarbon contaminated soil.

Background:

Soil that has been contaminated with hydrocarbons such as Petroleum fuels (petrol, diesel, paraffin) can be bio-remediated by following the steps below.

However, there are several requirements and limitations to this process as it is a live and biological process that needs to take place.

The basic requirements for successful remediation are air (oxygen), sunlight (ultra violet rays and heat), moisture (water), nutrients (phosphates) in the soil and the agent used to break down the hydrocarbon chain. UCG Environmental department uses Custom HC.

This is a process which takes several weeks and needs to be monitored. Special precaution needs to be taken to avoid the migration of contaminant, either laterally or due to flooding of the soil.

Site Survey:

1. Ensure safety of UCG staff, clients and associated bodies before entering the identified area. Consider the possible risks of:
    - Criminal activity, suspicious persons or vagrants.
    - Snakes
    - Wild animals
    - Poisonous plants and or thorns.
    - Dangerous erosion or excavations
    - Extreme weather conditions.
2. Establish what product the soil has been contaminated with.
3. Record date of and or duration period of product leak, as well as source and volume of product.
4. Stop and prevent any further contamination of the identified area.
5. Inspect the contaminated area, marking off the boundaries, by means of barrier tape.
6. Map out the surface area and record it in the form of a site lay out sketch. Calculate the area coverage in square meters. Take photographs indicating the spread of pollution.
7. Establish the type of soil (clay, sandy, turf etc.) and or medium (ballast rocks, fine stone etc.) the product has spilled onto and record it.
8. Excavate the affected area, to a depth that shows no further contamination. Photograph and record GPS location of each affected area.
9. Mark and number each affected area, using paint, a spike or both.

Bioremediation:

All bio jobs to be formally recorded, noting incident date, starting date, sampling and other dates and details such as weather patterns etc.!

1. The identified contaminated soil has to be spread over an area, as described above to a maximum height of 300mm, ensuring no free product can migrate of the site. The soil must be placed on a solid or well-compacted surface. If the identified surface is permeable soil, it must be lined with plastic sheeting.
2. Take at least two samples of the contaminated soil and check the pH of the soil (Between 1 and 5 means soil is acidic, 6 to 8 is neutral and above 8 is alkaline). Add some agricultural lime if the soil is too acidic. Re-test until pH is neutral.
3. Take at least one sample of the soil in the immediate vicinity of the contaminated area. This sample of clean soil will serve as your target for
4. Rotate the identified soil in order to aerate it sufficiently.
5. Dilute the Custom HC as per instruction.
6. Apply the Custom HC to the contaminated soil, spreading it evenly over the area at a 200 liter per 200 square meter ratio.
7. Install a rain meter. Ensure rain meter to be clean, empty and monitored as often as practical. Record all rainfall.
8. Monitor the treated area over the next 8 to 10 weeks.
9. Take soil samples after approximately 8 weeks to assess bioremediation progress. Ensure the samples are taken in the same marked area as the initial samples.
10. Once the bio remediation process is complete, the soil can be returned to its original location and be compacted or landscaped. All plastic sheeting must be removed and disposed of at a licensed disposal facility.
11. Vegetation of the same original species can be re-introduced where required.

ANNEXURE E:
GUIDELINES FOR POLLUTION PREVENTION AND REHABILITATION OF DISTURBED AREAS FOR DRILLING DEPARTMENT (UCG PC 2073-1392)

Eskom	PROCEDURE	MAJUBA UCG

Title:	**GUIDELINES FOR POLLUTION PREVENTION AND REHABILITATION OF DISTURBED AREAS FOR DRILLING DEPARTMENT**	Unique Identifier:	**UCG PC 2073-1392**
		Alternative Reference Number:	
		Area of Applicability:	**UCG**
		Documentation Type:	**PC**
		Revision:	**0**
		Total Pages:	**6**
		Next Review Date:	**FEBRUARY 2016**
		Disclosure Classification:	**CONTROLLED DISCLOSURE**

Compiled by	Functional Responsibility	Authorized by
Klaas Mahlangu	**S Maphumulo**	**Lou Duvenage**
Environmental Officer	**Site Engineer**	**Site Manager**
Date: 21/02/2013	Date: 21/2/2013	Date: 20/2/2013

CONTENTS

Page

1. INTRODUCTION 3

2. SUPPORTING CLAUSES 3

2.1 SCOPE 3
2.1.1 Purpose 3
2.1.2 Applicability 3
2.2 NORMATIVE/INFORMATIVE REFERENCES 3
2.2.1 Normative 3
2.2.2 Informative 3
2.3 DEFINITIONS 4
2.3.1 Classification 4
2.4 ABBREVIATIONS 4
2.5 ROLES AND RESPONSIBILITIES 4
2.6 PROCESS FOR MONITORING 4
2.7 RELATED/SUPPORTING DOCUMENTS 4

3. DOCUMENT CONTENT 4

3.1 PROCESS TO FOLLOW 4
3.2 REHABILITATION 5

4. AUTHORIZATION 5

5. REVISIONS 6

6. DEVELOPMENT TEAM 6

7. ACKNOWLEDGEMENTS 6

1. INTRODUCTION

The document will be used as a guideline for the Drilling Department in the rehabilitation and pollution prevention of the disturbed areas.

2. SUPPORTING CLAUSES

2.1 SCOPE

This document covers the rehabilitation and pollution prevention of the disturbed areas of the Drilling Department.

2.1.1 Purpose

This document is necessary to ensure Drilling leaves minimal environmental impact.

2.1.2 Applicability

This document shall apply to the Eskom Majuba UCG Site.

2.2 NORMATIVE/INFORMATIVE REFERENCES

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] ISO 14001 Environmental Management System

2.2.2 Informative

[3] UCG RG 2073-02002 Legal register

[4] Mine Safety and Health Act, 1996 (Act 29 of 1996)

[5] The National Water Act, 1998 (Act 36 of 1998)

[6] The National Environmental Management Act, 1998 (Act No. 107 of 1998)

[7] The Waste Act, 2008 (Act 59 of 2008)

[8] Environmental Conservation Act, 1989 (Act 73 of 1989)

[9] Hazardous Substances Act, 1973 (Act 15 of 1973)

[10] SABS Code 0228 – Hazard Classes

[11] Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002)

2.3 DEFINITIONS

2.3.1 Classification

a. **Controlled disclosure:** controlled disclosure to external parties (either enforced by law, or discretionary).

2.4 ABBREVIATIONS

Abbreviation	Description
ISO	International Organisation for Standards
SHEQ	Safety Health Environmental and Quality
UCG	Underground Coal Gasification

2.5 ROLES AND RESPONSIBILITIES

Management: Ensure compliance with the guidelines provided.

Environmental Official(s): Ensure all actions are completed as per legislation.

Drilling Team: Following the provided guidelines and ensuring the correct steps are followed to ensure minimal environmental impact on the Drilling Site.

2.6 PROCESS FOR MONITORING

- Photographs of drilling site must be taken before and during drilling activities and after rehabilitation and kept on record for the Environmental Officer's information.

2.7 RELATED/SUPPORTING DOCUMENTS

National Water Act, Act 36 of 1998

Document Control Procedure 32-6

Non-conformance and Corrective Action Procedure

Incidents Reports

3. DOCUMENT CONTENT

3.1 PROCESS TO FOLLOW

These steps are to be followed in the case of well completion or should the Drill Rig not be moved back to the uncompleted well within 21 days after moving.

- On moving from the drilling site, the drill site is to be cleaned from all rubble, tools, equipment and infrastructure. Nothing is to be left at the drill site.
- Rehabilitation of the Drilling site (should the rig not be planned to move back to the specific site within 21 days) to be initialised (by way of Works Request) within 24 hours of moving from the particular site.

- Rehabilitation to be done within 7 days of initiation of rehabilitation.

3.2 REHABILITATION

- Drilling site must be fenced off with appropriate danger signs displayed conspicuously on the fencing.
- All drilled holes must be properly closed up with caps and marked for future use and referencing.
- A bund wall must be installed around the drilling rig to collect any water which may spill (section 19 of the National Water Act, Act 36 of 1998).
- Soil pollution must be prevented by the use of drip trays under drill rig. In the event of an oil spillage, polluted soil must be removed and disposed of at an area identified by the Environmental Officer.
- No drilling infrastructure should be left onsite.
- The area must conform to the topography. The areas affected by drilling activities must be stable and erosion free.
- Equipment used in the drilling process must be adequately maintained so that during operations it does not spill oil, diesel, fuel, or hydraulic fluid.
- All used oils, grease or hydraulic fluids should be placed in containers and removed from the site on a regular basis for disposal at an area identified by the Environmental Officer.
- All spills should be cleaned up immediately to the satisfaction of the Site Manager by removing the spillage together with the polluted soil and by disposing of them at an area identified by the Environmental Officer.
- The area must be fertilised if necessary to allow vegetation to establish rapidly. The site must be seeded with a local or adapted indigenous seed mix in order to spread the locally or regionally occurring flora.
- Waste material of any description, including rods, scraps, rubble and tyres, must be removed entirely from the drilling area and disposed of an area identified by the Environmental Officer.
- Drill sites must be cleaned and cleared of any waste and must form part of the rehabilitation plan.
- Land must be returned to its original state, able to support grazing.
- Access tracks should remain where required. Elsewhere tracks should be ripped and allowed to re-vegetate naturally.

4. AUTHORIZATION

This document has been seen and accepted by:

Name	Designation
L Duvenage	Site Manager
S Maphumulo	Site Engineer
T Netshidongololwe	Mechanical Engineer – Drilling
P Lamberth	Drilling and Completion Consultant
K Mahlangu	Environmental Officer
J Du Plessis	Acting Drilling Supervisor
T Brink	Document Control Clerk

5. REVISIONS

Date	Rev.	Compiler	Remarks
October 2011	0 draft 1	R Duvenage	Initial Compilation of Document
February 2012	0	T Brink	Editing and formatting
February 2013		T Brink	New identifier numbers

6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- K Mahlangu
- R Duvenage

7. ACKNOWLEDGEMENTS

N/A

ANNEXURE F:
UCG REVISED WATER MONITORING PROGRAMME

Majuba UCG Water Monitoring Program *(Historical)*

Groundwater and surface water monitoring at the Majuba UCG site is essential to observe the impacts of the Underground Coal Gasification (UCG) process on the surrounding water resources and environment.

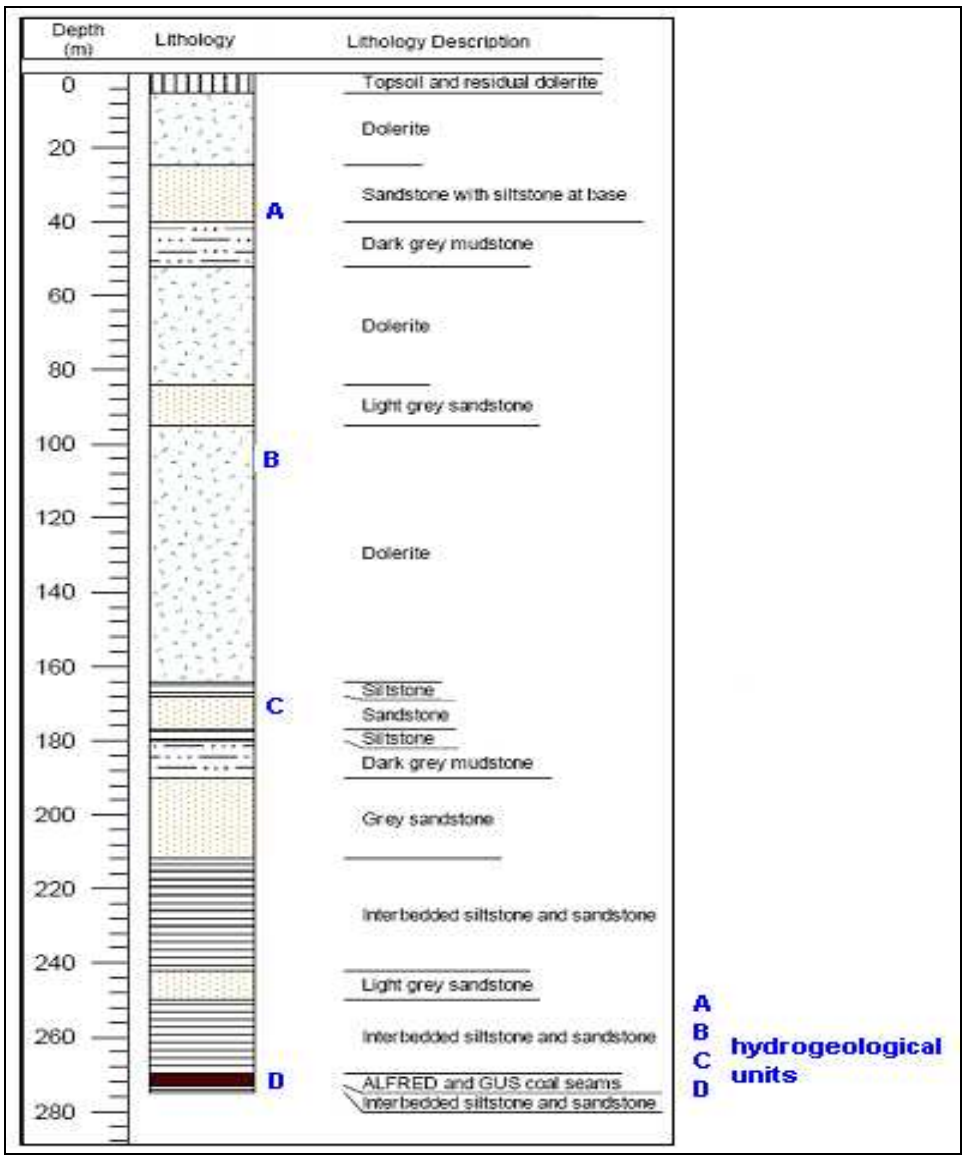
If a geological formation can yield enough water for a significant water supply, it is then termed as an aquifer. At the Majuba UCG site (Gasifier 1 area), 4 separate "hydrogeological units" have been established (the upper/closest to surface one (A), being an aquifer in the true definition of the word, and the remaining three (B, C, D) being hydro-geological units): from surface to the coal seam. Please refer to Figure 1, below to view the typical stratigraphy of the Gasifier 1 area, Roodekopjes 67HS.

The water from borehole abstractions is generally a composite of water from all fractures and/or conduits throughout the total length of bedrock in the borehole(illustrated in Figure1).However only two of these hydrogeological units were considered to be of concern during the monitoring processes at the early stages of the project;

- The shallow aquifer (approximately 40m deep borehole), where the farmers abstract water for agricultural and drinking purposes from,
- The coal seam "aquifer" (270 - 300m deep) as this is directly linked to the gasifier. The water levels as well as the chemical composition of these two hydrogeological units are monitored on a monthly basis. The chemical components that are monitored for are a full range of Inorganic and organic compounds.

Surface water monitoring is conducted by making use of the Witbankspruit a small stream that runs through the Majuba UCG site, farm Roodekopjes 67HS. This stream joins up with all the runoff water from the production area before leaving the Majuba UCG site. Inorganic water analyses are done upstream and downstream of Witbankspruit on a weekly basis. In the past year a full set of inorganic and organic analyses have been done, both upstream and downstream water samples of the Witbankspruit, on a monthly basis.

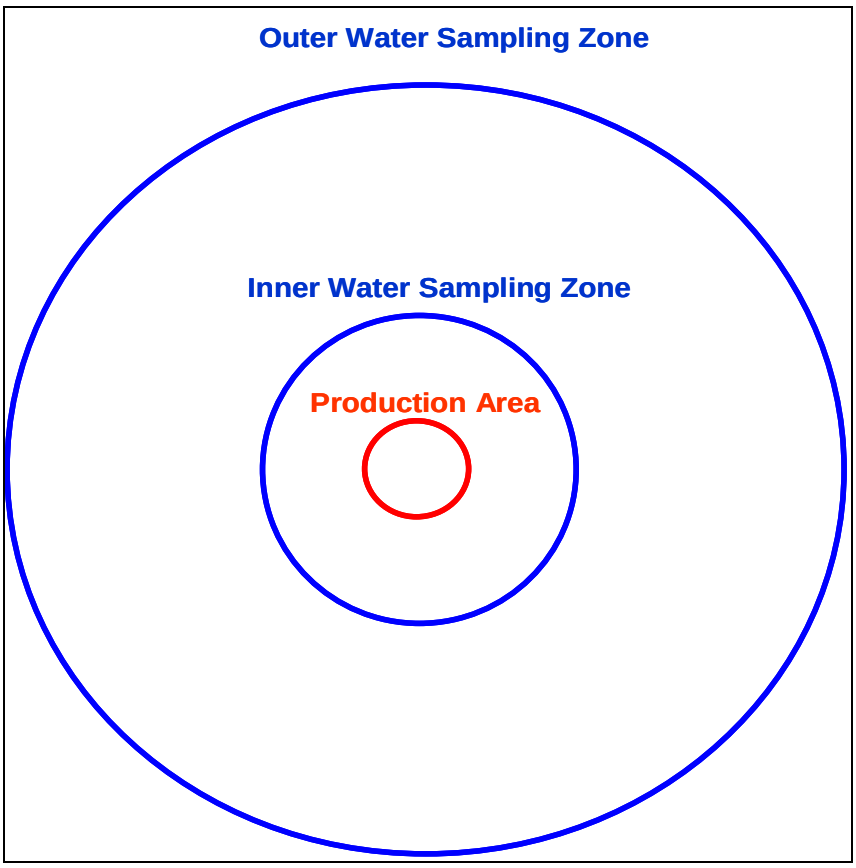
Figure 1: Typical stratigraphy at the Majuba UCG site, Gasifier 1 area



Development of the Groundwater Monitoring Program *(Historical)*

Six water monitoring boreholes were drilled prior to commencement of the UCG process in 2007. Four boreholes were drilled into the shallow aquifer (40m deep borehole), in a radius of 200m from the anticipated gasifier (WMS1-WMS4), and two boreholes were drilled into the coal seam (WMD1 and WMD2) approximately (280-300m deep boreholes). These boreholes were positioned in a radius of 500m from the anticipated gasifier. The inner and outer sampling zones are indicated in the Figure 2 below.

Figure 2: ***Illustration of the generic groundwater monitoring zones at the Majuba UCG site.***



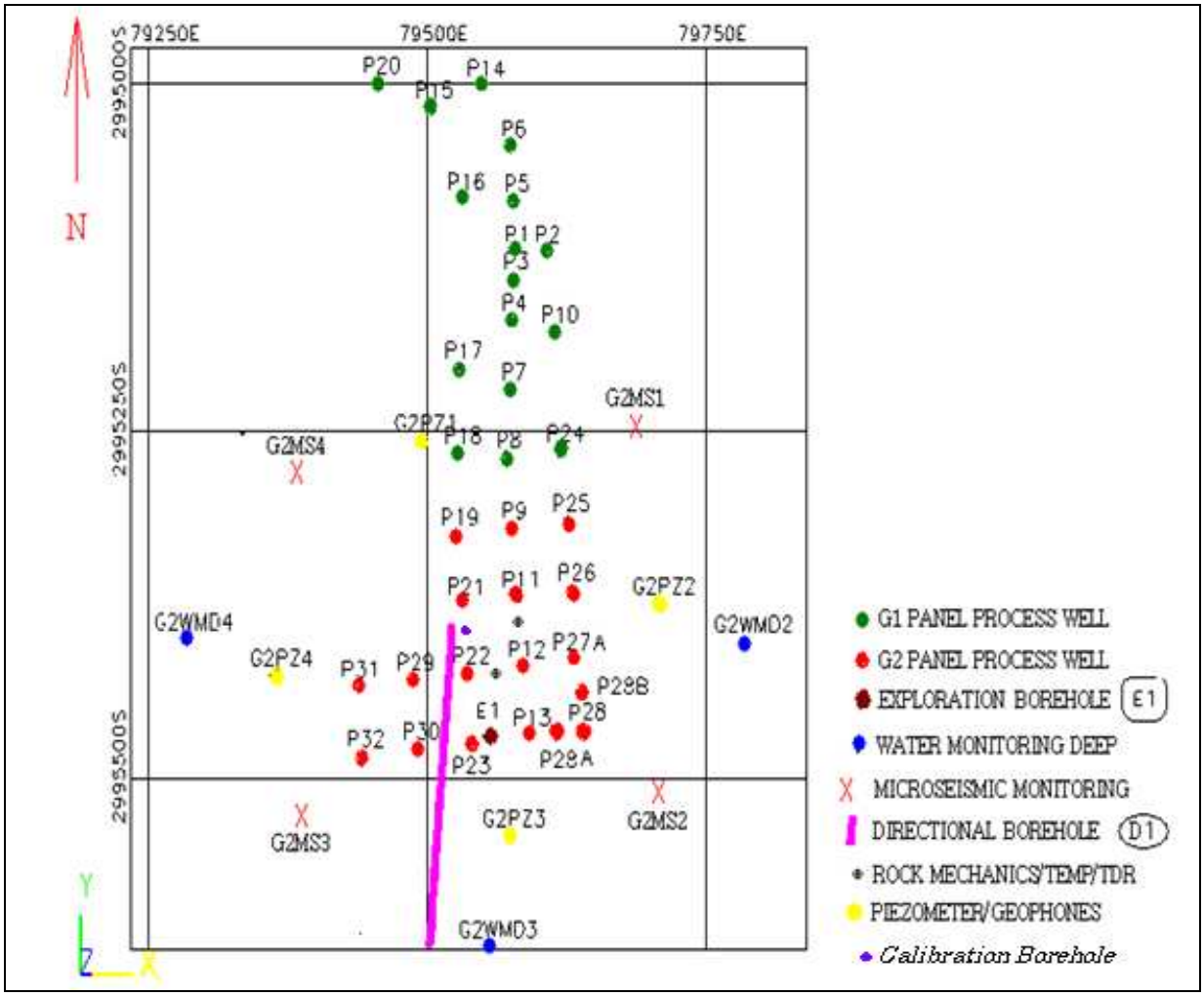
The information obtained from these groundwater monitoring wells allowed an external hydrogeological consultant to gain a better understanding of the groundwater distribution and its movement. Once the production area (G1 panel) had developed sufficiently, the hydrogeological consultant proposed an additional 4 shallow groundwater monitoring boreholes, which were drilled and completed in May 2008.

The process wells for the gasifier one area were drilled and completed in 2009. The Gasifier one area is subdivided into two panels (G1 and G2).Refer to Figure 3 on page 4. Production of UCG syngas were however limited to the G1 panel process wells only, and ultimately the groundwater monitoring programme was erected accordingly. The G1 area has been in controlled shutdown mode for the past 18months (no injection of air/oxidants). In September 2011 after a suspected casing failure in one of the process wells in G1, additional shallow groundwater monitoring boreholes were drilled. These

boreholes were located in such a way to monitor whether any contamination from the process in a closer radius to the leak could be observed. The revised groundwater monitoring program (*as proposed by external hydrogeological consultant*) allowed for the establishment of possible trends and impacts of the contaminants. The groundwater sampling schedule increased to a weekly base to allow for rapid response and mitigation strategies if any contaminants were identified in these boreholes.

By the end of 2011 a total of 15 shallow groundwater monitoring boreholes were in place around the Gasifier 1 area. The positions of these boreholes were chosen to ensure that there were sufficient monitoring points in the area where the gasifier cavity was anticipated to grow, and included monitoring boreholes downstream of the gasification area.

Figure 3: Layout of gasifier one (G1 and G2 panel) boreholes



Additional boreholes to monitor microseismic events in the G2 panel , as well as piezometer equiped monitoring boreholes were included as part of an advanced rock mechanics and hydrogeological monitoring programme. Details regarding the groundwater monitoring for the G2 area is discussed in the section below.

Groundwater Monitoring Programme for the G2 panel (2011-current)

Lessons learnt during the G1 panel operations led to an improved monitoring programme surrounding the G2 panel. The programme included the drilling of shallow (40m), intermediate upper (120m) , intermediate lower (180m) and deep 300m (into coal seam) groundwater monitoring boreholes. *(Exact depths of these boreholes can be obtained from the lithological logs).* A sequence of these boreholes was drilled south, east and west of the G2 panel. The northern portion included the drilling of an intermediate upper and intermediate lower borehole. The northern extent of the monitoring system falls within the G1 panel. Shallow monitoring borehole WMS3 of G1 is used as reference for the northern portion, which borders the G1 panel.

Figure 4: Borehole layout of the Majuba UCG Site (Golder and Associates, 2012)

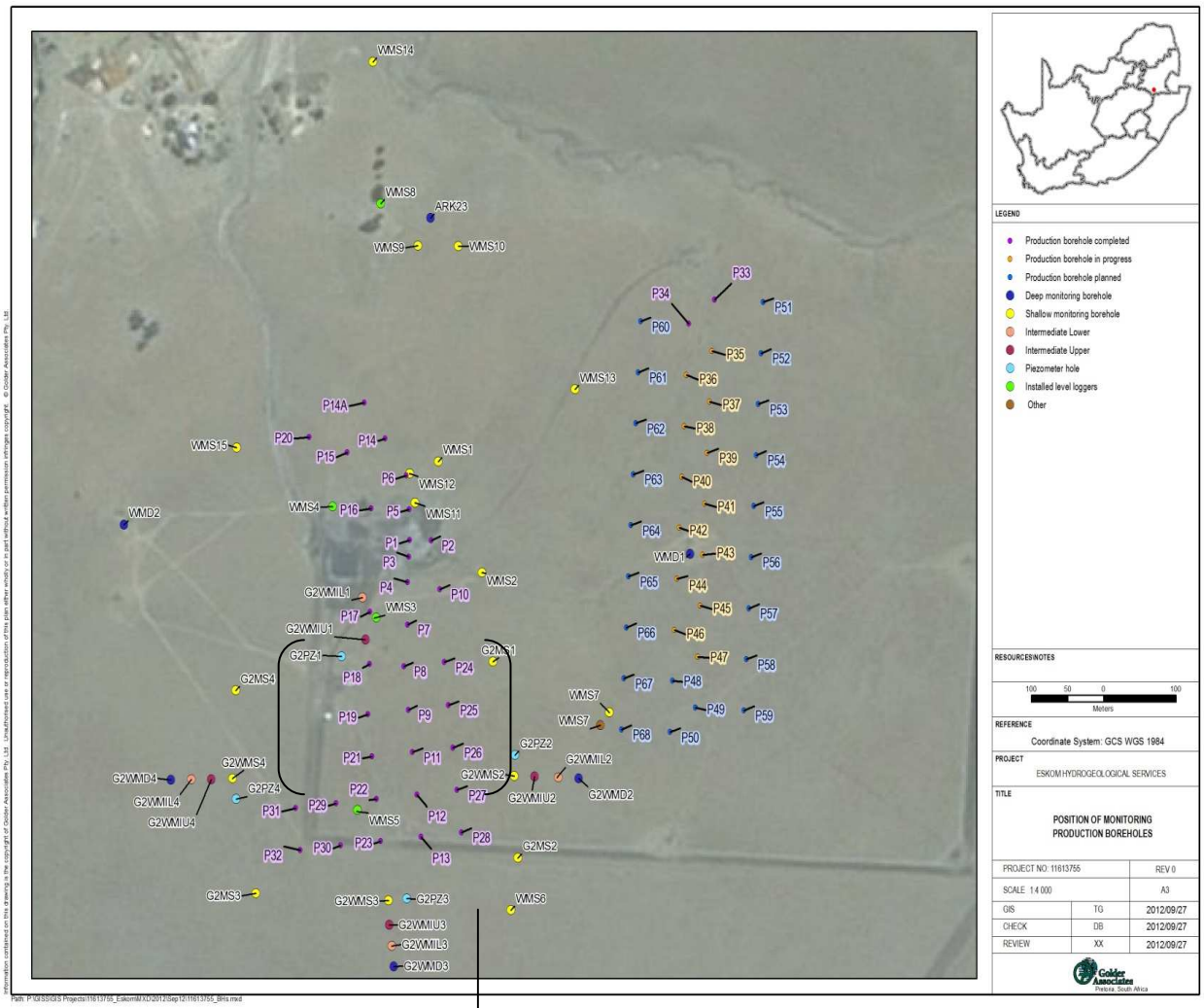
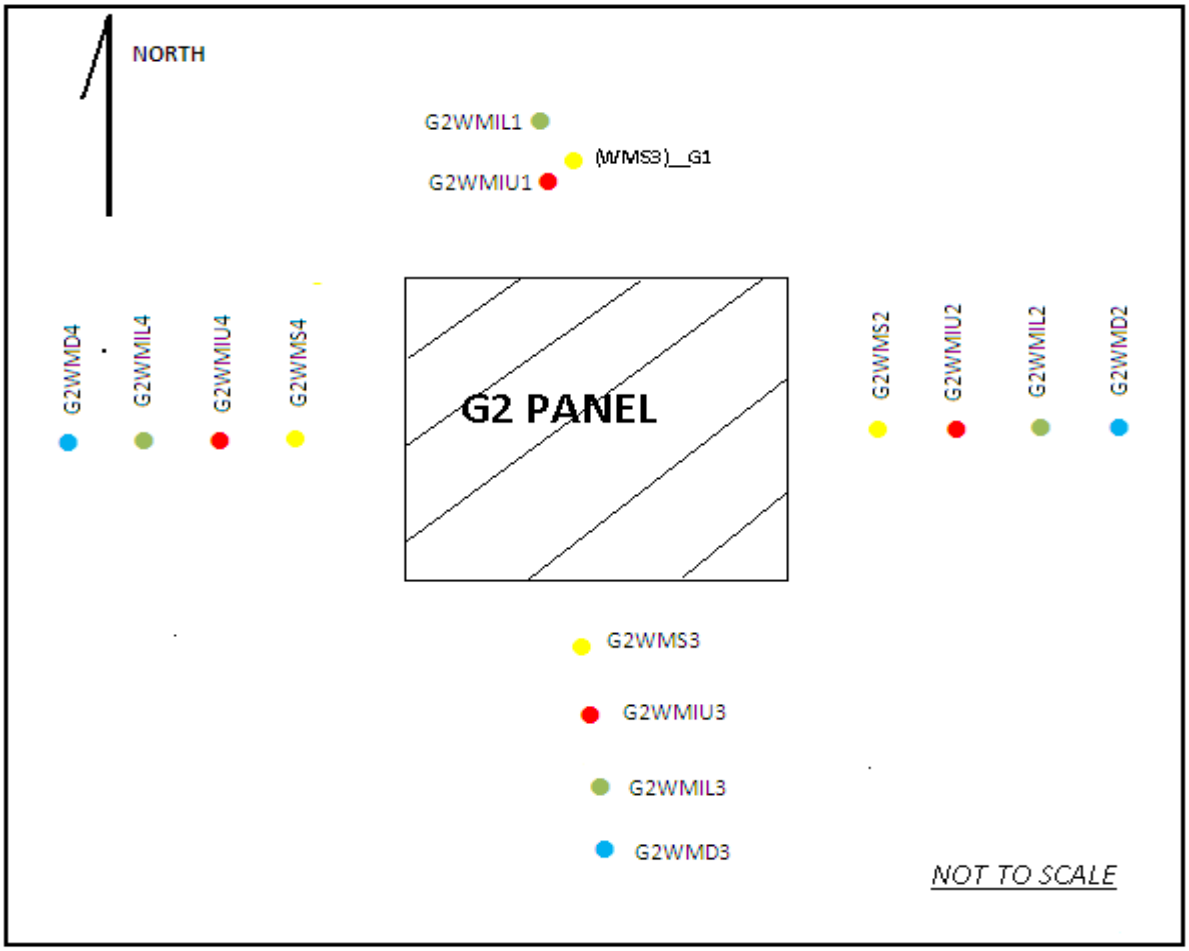
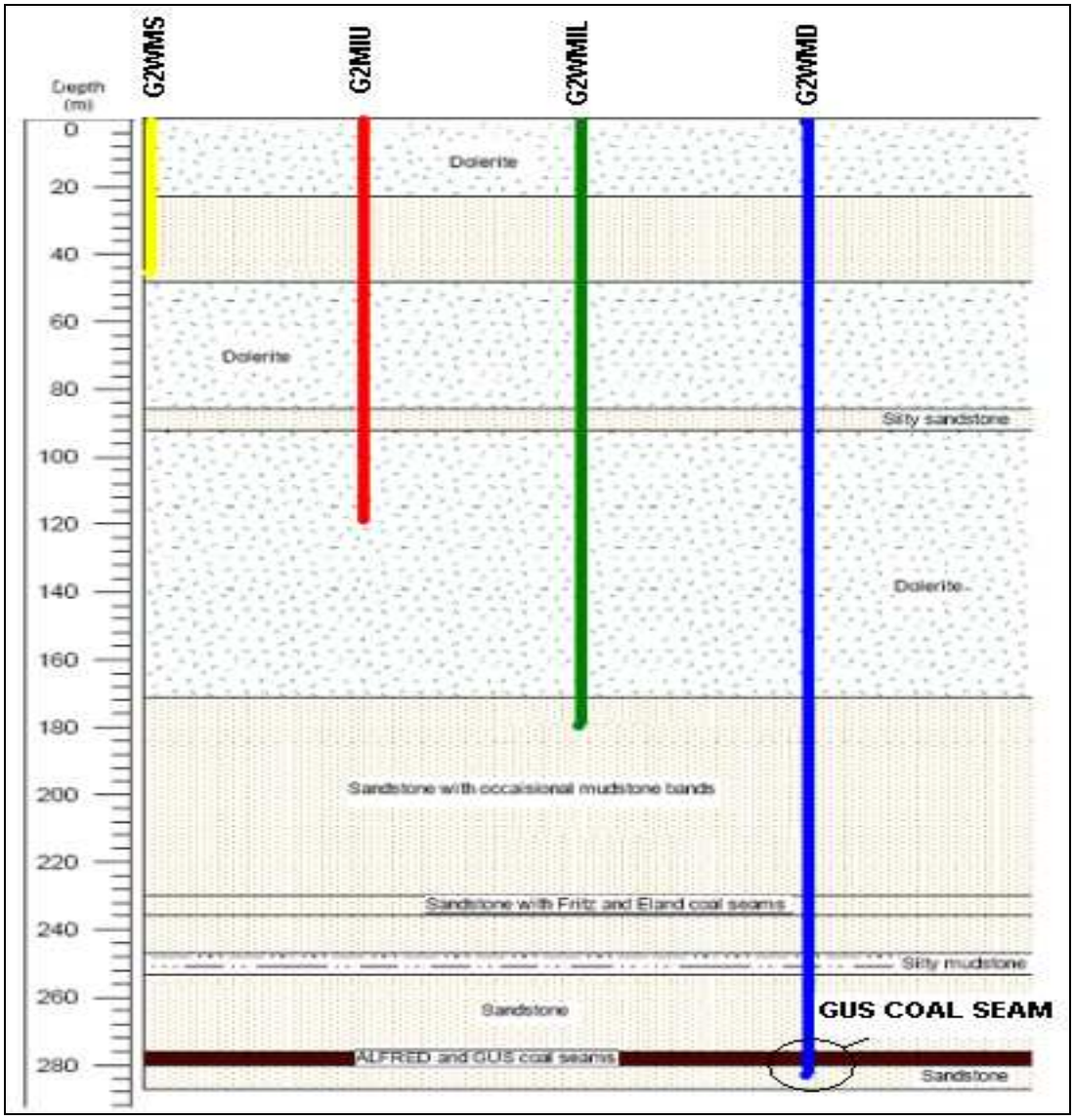


Figure 5: Groundwater monitoring boreholes for the G2 panel layout (detailed)



The shallow groundwater monitoring boreholes (G2WMS's) are located approximately 80m from the closest process wells (G2 panel). The WMIU, WMIL, and WMD boreholes are spaced in 50m increments Refer to Figure 6 below. The purpose was to have an early detection system in place, and to monitor additional hydrogeological units. These intermediate boreholes are cased and a portion of the boreholes where left uncased to ensure water migration from lower geological formations. Details of borehole construction can be found in the completion reports database.

Figure 6: Cross section of new groundwater monitoring borehole system around G2 panel



For this new development it was decided to monitor all 4 hydrogeological units from the surface to the coal seam. This is to verify the hydro-geologist's expectations that the migration between these hydrogeological units. Further monitoring boreholes will be determined by the hydro-geologist as the need arises and dependent on future expansion.

A diagram depicting the current monitoring wells on the UCG site is shown as Figure 7 below. It also illustrates the direction of the groundwater flow based on the WMS and WMD results.

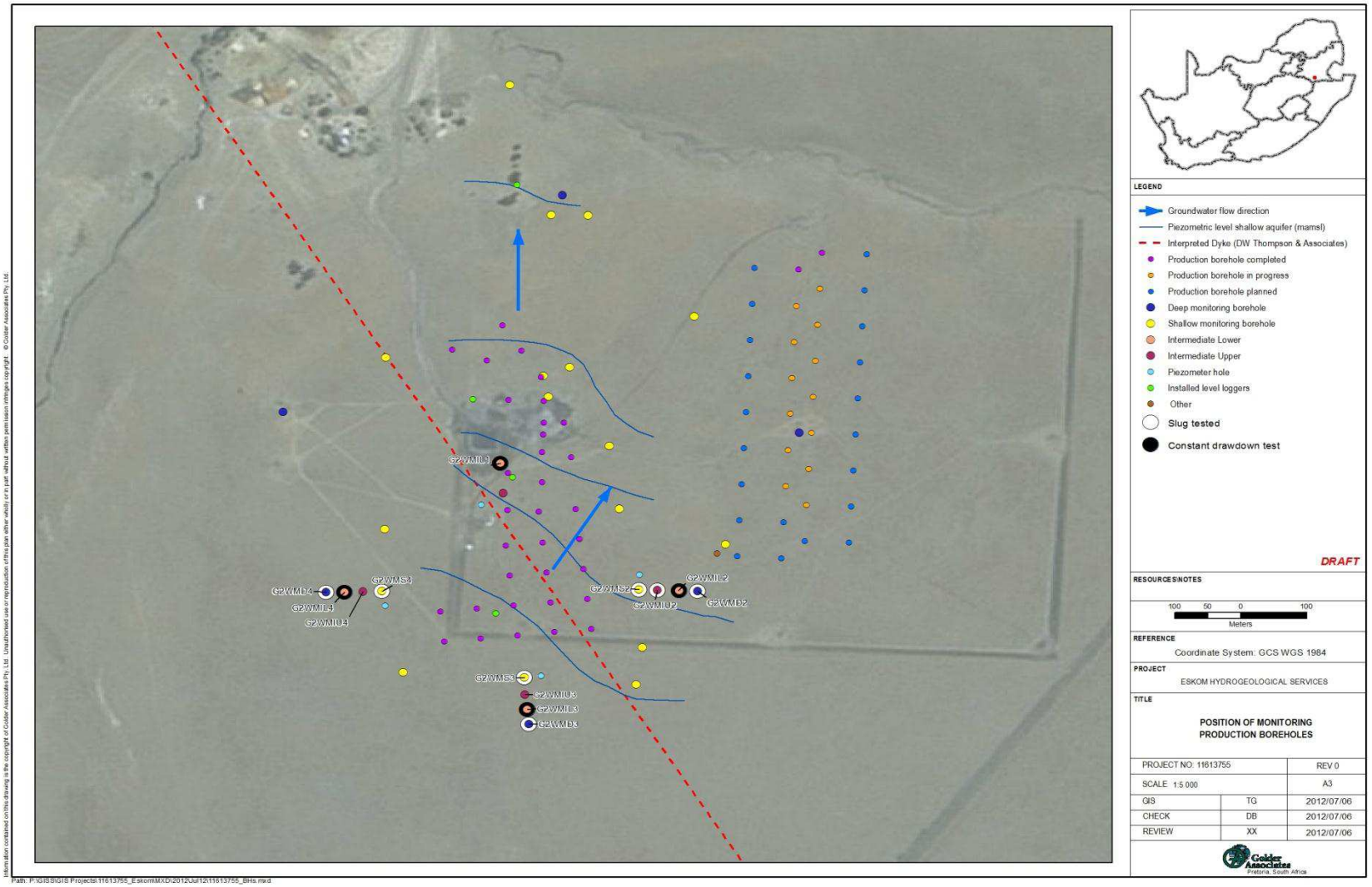


Figure 7. - Layout of Groundwater Monitoring Boreholes, blue arrow depicting ground water flow direction. (Source: Golder Associates, 2013)

References:

Moll,C. UCG Water Monitoring Programme, 20121126

Golder and Associates, 2012, Groundwater Monitoring Report for Majuba UCG Site 2010-2012.

Compiled by:	Reviewed by:	Accepted by:
Verdine Samuels	Mike Beeslaar	Lou Duvenage
Geologist	UCG Consultant	Site Manager

ANNEXURE G:
WETLAND REHABILITATION PLAN (EXTRACTED FROM THE WETLAND ASSESSMENT REPORT)

12 WETLAND REHABILITATION PLAN

12.1 Overall Objective of Rehabilitation of Wetlands affected by Crossings

It is important to establish the overall objective of rehabilitation, as this will guide the actions needed to be taken as part of the rehabilitation and management of the six existing (currently unauthorised) crossings on the site.

The six crossings are all road crossings on the site of the existing UCG operations on the Roodekopjes farm. These roads were constructed approximately five years ago when the UCG operations commenced. Four of the crossings (crossings 8, 9, 11 & 12) are crossed by internal roads access roads on the gasfield, while crossings 6 and 7 are located along the access road that runs along the above-ground gas pipeline. It is understood that all of these roads are important for the continued operations of the UCG on the site (to access the pipeline and in order to access the gasfield), and thus it is important to note that these roads are not able to be decommissioned and the affected wetlands fully rehabilitated.

Accordingly the overall objective of the rehabilitation of these six road crossings is to restore the wetlands / rivers crossed to a state as close to natural as possible, while retaining the presence of the roads. In this context the aim of the rehabilitation actions is to remediate impacts of the road on the hydrology, morphology, and vegetative structure of each wetland crossed as fully as possible.

Luckily in four of the six cases the spatial extent of the crossing across the wetland is spatially very limited, and these four crossings occur in the context of being located near the head of two very narrow valleyhead seepage wetlands which are characterised by a relatively high degree of bedrock outcropping within the wetland, the presence of vertic soils and which are characterised by a hydroperiod of limited saturation and limited deposition (rather the wetlands are conduits for the drainage of overland flow from the surrounding small catchment areas). These factors, in particular the presence of extensive bedrock outcropping and the presence of vertic soils entail that these wetlands are more resilient to impacts associated with road crossings than other wetland types, and it could be argued that these four crossings are less sensitive than crossings 6 and 7. The most important impact of the road in these settings relates to alteration of the hydrology of the wetland in preventing the free flow of drainage down the system due to the impounding effect of the road that has resulted from the provision of insufficient volume within the drainage pipes under the road. Accordingly for these four crossings the primary rehabilitation objective is to restore the hydrology to a regime as natural as possible, i.e. allowing flow in the system to easily underpass the road crossing. Limited alteration of wetland vegetative cover and composition was noted and limited effects on morphology were noted; nonetheless these aspects are addressed as part of the rehabilitation measures for each crossing.

Crossing 6 and 7 are more sensitive for varying reasons; crossing 6 occurs in the context of a valleyhead seepage wetland with active seepage that is characterised by dense grassy vegetation in a more steeply sloping context. Crossing 7 crosses the primary wetland unit on the site – the valley bottom floodplain of the Witbankspruit. The presence of floodplain components to this wetland unit engenders it with a high sensitivity value. The Witbankspruit is a perennial river and although baseflows in the dry winter months are much reduced, it can be prone to spate flows of significant volumes during rainfall events due to a high runoff component from the surrounding catchment. The wetlands at crossings 6 and 7 both contain areas of active bank / gulley erosion, and remediation of this erosion has needed to be considered. The primary rehabilitation objective for these two crossings is likewise to restore as natural a hydrological regime as possible, but with stronger emphasis on restoring the pre-impacted morphological state of the affected river channel in the case of crossing 7 in particular.

12.2 Generic Actions

A number of generic actions and rehabilitation principles apply to all of the six crossings. These are listed below.

12.2.1 Works recommended to occur during the dry season

Due to the strong seasonality of rainfall, significantly lower volumes of surface water drainage occur within the wetland and river systems in the study area during the dry winter months. From both an environmental and technical perspective, it is optimal to construct in-river or in-wetland works when flows are minimal, as this makes for an easier and safer working environment. Most importantly however from an environmental perspective a drier hydrological setting is associated with a lower risk of siltation and erosion of in-river and in-wetland works through fluvial action and it is much easier to manage flows in the drainage systems, allowing these to be bypassed past the works.

In this context it is recommended that if practical, works be undertaken during the drier low rainfall period from May to October.

12.2.2 Limiting of heavy machinery within wetlands

While it is acknowledged that heavy machinery such as excavators need to be used to complete certain aspects of the rehabilitation works, the large size of this and other types of heavy tracked vehicles can cause significant damage to wetland soils and vegetation, including many of the bulbous geophytes that typically occur within wetlands in such a grassland setting. It is thus important that the access of such machinery be limited to the parts of the wetlands where works are taking place. This is particularly an issue in the more sensitive wetlands at crossings 6 and 7, where machinery could damage saturated soils and river banks.

Accordingly measures to limit the areas in which heavy machinery is able to move must be put in place, and where relevant, a running track through the wetland must be constructed to allow machinery to access works areas without causing significant damage to soils and vegetation.

12.2.3 Stormwater Control

Poor stormwater management associated with roads was observed across most of the UCG site and it is noted that a number of road stretches on the site have had to be reconstructed to repair significant damage (surface wash ways) caused by stormwater. This absence of stormwater control is having an impact on certain of the wetlands in terms of silt deposition into the wetland (especially at crossing 6). Stormwater is believed to be affecting the hydrology of certain wetlands by creating channelised flow into the wetlands, especially as in some cases ditches have been excavated adjacent to the site roads that capture and channel overland flow from the catchment into the wetland.

Rehabilitation measures stipulated for each wetland crossing have included stormwater control measures in the catchment, but stormwater control must be viewed and addressed more holistically by Eskom and its contractors on the site. It is recommended that the use of ‘soft’ stormwater control measures be implemented to ensure that channelised stormwater is not directly discharged in the wetland. Such measures include the use of grassy swales into which stormwater can be discharged, allowing it to seep into the wetland.

12.2.4 Removal of Livestock from Rehabilitated Areas

Once works are complete, it is vital that the rehabilitated and reinstated areas are fenced off to prevent the entry of livestock, in particular cattle, into them. Cattle are attracted to areas where surface water is present and areas of new vegetation growth, and thus they have the potential to severely damage rehabilitated sites where vegetation is being re-established.

12.3 Site-specific Rehabilitation Measures

12.3.1 Rehabilitation Method Statement for Crossing 6

12.3.1.1 Summary of Overall Works:

- The existing road substrate is to be removed from the wetland and the single pipe is to be replaced with culverts. Culverts must be of sufficient size (height and width) to allow flow across the width of the wetland during a spate flow event to be maintained.
- The actively eroding gulley head and southern sidewall must be stabilised with rock gabions to prevent further extension of the headcut up towards the pipeline and road
- Proper stormwater control off the road in the in the immediate catchment of the wetland must be implemented to prevent silt ingress and channelised flow to enter the wetland

12.3.1.2 Preparatory Works

- Delineate the boundary of the wetland (away from the working areas immediately adjacent to the road crossing) with stakes and danger tape (or similar measures), and mark as a no-go area.
- Lay Geotextile material over the areas where topsoil and subsoil will be stored. Geotextile material with a plastic membrane underneath it shall be placed on top of the top soil for a concrete batching area if one is required at this site.
- A temporary soil berm (placed over the existing vegetation) approx. 0.5m wide, comprising preferably of impermeable clay soil must be placed immediately upstream of the works area across the wetland in order to prevent overland flow from entering the works area thus mobilising silt. Any ponded water must be pumped / flumed to a point downstream of the works and discharged into the channel of the wetland. If there is overland flow across the wetland, this flow must be temporarily channelled / flumed through the works area and discharged in a diffuse manner into the channel of the downstream wetland.
- For machinery to access the downstream side of the works area, machinery will be likely to need to move alongside the western side of the pipeline (opposite to the road). Heavy machinery must move immediately alongside the pipeline, and a construction right of way must be delineated to avoid heavy machinery ingress into adjacent natural grassland
- At silt fence must be placed across the width of the downstream wetland (channel).
- The wetland immediately upstream of the existing road crossing is sensitive as it contains dense grassy wetland vegetation. Due to the impounding action of the road crossing soils in this part of the wetland may be saturated. Machinery will be likely to need to access this part of the wetland to complete the works. In order to protect the topsoil and vegetation it is recommended that a running track be created alongside the road. The running track can comprise of bound wooden beams (bogmats) or imported crushed stone, at least 0.5m deep.

12.3.1.3 Removal of Existing Road Substrate, & excavation and storage of soil

- Existing rocky / soil substrate must be removed from the wetland and stored for re-use, if required. Road substrate material must be removed to natural ground level
- All artificial fill (concrete) material must be separated from the natural rock road substrate and removed to an appropriate landfill site and not dumped within the wetland
- Natural soil material underlying the existing road that may need to be excavated to enable the correct placement of culvert structures. Such removed topsoil must be removed and be stored separately
- All removed topsoil and any removed subsoil must be stored separately. Removed topsoil and subsoil must not be stockpiled within the wetland or on the steep immediate slopes of the catchment of the wetland, but on the flatter ground on the edge of the valley head.

12.3.1.4 Reconstruction of Road Crossing

- Culverts must be placed in the wetland to replace the existing pipe and rocky substrate of the road. Culverts must be constructed so that the bottom of the culvert is a ground level to allow movement of biota through the road crossing
- Available bedrock from the old road crossing can be used to stabilise reinstated ground around the new crossing. A compacted mix of stone and smaller rocks can be used to stabilise reinstated slopes
- It is recommended that 'stepped' rock basket gabions properly keyed into the soil be included in the design of the crossing downslope of the culverts to accommodate the drop in levels between the natural ground level on the upstream side of the crossing and the ground level at the top of the headcut downstream of the road crossing and pipeline.
- Smaller gabions or packed rock must be used to protect the area between the foot of the gabions and the gabions placed within the headcut
- Newly created embankments surrounding the newly constructed road crossing must not be designed to be too steep as these will easily erode. It is recommended that no slopes steeper than 40^{o} be incorporated into the design
- Newly created embankments surrounding the newly constructed road crossing must be reinstated with a layer of topsoil (ideally sourced from topsoil removed as part of the works in the wetland crossing or immediate catchment, as this soil will contain a natural seed base). After reinstatement, all exposed, newly created embankments are to be covered with geotextile or similar hessian sack material pegged into the surface to protect the soil from erosion by water and wind

12.3.1.5 Stabilisation of Gulley sidewalls (headcut) below the road crossing

- The headcut (head of the gulley) and eroding sidewalls of the gulley (especially those on the southern side) must be stabilised and prevented from eroding further by the placement of rock gabions at the head and in the eroding sidewalls of the gulley.
- Gabions must be properly keyed into the sides and foot of the gulley (channel floor) to ensure that flow in the wetland does not erode soils on the sides of the gabions
- Gabions must extend along the sidewalls to cover all actively eroding faces of the gulley sidewalls

12.3.1.6 Reinstatement

- Any soils removed from the works area must be properly reinstated to natural ground levels

- If topsoil is imported into any of the newly created slopes / embankments, it must be seeded with a natural grass mix comprising of grass species typically found in the surrounding area.
- The temporary berm must be fully removed from the wetland
- The running track on the upstream side of the wetland must be carefully removed so as not to uproot any existing vegetation. If crushed stone is used machinery can be used to remove the upper parts, but remaining stone closer to the natural ground level must be removed by hand
- Any areas of compacted wetland soils must be lightly ripped / scarified, with care to be taken to not unduly damage (uproot) vegetation. This should be applied particularly to areas where excavators and similar heavy machinery have worked (alongside the road), and in areas where the running track has been placed

12.3.1.7 Stormwater

- Stormwater controls must be implemented on the road on both sides of the wetland in its immediate catchment as stormwater inflow from the road is feeding silt into the wetland.
- Stormwater controls must be implemented that ensure that no silt from the road surface enters the wetland
- No channelised stormwater from the catchment / road surface must be discharged directly into the wetland. Flow retarding devices such as packed stone or rip-rap must be used to slow the velocity of stormwater down. It is recommended that stormwater from the road be discharged into grassy swales located outside of the wetland on its periphery in order to promote the slow infiltration of runoff into the wetland.

12.3.1.8 Service Areas and machinery

- No refuelling, servicing or chemical storage must occur within 50 m of the wetland boundary.
- A service area is to be established on the outside of the buffer zone of the wetland on each side of the pipeline consisting of at least a temporary refuelling area, maintenance area, waste collection and hazardous chemical storage points, all lined, impervious, demarcated and equipped with a spill kit.
- Any water pumps operating in the works area must be placed inside / on top of a drip tray to prevent any spillage and contamination to the wetland. The drip tray will be lined with absorbent pads and checked daily for spills
- No toilets are to be allowed within 50m of the water bodies – these are to remain outside the wetland.
- All equipment working in the wetland must be checked daily to ensure there are no oil / diesel leaks prior to entry into the wetland area

12.3.2 Rehabilitation Method Statement for Crossing 7

12.3.2.1 Summary of Overall Works:

- The existing road substrate is to be removed from the river crossing and is to be replaced with a series of box culverts. The culverts must be of sufficient size (height and width) to allow flow across the width of the river channel during a spate flow event to be maintained.

- The actively eroding eastern channel bank immediately downstream of the existing crossing must be stabilised with rock gabions to prevent further extension of the bank towards the adjacent pipeline support structure

- Proper stormwater control off the road in the in the immediate catchment of the wetland / floodplain must be implemented to prevent silt ingress and channelised flow to enter the wetland

- **Note:** It is strongly recommended that the works in the river be undertaken during low flow periods – in winter or in early summer before the onset of the rains. This is to reduce the risk of a rainfall event(s) causing temporary structures and material to be washed downstream, and to ensure as little water as possible to need to be bypassed past the works.

12.3.2.2 Preparatory Works

- Delineate the boundary of the wetland (away from the working areas immediately adjacent to the road crossing) with stakes and danger tape (or similar measures), and mark as no-go.
- Lay Geotextile material over the areas where topsoil and subsoil will be stored. These must be stored outside of wetland Geotextile material with a plastic membrane underneath it shall be placed on top of the top soil for the concrete batching area, if one is required for this area. This area covered with Geotextile material shall be a minimum of 3 meters from the pipe in all directions.
- Spill prevention measures must be put in place both up and down stream of the area where works are to be installed prior to any activities taking place. Other spill response equipment must also be onsite during activities.
- Prior to the onset of works, it is recommended that the flow in the river be impounded behind the works in order that the works can be completed in a 'dry' environment. It is recommended that a temporary impoundment consisting of clay and sand bags be constructed across the channel, *if works are undertaken during a low flow period.* Water must be pumped past the works and discharged downstream. A similar impoundment must be constructed at the downstream end of the works to prevent backflow into the works area from the downstream reach. The works area should be pumped dry once the impoundments have been completed, and any aquatic fauna stranded in the works area must be safely relocated to the downstream river channel.
- If works have to be undertaken during high flow periods with a stronger baseflow in the river, it is recommended that river flow be allowed to bypass the works on one side of the channel with temporary structures placed (e.g. sand bags etc.) to keep the works dry. Once work is completed on the one side, the river flow should be diverted through the newly completed culverts and work can be completed on the opposite side.
- In order to access the downstream side of the works, machinery will need to access the river bed via the bank on the downstream side of the pipe. If necessary this bank may need to be re-profiled to have a slope less than 40^{o} in slope and an access created to allow machinery to safely access the river bed and the downstream side of the works. Machinery must only access the works on the downstream side of the works from the western bank, and must not access the downstream side of the works from the eastern side (i.e.by crossing the floodplain).

- No servicing areas, laydown areas, or machinery turning areas must be allowed in the floodplain part of the wetland area on the eastern side of the channel. The construction right of way must be limited to the access track alongside the pipeline and the surrounding floodplain must be marked as a no-go area.
- 2 silt traps must be installed in the downstream part of the channel to trap any silt mobilised as part of the works. The integrity of these traps must be checked for the duration of the works.

12.3.2.3 In-river Works

- Once preparatory works in the river have been completed (as per above for low flow or high flow conditions), work can commence on the removal of the existing substrate and construction of box culverts in the channel.
- The large boulders that have slumped into the downstream side of the channel must be removed, and if to be used as part of the new structure must be stored out of the wetland, or taken for use elsewhere if not to be re-used at this crossing site.
- The existing rocky / soil substrate that comprise the current road access must be removed from the channel. All of this foreign material must be removed from the river bed to the natural level of the river bed. If it is to be re-used for the new road structure it must be temporarily stored outside of the wetland (i.e. on top of the river macro channel bank on the western side). If it is not to be re-used, it must be disposed of at a suitable site away from the river / wetland and must not be dumped within the channel or within the floodplain.
- The naturally-occurring substrate in the channel bed underlying the existing road may need to be excavated to enable the correct placement of culvert structures. Such removed substrate must not be dumped into the downstream channel; it must either be stored separately (temporarily) if it is to be re-used as part of the new structure, or suitably disposed of if not to be used at another site.
- Culverts must be placed in the channel in such a way that low flows within the channel *are not impounded behind the new bridge structure, and that water and aquatic biota are allowed to freely bypass the structure*. Culverts must be large enough to let flows of a volume that occupies most of the channel to underpass the road, thus culverts at least 3m in height must be used.
- Available bedrock from the old road crossing can be used to stabilise reinstated ground around the new crossing. A compacted mix of stone and smaller rocks can be used to stabilise reinstated slopes. Design of new embankments must take into account potential flood / spate flows within the system that would inundate the new structure and thus the embankments must be suitably secured to prevent erosion
- Newly created embankments surrounding the newly constructed road crossing must not be designed to be too steep as these will easily erode. It is recommended that no slopes steeper than 40^{o} be incorporated into the design
- Newly created embankments surrounding the newly constructed road crossing must be reinstated with a layer of topsoil (ideally sourced from topsoil removed as part of the works in the wetland crossing or immediate catchment, as this soil will contain a natural seed base). After reinstatement, all exposed, newly created slopes are to be covered with geotextile or similar hessian sack material pegged into the surface to protect the soil from erosion by water and wind.
- Silt / sediment that has backed up behind the existing structure must not be removed. This is naturally occurring material in the channel bed that will be likely to be re-mobilised by spate flows once the new structure is completed and the hydrology of the channel is restored to the baseline hydrology without any impounding structure.
- Rocky material that has slumped into the channel bed down the western bank must be removed towards the end of the works (this material may provide a suitable substrate to avoid the movement of machinery into the channel while works are underway). All rocky material must be removed to the natural ground level.

12.3.2.4 Stabilisation of channel sidewalls on the eastern bank downstream of the road crossing

- The eroding channel bank / sidewall on the eastern side of the river channel downstream of the existing road structure must be stabilised and prevented from eroding back to the pipeline supports by the placement of rock gabions.
- Gabions must be properly keyed into the sides of the bank and into the channel bed to ensure that flow in the wetland does not bypass the gabions and erode the bank or bed behind the gabions. Gabions must also be properly secured to the adjacent culvert structure to avoid undercutting.

12.3.2.5 Reinstatement

- Once works are complete, all temporary impounding structures in the channel must be fully removed down to the natural level of the channel bed.
- The western bank on the downstream side of the river crossing that may have been re-profiled to allow safe access of machinery must be restored to a natural profile as far as possible.
- Any areas of compacted wetland soils must be lightly ripped / scarified, with care to be taken to not unduly damage (uproot) vegetation. This should be applied particularly to areas where excavators and similar heavy machinery have worked (alongside the road)
- The silt traps downstream of the works must be carefully removed to ensure that silt trapped behind them is note re-mobilised into the downstream river. Manual removal of silt trapped behind these silt traps must be undertaken if necessary.

12.3.2.6 Stormwater

- Stormwater controls must be implemented on the road on both sides of the wetland in its immediate catchment as stormwater inflow from the road has the potential to feed silt into the wetland and to create channelised overland flows into the catchment. Stormwater controls must be implemented on the sloping ground to the east of the floodplain, and on the sloping ground to the west of (nearer) the channel.
- Stormwater controls must be implemented that ensure that no silt from the road surface enters the wetland
- No channelised stormwater from the catchment / road surface must be discharged directly into the wetland. Flow retarding devices such as packed stone or rip-rap must be used to slow the velocity of stormwater down. It is recommended that stormwater from the road be discharged into grassy swales located outside of the wetland on its periphery in order to promote the slow infiltration of runoff into the wetland.

12.3.2.7 Service Areas and machinery

- No refuelling, servicing or chemical storage must occur within 50 m of the wetland boundary.
- A service area is to be established on the outside of the buffer zone of the wetland on each side of the pipeline consisting of at least a temporary refuelling area, maintenance area, waste collection and hazardous chemical storage points, all lined, impervious, demarcated and equipped with a spill kit.
- Any water pumps operating in the works area must be placed inside / on top of a drip tray to prevent any spillage and contamination to the wetland. The drip tray will be lined with absorbent pads and checked daily for spills
- No toilets are to be allowed within 50m of the water bodies – these are to remain outside the wetland.
- All equipment working in the wetland must be checked daily to ensure there are no oil / diesel leaks prior to entry into the wetland area

12.3.3 Rehabilitation Method Statement for Crossing 8

12.3.3.1 Summary of Overall Works:

- The existing road substrate is to be removed from the wetland and the single pipe is to be replaced with a suitably sized box culvert.
- The physical footprint of the works is to be kept as spatially limited as possible
- Stormwater controls off the adjacent road area must be upgraded
- Sideslopes are to be properly vegetated and rehabilitated

12.3.3.2 Preparatory Works

- Delineate the boundary of the wetland (away from the working areas immediately adjacent to the road crossing) with stakes and danger tape (or similar measures), and mark as no-go.
- Lay Geotextile material over the areas where topsoil, subsoil, or rock will be stored. Geotextile material with a plastic membrane underneath it shall be placed on top of the top soil for the concrete batching area, if a batching area is required.
- Regular flow within the wetland is unlikely, however if works are being undertaken in the wet summer months, a temporary soil berm (placed over the existing vegetation) approx. 0.5m wide, comprising preferably of impermeable clay soil must be placed immediately upstream of the works area across the wetland in order to prevent overland flow from entering the works area and mobilising silt. Any ponded water must be pumped / flumed to a point downstream of the works and discharged into the channel of the wetland. If there is overland flow across the wetland, this flow must be temporarily channelled / flumed through the works area and discharged in a diffuse manner into the channel of the downstream wetland.
- 1 silt fence must be placed across the width of the wetland within the downstream wetland (channel).

12.3.3.3 Removal of Existing Road Substrate, & excavation and storage of soil

- Existing rocky / soil substrate forming the road must be removed from the wetland and stored for re-use as required. Road substrate material must be removed to natural ground level.
- However kikuyu was noted on the embankments on the downstream side of the crossing. Due to the invasive properties of this grass it is recommended that soil containing kikuyu roots not be re-used but rather disposed of at a suitable landfill site.
- All artificial fill (concrete) material must be separated from the natural rock road substrate and removed to an appropriate landfill site and not dumped within the wetland
- Natural soil material underlying the existing road that may need to be excavated to enable the correct placement of culvert structures. Such removed topsoil must be removed and be stored separately
- All removed topsoil and any removed subsoil must be stored separately. Removed topsoil and subsoil must not be stockpiled within the wetland.
- Access of machinery must be limited to the parts of the wetland immediately upstream / downstream of the crossing point, and machinery must not access any part of the wetland or the adjacent catchment more than 20m either upstream or downstream of the crossing.

12.3.3.4 Reconstruction of Road Crossing

- A box culvert of at least 1.5m in height and width must be placed in the wetland to replace the existing pipe and rocky substrate of the road. The culvert must be constructed so that the bottom of the culvert is at the natural ground level to allow movement of biota through the road crossing, and so as not to obstruct water flow in any way.
- Although bedrock outcropping is present in the in the wetland channel bed immediately downstream of the existing crossing that will prevent erosion, it is recommended that rip rap or similar large packed rocks be placed at the mouth of the culvert to retard flows exiting the culvert.
- Available bedrock from the old road crossing can be used to stabilise reinstated ground around the new crossing. A compacted mix of stone and smaller rocks can be used to stabilise reinstated slopes
- Newly created embankments adjacent to the newly constructed road crossing must not be designed to be too steep as these will easily erode. It is recommended that no slopes steeper than 40^{o} be incorporated into the design.
- Existing boulders can be used to stabilise or to form part of newly-created embankments on the upstream and downstream sides of the crossing
- Newly created embankments adjacent to the newly constructed road crossing must be reinstated with a layer of topsoil (ideally sourced from topsoil removed as part of the works in the wetland crossing or immediate catchment, as this soil will contain a natural seed base, but not topsoil from the existing embankments where kikuyu was growing). After reinstatement, all exposed, newly created slopes are to be covered with geotextile or similar hessian sack material pegged into the surface to protect the soil from erosion by water and wind

12.3.3.5 Reinstatement

- Any soils removed from the works area must be properly reinstated to natural ground levels
- If topsoil is imported, it must be seeded with a natural grass mix comprising of grass species typically found in the surrounding area.
- If a bund is placed across the wetland upstream of the crossing, this must be removed
- Any areas of compacted wetland soils must be lightly ripped / scarified, with care to be taken to not unduly damage (uproot) vegetation. This should be applied particularly to areas where excavators and similar heavy machinery have worked (alongside the road.

12.3.3.6 Stormwater

- Stormwater controls must be implemented on the road on both sides of the wetland in its immediate catchment that ensure that no silt from the road surface enters the wetland
- No channelised stormwater from the catchment / road surface must be discharged directly into the wetland. Flow retarding devices such as packed stone or rip-rap must be used to slow the velocity of stormwater down. It is recommended that stormwater from the road be discharged into grassy swales located outside of the wetland on its periphery in order to promote the slow infiltration of runoff into the wetland.

12.3.3.7 Service Areas and machinery

- No refuelling, servicing or chemical storage must occur within 50 m of the wetland boundary.
- A service area is to be established on the outside of the buffer zone of the wetland on each side of the pipeline consisting of at least a temporary refuelling area, maintenance area, waste collection and hazardous chemical storage points, all lined, impervious, demarcated and equipped with a spill kit.

- Any water pumps operating in the works area must be placed inside / on top of a drip tray to prevent any spillage and contamination to the wetland. The drip tray will be lined with absorbent pads and checked daily for spills
- No toilets are to be allowed within 50m of the water bodies – these are to remain outside the wetland.
- All equipment working in the wetland must be checked daily to ensure there are no oil / diesel leaks prior to entry into the wetland area

12.3.4 Rehabilitation Method Statement for Crossing 9

12.3.4.1 Summary of Overall Works:

- The existing road substrate is to be removed from the wetland and the single pipe is to be replaced with a suitably sized box culvert.
- The physical footprint of the works is to be kept as spatially limited as possible
- Sideslopes / embankments are to be properly vegetated and rehabilitated

12.3.4.2 Preparatory Works

- Delineate the boundary of the wetland (away from the working areas immediately adjacent to the road crossing) with stakes and danger tape (or similar measures), and mark as no-go.
- Lay Geotextile material over the areas where topsoil, subsoil, or rock will be stored. Geotextile material with a plastic membrane underneath it shall be placed on top of the top soil for the concrete batching area, if a batching area is required.
- Regular flow within the wetland is unlikely, however if works are being undertaken in the wet summer months, a temporary soil berm (placed over the existing vegetation) approx. 0.5m wide, comprising preferably of impermeable clay soil must be placed immediately upstream of the works area across the wetland in order to prevent overland flow from entering the works area and mobilising silt. Any ponded water must be pumped / flumed to a point downstream of the works and discharged into the channel of the wetland. If there is overland flow across the wetland, this flow must be temporarily channelled / flumed through the works area and discharged in a diffuse manner into the channel of the downstream wetland.
- 1 silt fence must be placed across the wetland within the downstream wetland (channel).

12.3.4.3 Removal of Existing Road Substrate, & excavation and storage of soil

- Existing rocky / soil substrate must be removed from the wetland and stored for re-use as required. Road substrate material must be removed to natural ground level. Soil from the existing embankments can be used for the newly-created embankments.
- All artificial fill (concrete) material must be separated from the natural rock road substrate and removed to an appropriate dumping site and not dumped within the wetland
- Natural soil material underlying the existing road that may need to be excavated to enable the correct placement of culvert structures. Such removed topsoil must be removed and be stored separately to be used to line embankments
- All removed topsoil and any removed subsoil must be stored separately. Removed topsoil and subsoil must not be stockpiled within the wetland.
- Access of machinery must be limited to the parts of the wetland immediately upstream / downstream of the crossing point, and machinery must not access any part of the wetland or the adjacent catchment more than 20m either upstream or downstream of the crossing.

12.3.4.4 Reconstruction of Road Crossing

- A box culvert of at least 1.5m in height and width must be placed in the wetland to replace the existing pipe and rocky substrate of the road. The culvert must be constructed so that the bottom of the culvert is

at the natural ground level to allow movement of biota through the road crossing, and so as not to obstruct water flow in any way.

- Although bedrock outcropping is present in the in the wetland channel bed immediately downstream of the existing crossing that will prevent erosion, it is recommended that rip rap or similar large packed rocks be placed at the mouth of the culvert to retard flows exiting the culvert.
- Available bedrock from the old road crossing can be used to stabilise reinstated ground around the new crossing. A compacted mix of stone and smaller rocks can be used to stabilise reinstated slopes
- Newly created embankments adjacent to the newly constructed road crossing must not be designed to be too steep as these will easily erode. It is recommended that no slopes steeper than 40^{o} be incorporated into the design.
- Existing boulders can be used to stabilise or to form part of newly-created embankments on the upstream and downstream sides of the crossing
- Newly created embankments adjacent to the newly constructed road crossing must be reinstated with a layer of topsoil (ideally sourced from topsoil removed as part of the works in the wetland crossing or immediate catchment, as this soil will contain a natural seed base). After reinstatement, all exposed, newly created slopes are to be covered with geotextile or similar hessian sack material pegged into the surface to protect the soil from erosion by water and wind

12.3.4.5 Reinstatement

- Any soils removed from the works area must be properly reinstated to natural ground levels
- If topsoil is imported, it must be seeded with a natural grass mix comprising of grass species typically found in the surrounding area.
- If a bund is placed across the wetland upstream of the crossing, this must be removed
- Any areas of compacted wetland soils must be lightly ripped / scarified, with care to be taken to not unduly damage (uproot) vegetation. This should be applied particularly to areas where excavators and similar heavy machinery have worked (alongside the road).

12.3.4.6 Stormwater

- Stormwater controls must be implemented on the road on both sides of the wetland in its immediate catchment that ensure that no silt from the road surface enters the wetland
- No channelised stormwater from the catchment / road surface must be discharged directly into the wetland. Flow retarding devices such as packed stone or rip-rap must be used to slow the velocity of stormwater down. It is recommended that stormwater from the road be discharged into grassy swales located outside of the wetland on its periphery in order to promote the slow infiltration of runoff into the wetland.

12.3.4.7 Service Areas and machinery

- No refuelling, servicing or chemical storage must occur within 50 m of the wetland boundary.
- A service area is to be established on the outside of the buffer zone of the wetland on each side of the pipeline consisting of at least a temporary refuelling area, maintenance area, waste collection and hazardous chemical storage points, all lined, impervious, demarcated and equipped with a spill kit.
- Any water pumps operating in the works area must be placed inside / on top of a drip tray to prevent any spillage and contamination to the wetland. The drip tray will be lined with absorbent pads and checked daily for spills
- No toilets are to be allowed within 50m of the water bodies – these are to remain outside the wetland.
- All equipment working in the wetland must be checked daily to ensure there are no oil / diesel leaks prior to entry into the wetland area

12.3.5 Rehabilitation Method Statement for Crossing 11

12.3.5.1 Summary of Overall Works:

- The existing road substrate is to be removed from the wetland and the single pipe is to be replaced with a suitably sized box culvert.
- The physical footprint of the works is to be kept as spatially limited as possible
- Sideslopes / embankments are to be properly vegetated and rehabilitated
- The two excavated depressions and associated bunds downstream of the crossing must be rehabilitated

12.3.5.2 Preparatory Works

- Delineate the boundary of the wetland (away from the working areas immediately adjacent to the road crossing) with stakes and danger tape (or similar measures), and mark as no-go.
- Lay Geotextile material over the areas where topsoil, subsoil, or rock will be stored. Geotextile material with a plastic membrane underneath it shall be placed on top of the top soil for the concrete batching area, if a batching area is required.
- Regular flow within the wetland is unlikely, however if works are being undertaken in the wet summer months, a temporary soil berm (placed over the existing vegetation) approx. 0.5m wide, comprising preferably of impermeable clay soil must be placed immediately upstream of the works area across the wetland in order to prevent overland flow from entering the works area and mobilising silt. Any ponded water must be pumped / flumed to a point downstream of the works and discharged into the channel of the wetland. If there is overland flow across the wetland, this flow must be temporarily channelled / flumed through the works area and discharged in a diffuse manner into the channel of the downstream wetland.
- 1 silt fence must be placed across the wetland immediately downstream of the crossing and a second must be placed across the wetland immediately downstream of the lower excavated depression to be re-filled.

12.3.5.3 Removal of Existing Road Substrate, & excavation and storage of soil

- Existing rocky / soil substrate must be removed from the wetland and stored for re-use as required. Road substrate material must be removed to natural ground level. Soil from the existing embankments can be used for the newly-created embankments.
- All artificial fill (concrete) material must be separated from the natural rock road substrate and removed to an appropriate landfill site and not dumped within the wetland
- Natural soil material underlying the existing road may need to be excavated to enable the correct placement of culvert structures. Such removed topsoil must be removed and be stored separately to be used to line embankments
- All removed topsoil and any removed subsoil must be stored separately. Removed topsoil and subsoil must not be stockpiled within the wetland.
- Access of machinery must be limited to the parts of the wetland immediately upstream / downstream of the crossing point and the excavated depressions downstream of the crossing, and machinery must not access any part of the wetland or the adjacent catchment more than 20m either upstream or downstream of the works area.

12.3.5.4 Reconstruction of Road Crossing

- A box culvert of at least 1.5m in height and width must be placed in the wetland to replace the existing pipe and rocky substrate of the road. The culvert must be constructed so that the bottom of the culvert is at the natural (pre-road construction) ground level to allow movement of biota through the road crossing, and so as not to obstruct water flow in any way.
- An attempt must be made to re-fill the excavated area immediately upstream of the exiting crossing (from which soil was excavated) to restore the natural ground level as far as possible. Material from the existing road embankments can be used for this purpose but must be consolidated / protected to prevent erosion and wash-away of the material
- Rip-rap or similar large packed rocks must be placed at the mouth of the culvert to retard flows exiting the culvert.
- Available bedrock from the old road crossing can be used to stabilise reinstated ground around the new crossing. A compacted mix of stone and smaller rocks can be used to stabilise reinstated slopes
- Newly created embankments adjacent to the newly constructed road crossing must not be designed to be too steep as these will easily erode. It is recommended that no slopes steeper than 40^{o} be incorporated into the design.
- Existing boulders can be used to stabilise or to form part of newly-created embankments on the upstream and downstream sides of the crossing
- Newly created embankments adjacent to the newly constructed road crossing must be reinstated with a layer of topsoil (ideally sourced from topsoil removed as part of the works in the wetland crossing or immediate catchment, as this soil will contain a natural seed base). After reinstatement, all exposed, newly created slopes are to be covered with geotextile or similar hessian sack material pegged into the surface to protect the soil from erosion by water and wind

12.3.5.5 Reinstatement

- Any soils removed from the works area must be properly reinstated to natural ground levels
- If topsoil is imported, it must be seeded with a natural grass mix comprising of grass species typically found in the surrounding area.
- If a bund is placed across the wetland upstream of the crossing, this must be removed
- Any areas of compacted wetland soils must be lightly ripped / scarified, with care to be taken to not unduly damage (uproot) vegetation. This should be applied particularly to areas where excavators and similar heavy machinery have worked (alongside the road).

12.3.5.6 Rehabilitation of excavated depressions

- Two elongated depressions were created downstream of the crossing point through an excavator digging out the topsoil within 2 areas of the downstream wetland. The excavated material was used to create a bund to impound water in the excavated depressions. The excavated soil must be reinstated to the excavated depression and lightly compacted, with the level slightly higher than ground level to allow for natural settling of material. Any excess material must be removed from this part of the wetland.
- If necessary the reinstated material placed back into the excavated depressions can be covered with geotextile material to protect it from erosion.

12.3.5.7 Stormwater

- Stormwater controls must be implemented on the road on both sides of the wetland in its immediate catchment that ensure that no silt from the road surface enters the wetland

- No channelised stormwater from the catchment / road surface must be discharged directly into the wetland. Flow retarding devices such as packed stone or rip-rap must be used to slow the velocity of stormwater down. It is recommended that stormwater from the road be discharged into grassy swales located outside of the wetland on its periphery in order to promote the slow infiltration of runoff into the wetland.

12.3.5.8 Service Areas and machinery

- No refuelling, servicing or chemical storage must occur within 50 m of the wetland boundary.
- A service area is to be established on the outside of the buffer zone of the wetland on each side of the pipeline consisting of at least a temporary refuelling area, maintenance area, waste collection and hazardous chemical storage points, all lined, impervious, demarcated and equipped with a spill kit.
- Any water pumps operating in the works area must be placed inside / on top of a drip tray to prevent any spillage and contamination to the wetland. The drip tray will be lined with absorbent pads and checked daily for spills
- No toilets are to be allowed within 50m of the water bodies – these are to remain outside the wetland.
- All equipment working in the wetland must be checked daily to ensure there are no oil / diesel leaks prior to entry into the wetland area

12.3.6 Rehabilitation Method Statement for Crossing 12

12.3.6.1 Summary of Overall Works:

- The existing road substrate is to be removed from the wetland and the single pipe is to be replaced with a suitably sized box culvert.
- The physical footprint of the works is to be kept as spatially limited as possible
- Sideslopes / embankments are to be properly vegetated and rehabilitated
- Stormwater from the road in the immediate (sloping) catchment must be properly managed.

12.3.6.2 Preparatory Works

- Delineate the boundary of the wetland (away from the working areas immediately adjacent to the road crossing) with stakes and danger tape (or similar measures), and mark as no-go.
- Lay Geotextile material over the areas where topsoil, subsoil, or rock will be stored. Geotextile material with a plastic membrane underneath it shall be placed on top of the top soil for the concrete batching area, if a batching area is required.
- Regular flow within the wetland is unlikely, however if works are being undertaken in the wet summer months, a temporary soil berm (placed over the existing vegetation) approx. 0.5m wide, comprising preferably of impermeable clay soil must be placed immediately upstream of the works area across the wetland in order to prevent overland flow from entering the works area and mobilising silt. Any ponded water must be pumped / flumed to a point downstream of the works and discharged into the channel of the wetland. If there is overland flow across the wetland, this flow must be temporarily channelled / flumed through the works area and discharged in a diffuse manner into the channel of the downstream wetland.
- 1 silt fence must be placed across the wetland immediately downstream of the crossing and a second must be placed across the wetland immediately downstream of the lower excavated depression to be re-filled.

12.3.6.3 Removal of Existing Road Substrate, & excavation and storage of soil

- Existing rocky / soil substrate must be removed from the wetland and stored for re-use as required. Road substrate material must be removed to natural ground level. Soil from the existing embankments can be used for the newly-created embankments.
- All artificial fill (concrete) material must be separated from the natural rock road substrate and removed to an appropriate landfill site and not dumped within the wetland
- Natural soil material underlying the existing road may need to be excavated to enable the correct placement of culvert structures. Such removed topsoil must be removed and be stored separately to be used to line embankments
- All removed topsoil and any removed subsoil must be stored separately. Removed topsoil and subsoil must not be stockpiled within the wetland.
- Access of machinery must be limited to the parts of the wetland immediately upstream / downstream of the crossing point and the excavated depressions downstream of the crossing, and machinery must not access any part of the wetland or the adjacent catchment more than 20m either upstream or downstream of the works area.

12.3.6.4 Reconstruction of Road Crossing

- A box culvert of at least 1.5m in height and width must be placed in the wetland to replace the existing pipe and rocky substrate of the road. The culvert must be constructed so that the bottom of the culvert is at the natural (pre-road construction) ground level to allow movement of biota through the road crossing, and so as not to obstruct water flow in any way.
- An attempt must be made to re-fill the excavated area immediately upstream of the exiting crossing (from which soil was excavated) to restore the natural ground level as far as possible. Material from the existing road embankments can be used for this purpose but must be consolidated / protected to prevent erosion and wash-away of the material
- Although bedrock outcropping occurs in the channel bed downstream of the crossing rip-rap or similar large packed rocks must be placed at the mouth of the culvert to retard flows exiting the culvert.
- Available bedrock from the old road crossing can be used to stabilise reinstated ground around the new crossing. A compacted mix of stone and smaller rocks can be used to stabilise reinstated slopes
- Newly created embankments adjacent to the newly constructed road crossing must not be designed to be too steep as these will easily erode. It is recommended that no slopes steeper than 40^{o} be incorporated into the design.
- Existing boulders can be used to stabilise or to form part of newly-created embankments on the upstream and downstream sides of the crossing
- Newly created embankments adjacent to the newly constructed road crossing must be reinstated with a layer of topsoil (ideally sourced from topsoil removed as part of the works in the wetland crossing or immediate catchment, as this soil will contain a natural seed base). After reinstatement, all exposed, newly created slopes are to be covered with geotextile or similar hessian sack material pegged into the surface to protect the soil from erosion by water and wind

12.3.6.5 Reinstatement

- Any soils removed from the works area must be properly reinstated to natural ground levels
- If topsoil is imported, it must be seeded with a natural grass mix comprising of grass species typically found in the surrounding area.
- If a bund is placed across the wetland upstream of the crossing, this must be removed
- Any areas of compacted wetland soils must be lightly ripped / scarified, with care to be taken to not unduly damage (uproot) vegetation. This should be applied particularly to areas where excavators and similar heavy machinery have worked (alongside the road).

12.3.6.6 Stormwater

- Stormwater controls must be implemented on the road on both sides of the wetland in its immediate catchment that ensure that no silt from the road surface enters the wetland, especially as the immediate catchment is sloping and may input silt into the wetland.
- No channelised stormwater from the catchment / road surface must be discharged directly into the wetland. Flow retarding devices such as packed stone or rip-rap must be used to slow the velocity of stormwater down. It is recommended that stormwater from the road be discharged into grassy swales located outside of the wetland on its periphery in order to promote the slow infiltration of runoff into the wetland.

12.3.6.7 Service Areas and machinery

- No refuelling, servicing or chemical storage must occur within 50 m of the wetland boundary.

- A service area is to be established on the outside of the buffer zone of the wetland on each side of the pipeline consisting of at least a temporary refuelling area, maintenance area, waste collection and hazardous chemical storage points, all lined, impervious, demarcated and equipped with a spill kit.
- Any water pumps operating in the works area must be placed inside / on top of a drip tray to prevent any spillage and contamination to the wetland. The drip tray will be lined with absorbent pads and checked daily for spills
- No toilets are to be allowed within 50m of the water bodies – these are to remain outside the wetland.
- All equipment working in the wetland must be checked daily to ensure there are no oil / diesel leaks prior to entry into the wetland area

13 POST REHABILITATION MANAGEMENT ACTIONS

It is important that the rehabilitation works be followed up with management and monitoring actions to ensure the integrity of newly constructed structures, and to counteract any erosion and other factors that could negatively impact the integrity of the rehabilitation effort. Such management actions are detailed below.

13.1 Exclusion of Livestock from Rehabilitation Sites

As detailed in the EIA wetland specialist report, livestock movement in the study area is a critical factor in the creation of erosion through the trampling of soils which results in the destruction of vegetation and the exposure and desiccation of these soils. Livestock tend to congregate around wetlands and rivers in order to drink water and in order to graze vegetation which is more nutritious than vegetation in surrounding grassland, especially in the non-growing season (winter).

Due to the physical reconstruction of the crossing sites which entails the re-profiling and re-vegetation of parts of the newly-constructed crossing, these areas will be vulnerable to erosion and physical disturbance, especially while newly reinstated areas are allowed to re-vegetate. If livestock (cattle) are allowed to access the sites immediately after reconstruction, trampling and the movement of livestock down banks / embankments could disturb re-vegetated topsoil. This risk applies to re-profiled slopes surrounding the culverts, as well as the wetland channel bed. All sites are vulnerable to cattle movement and disturbance, but the Witbankspruit (crossing 7) is particularly vulnerable due to cattle movement due to the perennial flow in the river.

As a result the following management actions are recommended:

- Immediately after rehabilitation works are completed, the rehabilitated area must be completed fenced off with a stock-proof fence to ensure that no livestock are able to access the new crossing and the area immediately upstream and downstream of the crossing.
- The rehabilitated sites are to remain fenced off for at least 6 months or until a full growing season has passed in order to allow reinstated surfaces to be fully vegetated.
- Prior to removal of fencing after this period has lapsed, the sites must be checked to ensure that re-vegetation has been complete and that topsoil is sufficiently protected. If not, sites must remained fenced off from livestock
- Once fencing is removed, part of the longer term monitoring of these sites must include monitoring of sites for signs of livestock-related / livestock-initiated erosion and trampling.

13.2 Fire and Burning:

In the same way as livestock movement and trampling can expose newly-reinstated soils and rehabilitating vegetation, fire can destroy or at least temporarily remove vegetation cover, leaving soils exposed to wind and water erosion. Thus:

- (Controlled) Veld burning actions / programmes in the area surrounding the rehabilitated sites must be prevented from causing vegetation at the rehabilitated sites from being damaged / burnt. If necessary a firebreak surrounding the rehabilitated sites must be created to ensure that vegetation at the sites is not damaged by fire.

13.3 Monitoring of Rehabilitated Sites

It is critical that the success of rehabilitation efforts be monitored once the works have been completed to check the stability and integrity of rehabilitated structures and areas and to make note of any developing problems that require follow up actions.

Following the completion of works, the following monitoring regime is recommended:

- For a period of 2 months after the completion of works, weekly monitoring of all sites is recommended. This monitoring must be undertaken by a suitably qualified environmental practitioner, preferably with wetland assessment and rehabilitation experience.
- Beyond 2 months of the completion of the works, bi-monthly monitoring must occur for the ensuing 4 months if in the dry season, or weekly monitoring must continue for the ensuing 4 months if these fall in the wet season (November to April).
- After 6 months of the completion of works, monthly monitoring of all sites must be undertaken for a period of up to 1 year from the completion of the works
- After a 1 year period has lapsed, monitoring must occur once every 3 months for the next year.

Monitoring must check for / report on:

- The integrity of reinstated soils and embankments at the rehabilitation sites
- The degree of vegetation-regrowth
- The presence of any emergent erosion in the form of rill erosion, headcut development, slumping or undercutting
- The emergence of weeds and alien invasive plant species
- The hydrological state of the wetland / river through the crossing – i.e. is water being ponded / impounded behind the new structure(s) or is it free-flowing
- The integrity of gabion structures, especially those installed along the banks of the Witbankspruit should be regularly checked.
- The integrity of stormwater controls from the road in the immediate catchment, taking note of the presence of any siltation related to stormwater ingress.

The following action must be taken if issues regarding the above are noted:

- Remedial actions must be undertaken preferably by manual means, rather than with machinery. If machinery needs to be used light machinery such as a bobcat excavator should be used.
- All erosion must be immediately rectified to prevent its further spread. The source of the erosion must be rectified if applicable. Eroded areas must be re-topsoiled and re-vegetated if necessary.
- Re-seeding of poorly re-vegetated areas can be considered if the initial seeding has not been successful. This can be considered especially if initial seeding was not undertaken in the growing season, and follow up seeding should ideally be undertaken just prior to the start of the growing season

In addition:

- A regular weed-clearing programme needs to be implemented at all crossings, and all declared invader plant species need to be removed at regular intervals (in line with the monitoring schedule above)