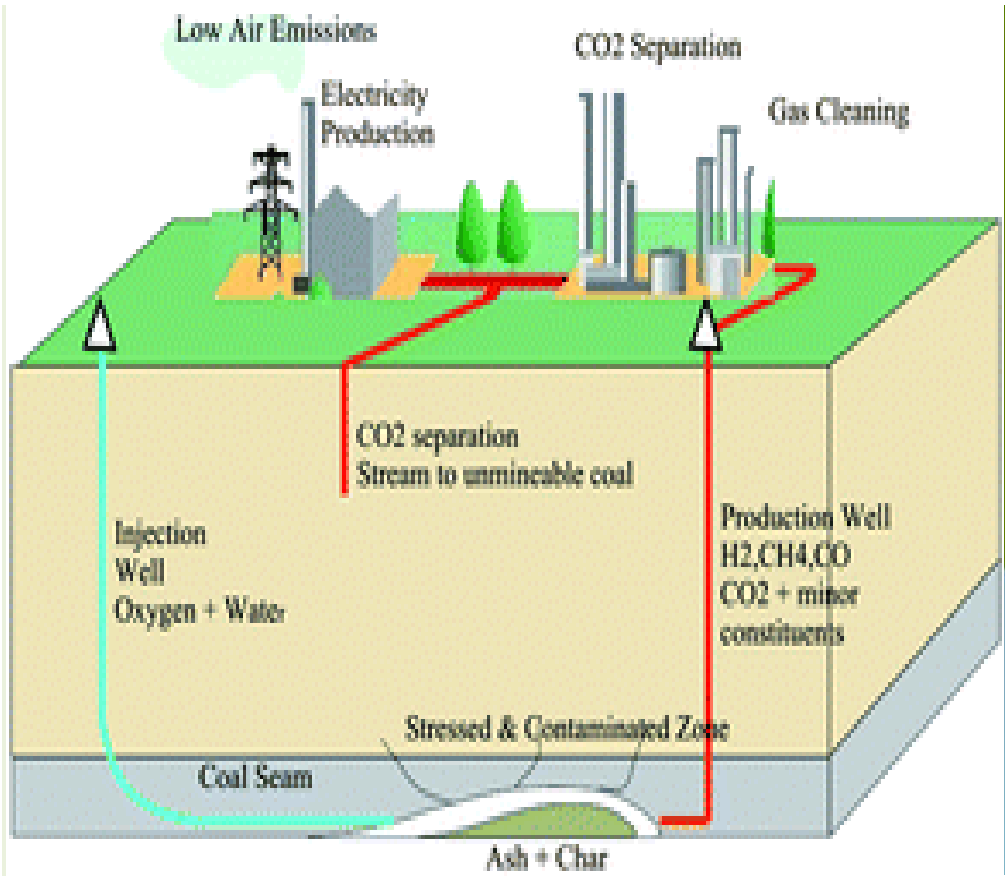
APPENDIX N:
WASTE IMPACT ASSESSMENT



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

Waste Impact Assessment

Eskom

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Definitions

By-product	Means a substance that is produced as part of a process that is primarily intended to produce another substance or product and that has the characteristics of an equivalent virgin product or material.
Constitution	Means the Constitution of the Republic of South Africa, 1996.
Container	Means a disposal or re-usable vessel in which waste is placed for the purposes of storing, accumulating, handling, transporting, treating or disposal of that waste, and includes bins, bin-liners and skips.
Decommissioning	In relation to waste treatment, waste transfer or waste disposal facilities, means the planning for and management and remediation of the closure of a facility that is in operation or that no longer operates;
Disposal	Means the burial, deposit, discharge, abandoning, dumping, placing or release of any waste into, or onto any land.
Domestic waste	Means waste, excluding hazardous waste, that emanates from premises that are used wholly or mainly for residential, educational, healthcare, sport or recreation purposes.
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, plant and animal life; (iii) Any part or combination of (i) and (ii) and the interrelationship among and between them; and (iv) The physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.[1]

[1] National Environmental Management Act 107 of 1998

Extended producer responsibility measures	Means measures that extend a person's financial or physical responsibility for a product to the post-consumer stage of the product that includes – (a) Waste minimisation programmes (b) Financial arrangements for any fund that has been established to promote the reduction, re-use, recycling and recovery of waste. (c) Awareness programmes to inform the public of the impacts of waste emanating from the product on health and the environment; and (d) Any other measures to reduce the potential impact of the product on health and the environment.
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.
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.
Inert waste	Means waste that- (a) Does not undergo any significant physical, chemical or biological transformation after disposal; (b) Does not burn, react physically or chemically biodegrade or otherwise adversely affect any other matter or environment with which it may come into contact; and (c) Does not impact negatively on the environment, because of its pollutant content and because the toxicity of its leachate is insignificant.
Landfill	The waste body created by landfilling. This may be above or

	below grade, or both.[2]
Minimisation	When used in relation to waste, means the avoidance of the amount and toxicity of waste that is generated and, in the event where waste is generated, the reduction of the amount and toxicity of waste that is disposed of.
Materials Recovery Facility	A specialized plant that receives, separates and prepares recyclable materials for marketing to the end-user manufacturers. Generally there are two types of MRF's: (a) Clean MRF which accepts recyclable commingled materials that have already been separated at the source from the MSW. (b) Dirty MRF accepts a mixed solid waste stream and then proceeds to separate designated recyclable materials through combination of manual and mechanical sorting.[3]
Pollution	Means any change in the environment caused by- (i) Substances; (ii) Radioactive or other waves; or (iii) Noise, odours, dust or heat, emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystem, or on materials useful to people, or will have such an effect in the future.[4]
Recovery	Means the controlled extraction of a material or the retrieval of energy from waste to produce a product.
Recycle	Means a process where waste is reclaimed for future use, which process involves the separation of waste from a waste stream for further use and the processing of that separated material as a

[2] Department of Water Affairs and Forestry, Second Edition, 1998. Waste Management Series. Minimum Requirements for waste disposal by Landfill
[3] http://en.wikipedia.org/wiki/Materials_recovery_facility
[4] National Environmental Management Act 107 of 1998

	product or raw material.
Re-use	Means to utilise articles from the waste stream again for a similar or different purpose without changing the form or properties of the articles.
Storage	Means the accumulation of waste in a manner that does not constitute treatment or disposal of that waste.
Treatment	Means any method, technique or process that is designed to- (a) Change the physical, biological or chemical character or composition of a waste; or (b) Remove, separate, concentrate or recover a hazardous or toxic component of a waste; or (c) Destroy or reduce the toxicity of a waste, in order to minimise the impact of the waste on the environment prior to further use or disposal.
Waste	Means any substance, whether or not that substance can be reduced, re-used, recycled and recovered- (a) That is surplus, unwanted, rejected, discarded, abandoned or disposed of. (b) Which the generator has no further use of for the purposes of production. (c) That must be treated or disposed of; or (d) That is identified as a waste by the Minister by notice in the Gazette, and includes waste generated by the mining, medical or other sector, but- (i) A by-product is not considered a waste; and (ii) Any portion of waste, once re-used, recycled and recovered, ceases to be waste.

Acronyms

BPEO	Best Practicable Environmental Option
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
D:EA&DP	Department of Environmental Affairs and Development Planning
DEA	Department of Environmental Affairs
DWAE	Department of Water Affairs and Environment
DWAF	Department of Water Affairs and Forestry
EIA	Environmental Impact Assessment
EPR	Extended Producer Responsibility
GHG	Greenhouse Gas
H_2S	Hydrogen sulphide
I&AP	Interested and Affected Parties
IEM	Integrated Environmental Management
IPC	Integrated Pollution Control
IPWC	Integrated Pollution and Waste Control
IPWIS	Integrated Pollutant Waste Information System
IWM (P)	Integrated Waste Management (Plan)
LWMA	Listed Waste Management Activities
MRF	Materials Recovery Facility
MSW	Municipal Solid Waste
NEAS	National Environmental Authorisation System
NEMA	National Environmental Management Act 107 0f 1998
NEMWA	National Environmental Management: Waste Act 59 of 2008
NWMS	National Waste Management Strategy
OCGT	Open Cycle Gas Turbine
PCF	Prototype Carbon Fund
POPs	Persistent Organic Pollutants
SANS	South African National Standards
SAWIS	South African Waste Information System

SDP	Site Development Plan
SMME	Small, Medium and Micro Enterprise
UNFCCC	United Nations Framework Convention on Climate Change
WMO	Waste Management Officer

1 INTRODUCTION

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. The technology has been through 11 years of intensive research by Eskom to achieve a better understanding of the gasification process, and the nature of the gas produced. In order to meet the fuel requirements for optimal power generation at the Majuba Power Station, Eskom proposes the use of synthetic gas (*syngas)* produced by the UCG process as a supplementary fuel source within the boilers at the power station. The plant has the capacity to produce 70000 Nm^3/hr (Normal Cubic Meter per hour) of gas. Based on the outcomes of the plant, Eskom may investigate the option of a commercial size power plant based on UCG technology.

A waste assessment has been undertaken to define the nature and scale of the potential environmental impacts associated with the project, specifically in terms of the amount and type of wastes generated during construction and options to avoid and manage the wastes. Both construction and operational phase impacts are considered and assessment of these in terms of waste management mitigation has been identified to determine whether any residual impacts can be reduced. A review of the legal requirements is also included.

The UCG site is located in the 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 and the Gert Sibande District Municipality.

2 PROJECT NEED AND BACKGROUND

Eskom Holdings 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. To guarantee medium to long term energy supply, Eskom has explored the concept of Underground Coal Gasification (UCG).

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. The technology has been through 11 years of intensive research by Eskom since 2001 to achieve a better understanding of the gasification process, and the nature of the gas produced. In order to meet the fuel requirements for optimal power generation at the Majuba Power Station, Eskom proposes the use of synthesis gas or *syngas (*15000 Nm^3/hr) produced by the UCG process as a supplementary fuel source within the boilers at the power station. The 15000 Nm^3/hr plant will be scaled up to 70000 Nm^3/hr and based on the outcomes of the 70000 Nm^3/hr plant, Eskom may investigate the option of a commercial size power plant based on UCG technology.

Further discussions on the rational for the project can be found in the Draft Environmental Scoping Report compiled by Royal HaskoningDHV and we refer to Sections 1.1 and 1.2 of the said report for more details.

3 LEGISLATION, STANDARDS, GUIDELINES AND CRITERIA

A legal review was conducted to ensure that the latest legislation is included as well as to achieve compliance with the requirements of the DEA. This review gives a brief overview of the pertinent sections of the respective legislation. The following legislation has been included for review:

A. International Conventions

- Basel Convention 1989
- Rotterdam Convention, 1998
- Stockholm Convention, 2004

B. National Legislation

- Constitution of the Republic of South Africa Act 108 of 1996
- National Environmental Management Act 107 of 1998
- National Environmental Management: Waste Act 59 of 2008
- National Water Act 36 of 1998
- National Health Act 61 of 2003
- National Roads Traffic Act 93 of 1996
- Hazardous Substances Act 15 of 1973
- Atmospheric Pollution Prevention Act 45 of 1965
- National Environment Management: Air Quality Act 39 of 2004
- Local Government (LG): Municipal Finance Management Act 56 of 2003
- LG: Municipal Structures Act 117 of 1998
- LG: Municipal Systems Act 32 of 2000
- Occupational Health and Safety Act 85 of 1993
- National Road Traffic Act 93 of 1996

C. Other Policies, Regulations and Standards

- White Paper on Integrated Pollution and Waste Management for South Africa May, 2000
- Minimum Requirements for waste disposal by landfill, 2nd Edition DWAF, 1998
- Minimum Requirements for handling, classification and disposal of hazardous waste, 3rd Edition DWAF, 2005
- South African National Standards 10228
- National Waste Management Strategy, 2011
- SANS 10234:2007 Global Harmonised System (GHS) classification and labelling of chemicals
- NEM:WA Draft national standard for disposal of waste to landfill: Government Notice (GN) 636, Gazette No. 36784 of 23 Aug 2013
- NEM:WA Draft standard for assessment of waste for landfill disposal: GN 635, Gazette No. 36784 of 23 Aug 2013
- NEM:WA Draft waste classification and management regulations: GN 634, Gazette No. 36784 of 23 Aug 2013
- NEM:WA Draft National Norms and Standards for the Storage of Waste : GN 926, Gazette No. 37088 of 29 Nov 2013

3.1 International Conventions

3.1.1 Basel Convention on the control of trans-boundary movement of hazardous waste and their disposal, 1989

The Basel Convention is a global agreement which seeks to address the trans-boundary movement of hazardous waste. Production of hazardous waste and trans-boundary movement of such could lead to violation of an existing treaty which may consequently attract severe sanctions. The focus of the convention is on the reduction of the production of hazardous waste and the restriction of trans-boundary movement and disposal of such waste. The agreement also ensures that there are strict controls in place when any trans-boundary movement and disposal of hazardous waste occur, and ensures it is undertaken in an environmentally responsible manner. The first Basel Convention which was held on 22 March 1989, called for the control of trans-boundary movement of hazardous waste and its disposal. Currently there is no legislation which gives effect to the convention, but South Africa has acceded to this. The second Basel Convention, held on 8 October 2005, set standards for the control of trans-boundary movements of hazardous waste and their disposal and includes the setting out of categorization of hazardous wastes and the policies between member countries.

The key objectives of the Basel Convention include:

- Minimisation of general or hazardous wastes in terms of quantity and hazardous status;
- Disposal of hazardous waste as close to the source of generation as possible.
- Reduction of the movement of hazardous wastes.

The most significant provision of the Convention relates to the ban on certain importations and exportations; illegal traffic, bilateral, multilateral and regional agreements and the control system of the Convention.

Eskom should take cognizance of this in terms of new technology and potential impacts that this could have on how they operate.

3.1.2 Rotterdam Convention, 1998

This Convention was held in September 1998 to address the importation of hazardous chemicals by promoting shared responsibility. A key provision in the Convention is the Prior Informed Consent (PIC) procedure which lists information on hazardous chemicals as Annex III. The Convention became legally binding on its parties in 2004. The Convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions on safe handling, and inform purchasers of any known restrictions or bans. Parties can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged make sure that producers within their jurisdiction comply. The Convention resulted in a PIC circular which is distributed every six months giving updated information on the listed chemicals, member compliance and sources of supporting information.

In 1995 the United Nations Environment Programme called for global action to be taken on persistent organic pollutants (POPs), which pose a threat to both health and the environment. As a result, the negotiations for the Stockholm Convention on POPs were initiated and culminated in May 2001, with the convention entered into force in May 2004. South Africa accedes to this convention, whereby member countries have agreed to phase out POPs, and prevent their import or export.

Eskom needs to be aware of these agreements to ensure that should they find that these hazardous materials are necessary for their operations, they need to be informed on the latest information which is shared through the PIC circular.

3.1.3 Stockholm Convention

The Stockholm Convention which was entered into force during May 2004 is another agreement which South Africa is signatory to. By acceding to this Convention, member countries like South Africa have agreed to phase out Persistent Organic Pollutants (POPs) and prevent their import or export. The Convention rules impose restrictions on the handling of all intentionally produces POPs which are highly toxic persistent chemicals. Twelve (12) POPs which have been identified include:

- Aldrin,
- Chlorade,
- Dieldrin,
- Dichloro-diphenyl-trichloroethan (DDT),
- Endrin,
- Hexachlorobenzene (,HCB),
- Heptachlor,
- Mirex,
- Polychlorinated biphenels (PCBs),
- Toxaphene,
- Dioxins,

Furans.

The two POPs which are still being used in South Africa include DDT and Chlordane, although their use is restricted under the Fertiliser Act as administered by the Department of Agriculture.

The relevance of the above is where there is any management of obsolete and banned substances. Although the use of DDT has been negotiated for further use due to its effectiveness in fighting malaria and PCBs will be phased out as well.

Currently there are programmes being initiated to reduce the amount of pesticides stocks to ensure these are phased out and through the programmes disposed of responsibly. Should it be necessary to control pests, Eskom needs to be aware of this and ensure compliance with this treaty.

3.2 National Legislation

3.2.1 Constitution of South Africa

The constitution is the supreme law of South Africa. Section 24 of the Constitution states that everyone has a right to an environment that is not harmful to their health or well being, and to have the environment protected for the benefit of the present and future generations. In terms of Section 32 everyone has the right of access to information held by the state as well as by another person for the exercise and protection of any rights.

Section 33 states that everyone has the right to administrative action that is lawful, reasonable and procedurally fair. This section will have an impact on the way in which local authorities carry out their responsibilities.

In terms of Section 36 the rights granted in the Bill of Rights may be limited only in terms of laws of general application that results in limitations that are reasonable and justifiable in an open and democratic society.

Section 38 of the Constitution states that anyone alleging an infringement of their constitutional rights may approach a competent court who may grant appropriate relief.

3.2.2 Environmental Rights

Section 24 of the Constitution's Bill of Rights states that:

Everyone has the right- to an environment that is not harmful to their health or well-being; and to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that - prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

3.2.3 Local Government Provisions

Local government matters are dealt with in Chapter 7 of the Constitution, and the following provisions must be highlighted:

Section 151 – Status of municipalities

(3) A municipality has the right to govern, on its own initiative, the local government affairs of its community, subject to national and provincial legislation, as provided for in the Constitution.

Section 152 – Objects of local government

(1) The objects of local government are -

(b) to ensure the provision of services to communities in a sustainable manner;

(d) to promote a safe and healthy environment

(2) A municipality must strive, within its financial and administrative capacity, to achieve the objects set out in subsection (1).

Section 156 – Powers and functions of municipalities

(1) A municipality has executive authority in respect of, and has the right to administer -

(a) the local government matters listed in Part B of Schedule 4 and Part B of Schedule 5; and

(b) any other matter assigned to it by national or provincial legislation.

(2) A municipality may make and administer by-laws for the effective administration of the matters which it has the right to administer.

(3) Subject to section 151(4), a by-law that conflicts with national or provincial legislation is invalid.

(5) A municipality has the right to exercise any power concerning a matter reasonably necessary for, or incidental to, the effective performance of its functions.

Section 162 – Publication of municipal by-laws

(3) Municipal by-laws must be accessible to the public.

3.2.4 Schedules 4 and 5

Schedules 4 and 5 to the Constitution are highly relevant as they clearly set out the legislative, functional and executive competences of national, provincial and local government respectively. The Schedules are divided into Parts A and B respectively. Part B of both Schedules lists those areas over which local government has some executive authority.

Schedule 4 describes the functional areas of concurrent national and provincial legislative competence. Of importance for present purposes are the following areas, set out under Part A of Schedule 4:

- Agriculture
- Environment
- Pollution control

Schedule 4 Part B contains amongst others this functional area of local government:

- Air pollution
- Municipal planning
- Water and sanitation services limited to potable water supply systems and domestic wastewater and sewage disposal systems

Schedule 5 lists functional areas of exclusive provincial legislative competence. Schedule 5 Part B contains, inter alia, these functional areas of local government:

- Cleansing
- Control of public nuisances
- Refuse removal, refuse dumps and solid waste disposal

Municipalities have executive authority over and the right to administer those local government matters listed in Part B of Schedules 4 and 5 respectively or which were assigned to them in terms of national or provincial legislation (e.g. certain health and environmental health functions). To this end municipalities may pass and administer by-laws for the effective administration of those matters. This process is governed by section 156.

These functional distinctions are of vital importance as any by-law or function of a municipality will always have to be evaluated against the provisions of Schedules 4 and 5. Should there be a conflict or contravention then such by-law or function may be found to be unconstitutional (Section 156(3)).

Eskom therefore needs to ensure that they are aware of their responsibilities as well as the Municipalities responsibilities with respect to waste management.

3.2.5 National Environmental Management Act, 107 of 1998

A detailed description has been provided in the Draft ESR which was compiled by Royal HaskoningDHV. The review below focuses on the waste management aspects.

This Act (hereafter referred to as NEMA) is the framework legislation governing environmental matters and all other related legislation must be read subject to its provisions. Any functions and actions carried out by organs of state must follow the general principles (section 2) and spirit of this law due to the fact that these organs are bound by the Act (section 48).

While NEMA does not deal much with waste management per se, it nonetheless sets out some important provisions which will be discussed below.

Sustainable development requires the consideration of, amongst other factors:

> *that waste is avoided, or where it cannot altogether be avoided, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner (section 2(4)(a)(iv)).*

NEMA also defines "pollution" as

any change in the environment caused by-

- *(i) substances;*
- *(ii) noise, odours, dust or heat,*

emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future (section 1).

There is a duty on persons to take reasonable measures to prevent pollution or degradation of the environment from occurring, continuing or recurring, or in so far as such harm is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution or degradation of the environment (section 28(1)). This duty rests on, amongst others, the landowner, the person in control or user thereof (section 28(2)). State organs are also subject to these provisions.

Chapter 5 of the Act also requires the application of integrated environmental management principles and objectives.

3.2.6 National Environmental Management: Waste Act 59 of 2008

The Act is the product of the National Waste Management Strategy as well as the White Paper on Integrated Pollution and Waste Management (IPWM). It sets the framework for integrated waste management for the entire country. Future policies and legislation will need to follow its provisions and as such it will become a key law.

The Act gives legal effect to the waste management hierarchy and the MEC has the right to set waste minimization norms and targets. Importantly the Act aims to ensure the minimising of natural resources and hence promotes sustainable practices in the waste management arena. It therefore promotes and enforces improved prevention of pollution and ecological degradation. The Act will achieve integrated waste management reporting and direct the licensing of waste management facilities.

Specific sections in the Act that the Eskom should be cognisant of include:

Part 1 which deals with the National Waste Management Strategy.

Section 16 refers to the generator of waste's responsibilities. A generator of waste has a general duty to take all reasonable measures to adhere to the waste management hierarchy. The generator of waste must ensure that the management of the waste is carried out to cause the least or no harm to the environment or human beings.

Section 18 refers to the extended producer responsibility (EPR) which may be imposed for certain products or classes of products, alternatively certain classes of persons (i.e. industries). A category or an industry may be required to produce industry waste management plans.

Section 19 refers to listed waste management activities (LWMA). Government Notice no 718 of 3 July 2009 lists the waste management activities that have, or are likely to have a detrimental effect on the environment. Category A activities are those LWMA which require a basic assessment as stipulated in the EIA regulations made under section 24(5) of the NEMA as part of the waste management licence application process. Category B activities are those LWMA which require a full EIA as stipulated in the EIA regulations made under section 24(5) of the NEMA as part of the waste management licence application process (Government of South Africa, 2008b)[5]

[5] National Environmental Management: Waste Act 59 of 2008

Industry Waste Management Plans (IndWMPs) are the main co-regulatory instruments within the waste management system. They describe the waste related issues within an industry, and specify how the industry will address these issues, giving specific actions, targets and timeframes.

Part 7 of the Waste Act, section 28 to section 34, sets out the requirements for IndWMPs, which may be prepared on a mandatory or voluntary basis. The Minister may request an IndWMP for waste generating activities that affect more than one province or which occur in more than one province. The provincial MEC may request an IndWMP for waste generating activities within the province, provided that such a plan has not already been requested by the Minister. Industry may also prepare and submit plans on a voluntary basis.

The current system does not require Eskom to compile a waste management plan, however best practice should be adopted which is achieved through the implementation of the waste management hierarchy and waste management planning.

3.2.7 National Water Act, 36 of 1998

In terms of the Water Act 54 of 1956 water pollution was controlled through the setting of emission control standards. This particular practice is still in force in terms of Section 21 of the National Water Act of 1998. The National Water Act 36 of 1998 combines the prevention of pollution approach with the control of pollution. This is done through the regulation of waste standards, the monitoring of waste discharged and prescribing the outcome of effect which must be achieved through management practices for the treatment of waste or any class of waste before it is discharged or deposited into or allowed to enter a water resource (Glazewski, 2005)

3.2.8 National Health Act 61 of 2003

Compliance in terms of Section 83 of the act needs to be ensured. Section 83 states that:

"(1) (a) If a health officer has reasonable grounds to believe that any condition exists which-

(a) constitutes a violation of the right contained in section 24(a) of the Constitution

(b) constitutes pollution detrimental to health;

(c) is likely to cause a health nuisance; or

(d) constitutes a health nuisance,

the health officer must investigate such condition". (Government of South Africa, 2008b)

3.2.9 National Road Traffic Act, Act 93 of 1996

This Act provides for road traffic matters which apply uniformly throughout South Africa. Chapters IV, V and VI are important with regard to waste, as it controls the fitness of drivers, operators and vehicles.

Chapter VIII deals with the transportation of dangerous goods (previously hazardous substances), which could be applicable to certain types of hazardous waste types. It is prescriptive and deals with the registration of operators and prescribes the duties of consignors, consignees and operators of dangerous goods, products and vehicles. There are certain SANS standards that have to be adhered. Routes for the transport of certain dangerous goods must also be pre-planned and coordinated with the relevant authorities.

3.2.10 Hazardous Substances Act 15 of 1973

Hazardous substances are governed mainly by the Hazardous Substances Act, 15 of 1973. The Act classifies certain types of hazardous substances into four groups and imposes detailed requirements (through the use of Regulations) dealing with the handling, selling, using, operating, applying and installation etc thereof. The disposal of hazardous substances is also regulated, although only minimally (see e.g. the disposal of empty containers for Group I hazardous substances - Regulation 10 of the Group I Hazardous Substances Regulations (GN R 453 of 25 March 1977).

3.2.11 Occupational Health and Safety Act, 85 of 1993

This Act has relevance for environmental matters as it governs and regulates the health and safety of employees and the public in general. Employers, self-employed persons and employees are under a duty not to endanger or risk the health of others and to maintain a safe (working) environment (see e.g. sections 8, 9 and 15).

In addition several Regulations promulgated in terms of the Act contain provisions dealing with the handling or disposal of hazardous substances/chemicals or waste in general. Examples are:

- Asbestos Regulations – disposal of asbestos (Regulation 20) (GN R 155 of 10 February 2002)
- Lead Regulations – disposal of lead waste (Regulation 17) (GN R 236 of 28 February 2003)
- Hazardous Chemical Substances Regulations - disposal of hazardous chemical substances (Regulation 15) (GN R 1179 of 25 August 1995
- Environmental Regulations for Workplaces – housekeeping (Regulation 6) (GN R 2281 of 16 October 1987)

The first three Regulations require an employer to control exposure of employees by investigating the use of alternative substances, to the extent that this is possible, and furthermore, to recycle such substances (in the case of lead and hazardous chemical substances).

3.3 Other Policies, Regulations and Standards

3.3.1 White Paper on Integrated Pollution and Waste Management (2000)

One of the fundamental approaches in terms of the White Paper's policy is to prevent pollution, minimise waste and to control and remediate impacts. Waste management is to be implemented in a holistic and integrated manner, extending over the entire waste cycle.

The White Paper advocates a shift from the present focus on waste disposal and impact control (i.e. end of pipe) to integrated waste management, prevention as well as minimisation.

The White Paper defines "waste" (see Glossary to White Paper) as

"an undesirable or superfluous by-product, emission, or residue of any process or activity which has been discarded, accumulated or been stored for the purpose of discharging or processing. It may be gaseous, liquid or solid or any combination thereof and may originate from a residential, commercial or industrial area." This definition includes industrial wastewater, sewage, radioactive substances, mining, metallurgical and power generation waste.

As is apparent from the above, the White Paper (quite correctly so) adopts a much broader and integrated definition of waste in that it does not limit the definition to solid waste only. The focus of this Review is, however, legislation dealing largely with solid waste and its management. This was already pointed out in 2.1.

The following waste management hierarchy is to be adopted in the NEMWA:

- Waste avoidance, minimisation and prevention
- Recycling and reuse
- Treatment and handling
- Storage and final disposal

As can be seen, the avoidance, minimisation and prevention of waste are accorded absolute priority. However NEM:WA now also emphasises the adoption of Reclamation in the waste hierarchy and this needs to be enforced through all government structures.

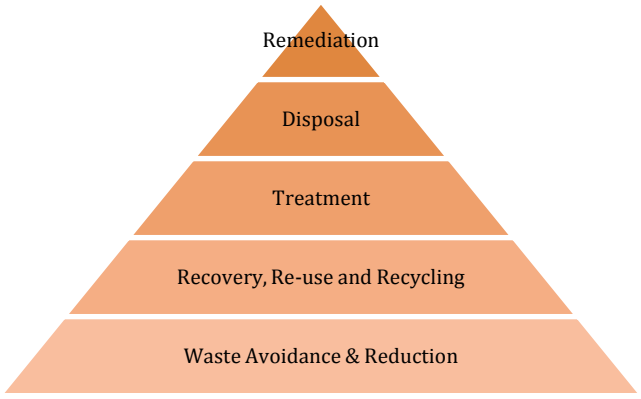

Figure 1: Waste Hierarchy, NWMS 2010 (DEA, 2011a)[6]

[6] National Waste Management Strategy, 2011

A functional approach to integrated pollution and waste management is to be adopted by putting in place :

- Source-based controls
- Management of the receiving environment (impact management)
- Remediation

3.3.2 Draft National Waste Management Strategies and Action Plans (NWMS) (November 2011)

- The 1999 National Waste Management Strategy (NWMS) has laid the foundations for a coherent waste management regime with:
- the development of a comprehensive Waste Information System;
- the development of an integrated waste management planning system;
- the development of draft regulations and guidelines;
- significant advances in approaches to waste minimisation and recycling;
- innovations in the sphere of waste collection; and
- improvements in the way in which different forms of waste are disposed of and the regulation thereof.
- The greatest challenge to its successful implementation was the absence of a coherent regulatory framework, a factor that has now been addressed through the promulgation of the Waste Act (No 59. of 2008) (the Waste Act).
- The Department of Environmental Affairs (DEA) has commenced with the process for the development of the strategy. A framework for the strategy has been prepared, stakeholders have been consulted, baseline research on the main themes has been commissioned to inform the drafting process, and the findings of the research have been debated by government and stakeholders in the sector.
- The Polokwane Declaration at the National Waste Management Summit in 2002 set targets for waste generation to decrease by 50% by 2012, and
- Waste disposal to decrease by 25% by 2012, with the ultimate aim of developing a plan for zero waste by 2022.

These ambitious targets not only draw attention to government's commitment to integrated waste management, but also emphasize waste minimisation as an environmental policy priority.

a) Implementation process of the National Waste Management Strategy

The Waste Act provides a range of mandatory and discretionary regulatory instruments that can be used to achieve the objectives of the Waste Act. There is a suite of economic and fiscal measures that can play a complementary role to the regulatory instruments. Lastly there are the voluntary initiatives that can be taken by government and citizens, which constitute the mainstay of the strategy. Drawing on the above approach to implementing the waste hierarchy, the main instruments that will be used as elements of the overall strategy include:

- Norms and Standards;
- Categorisation and Classification;

- Waste Information System;
- Industry Waste Management Plans;
- Listing and Licensing of Waste Management Activities;
- Special Measures;
- Producer Responsibility;
- Consumer Protection;
- Economic Instruments; and
- Fiscal Mechanisms for Waste Management

Included in the implementation process is provision for mechanisms to co-ordinate activities between different implementation agencies, to develop processes for the introduction of waste minimisation and reduction, to record progress with the implementation through waste management information systems, and to establish appropriate funding mechanisms.

b) Role of Integrated Waste Management Planning (IWMP) in the development of the IDP

The IWMP should be seen as an integral part of the Integrated Development Plan (IDP) that needs to be developed by municipalities. The requirements with regard to integrated development planning, as stipulated in the Municipal Systems Act, and recently published regulations, must therefore be considered and complied with. Waste management input into the IDP is guided through the development of an Integrated Waste Management Plan (IWMP).

The primary objective of integrated waste management (IWM) planning is to integrate and optimise waste management, in order to maximise efficiency and minimise the associated environmental impacts and financial costs, and to improve the quality of life of all South Africans. The integration must be both horizontal and vertical within the government departments, as well as in other sectors and throughout the 'waste life-cycle'.

The integrated waste management planning process incorporates all the major stages of the environmental planning process, namely:

- Reviewing the existing baseline situation and legal environment;
- Making projections of future requirements;
- Setting objectives;
- Identifying system components;
- Identifying and evaluating alternative methods/approaches for meeting requirements;
- Developing and implementing an integrated waste management plan;
- Evaluating and reviewing the plan to ensure the respective objectives are being met.

3.3.3 Current and future IndWMPs[7]

The MEC has identified priority Industries which are required to prepare and submit InWMPs. An initial set of IndWMPs are being prepared by the following industries in consultation with DEA:

- Tyres industry to manage waste tyres.
- Paper and Packaging industry to manage packaging and paper waste.
- Lighting industry manufacturing mercury containing lamps e.g. CFLs.
- Pesticide Industry to manage residual pesticides and pesticide containers.

It is envisaged that these plans will be completed and approved by the end of 2010. Over the course of the next five years, it is envisaged that IndWMPs will be required at sector level from the following industries:

Table 1: Priority Waste Streams with related timeframes from NWMS

Waste stream	Specific considerations	Timeframe
eWaste	There are seven types of recognised eWaste, lighting waste is already subject to an IndWMP, and therefore the other six types of eWaste should be considered and prioritized. Separate IndWMPs may be required.	Plans to be prepared within 2 years
Batteries	There are seven types of batteries and each type should be considered within the plan.	Plan to be prepared within 2 years
Mining waste		Plan to be prepared within 3 years

Once the sector level plans have been approved for the above industries, company level plans will be required to be submitted to give effect to the provisions of the sector plan within one year of the approval of the relevant sector level plan.

3.3.4 Polokwane Declaration on Waste Management (2001)

In 2001 representatives from all three government levels, civil society and business met at Polokwane to formulate a declaration on waste management.

In its preamble the declaration realises that there is a need for urgent action to reduce, reuse and recycle waste. Furthermore, the represented sectors recommitted themselves to the objectives of an integrated pollution and waste management policy.

A goal was set to reduce waste generation and disposal by 50% and 25% respectively by 2012 and to develop a plan for zero waste by 2022.

It remains to be seen if these targets will or can be achieved within the above timeframes.

3.3.5 Department of Water Affairs: Minimum Requirements

The National Environmental Management: Waste Act 59 of 2008 (NEMWA) makes provision for the licensing of waste disposal facilities through co-operative governance.
Currently there is an agreement in place between Department of Water Affairs and national and provincial departments of environment to include water protection conditions provided by the Department of Water Affairs in terms of the National Water Act in the waste management licenses. Part of the above-mentioned agreement was also to still use the DWAF minimum requirements guidelines.
The three documents produced by the DWAF in 1998 refer:

- Minimum Requirements for the Handling and disposal of Hazardous waste
- Minimum Requirement for Waste Disposal by landfill
- Minimum Requirements for Monitoring at Waste Management Facilities.

The objectives of the Minimum Requirements for Waste Disposal include:

- Guidelines for Permitting, Design, Operation and Closure
- Classification of landfill, G – general and H – Hazardous
- Integrated Environmental Management approach
- Promoting waste minimisation through the emphasis of the waste management hierarchy.

3.3.6 SANS 10228

SANS 10228 is the code for identification and classification of dangerous goods and substances. This is a system for classifying hazardous substances for transport purposes. Until the new classification system is in place adherence to this standard has to be ensured.

In the Code, hazardous substances are given an identification number and divided into nine classes and various sub-divisions. These are listed in the table below:

Table 2: SANS 10228

Class	Description
Class 1	**Explosives**
Class 2	**Flammable gases**
2.1	**Non-flammable gases**
2.2	**Poisonous gases**
2.3	**Explosives**

Class	Description
Class 3	**Flammable liquids**
3.1	**Low flashpoint group of liquids; flashpoint below – 18°C c.c*.**
3.2	**Intermediate flashpoint group of liquids; flashpoint of –18°C up to, but not including 23°C c.c.**
3.3	**High flashpoint group of liquids flashpoint of 23°C up to, and including, 61°C c.c**
Class 4	**Flammable solids or substances**
4.1	**Flammable solids**
4.2	**Flammable solids liable to spontaneous combustion**
4.3	**Flammable solids which emit flammable gases when in contact with water**
Class 5	**Oxidising Substances**
5.1	**Oxidising agents**
5.2	**Organic peroxides**
Class 6	**Poisonous (toxic) and infectious substances**
6.1	**Toxic substances**
6.2	**Infectious substances**
Class 7	**Radioactive substances**
Class 8	**Corrosive substances**
Class 9	**Other miscellaneous substances, that is any other substance which experience has shown, or may show, to be of such dangerous character that the provisions of this Section should apply to it**

Waste must be tested against the nine classes mentioned above, to see into which class it falls. The Minimum Requirements for that class must then be complied with. If the minimum requirement show that the waste must be treated to reduce its hazardousness such treatment must be deployed. After treatment one would have to determine the toxicity of the waste or the residue remaining after in order to determine the Hazard Rating which in return will determine the method of final disposal.

SANS Code 10228 also provides a danger rating for transport. This rating is, however, only related to the risk the substance poses to man during transport. The Hazard Rating for disposal, on the other hand, also takes into account risk to the environment.

To determine the Hazard Rating, the Estimated Environmental Concentration (EEC) of the substance in the waste is calculated in grams disposed of per hectare per month multiplied by a factor of 0, 66. The EEC is compared to the Acceptable Risk Level and if the EEC is higher than the Acceptable Risk Level, then the waste remains in the originally classified Hazard Rating. If the EEC is lower than the Acceptable Risk Level, the waste may delist to a lower Hazard Rating for final disposal.

The EEC is therefore used to determine the amount of a substance that can safely be disposed of per hectare per month at a landfill site. The EEC is also used to determine the total amount of a hazardous substance that may be accepted at a certain landfill site.

3.3.7 NEM:WA : Government Notice 636 Gazette No. 36784 of 2013

This Standard determines the requirements for the disposal of waste to landfill as contemplated in regulation 8{1){b) and 8(1)(c) of the Regulations. Chapter 2 focuses on the landfill design requirements, hazard requirements and permissible disposal at the landfill sites as per the latest classification standards, waste acceptance criteria for waste disposal to landfill and waste disposal restrictions.

3.3.8 NEM:WA : Government Notice 635 Gazette No. 36784 of 2013

Chapter 2 specifically deals with waste disposal risk rating of total concentrations and leachable concentrations associated with wastes. If the waste is classified according the DWAF Minimum Requirements, then the waste material will need to be re-classified. See below.

12. Implementation and Transitional Provisions

(1) All wastes that were classified in terms of the Minimum Requirements for the Handling, Classification and Disposal of Hazardous Waste (2nd Edition, 1998; Department of Water Affairs and Forestry), or waste for which an alternative classification was approved by the Department of Water Affairs or Department of Environmental Affairs, prior to these Regulations taking effect, must be—

(a) re-classified in terms of Regulation 4(1); and

(b) assessed in terms of Regulation 8(1)(a) if the waste is to be disposed to landfill,

within three (3) years from the date of commencement of these Regulations.

3.3.9 NEM:WA Draft Waste Classification and Management Regulations: Government Notice 634 Gazette No. 36784 of 2013

Waste must be kept separate for the purposes of classification. A revised Waste Classification and Management System that will support South Africa's drive to ensuring the protection of the environment through application of the waste management hierarchy was gazetted and published on 23 August 2013. The waste management hierarchy requires firstly that the generation of waste is reduced, waste that cannot be reduce is reused or recycled, waste that cannot be reused or recycled should be treated or the energy should be recovered before landfilling. The landfill option is the least favoured option in this hierarchy.

Criteria	Waste Disposal Risk Rating	Description of Risk associated with Disposal to Landfill
LC > LCT2, or TC > TCT2	Type 0: Very High Risk	Considered very high risk waste with a very high potential for contaminant release. Requires very high level of control and ongoing management to protect health and the environment.
LCT1 < LC ≤ LCT2, or TCT1 < TC ≤ TCT2	Type 1: High Risk	Considered high risk waste with high potential for contaminant release. Requires high level of control and ongoing management to protect health and the environment.
LCT0 < LC ≤ LCT1 and TC ≤ TCT1	Type 2: Moderate Risk	Considered moderate risk waste with some potential for contaminant release. Requires proper control and ongoing management to protect health and the environment.
LCTi < LC ≤ LCT0 and TC ≤ TCT0	Type 3: Low Risk	Low risk waste with low potential for contaminant release. Requires some level of control and ongoing management to protect health and the environment.
TC < 20 x LCTi, or LC ≤ LCTi and TC ≤ TCTi	Type 4: Inert Waste	Very low risk waste that– (a) does not undergo any significant physical, chemical or biological transformation; (b) does not burn, react physically or chemically or otherwise affect any other matter with which it may come into contact; and (c) does not impact negatively on the environment because of its very low pollutant content and because the toxicity of its leachate is insignificant. Only basic control and management required.

(d) Wastes with any element or chemical substance concentration above the LCT0 but below LCT1 values () and all concentrations below the TCT1 values (LCT0 < LC ≤ LCT1 and TC ≤ TCT1) are Type 3 Wastes;

Refer to Gazette no 36784 notice no. 635, August 2013. Norms and Standards for the Assessment of Waste for Landfill Disposal

Refer to National Waste Information Regulations (Gazette number 36784 notice no. 634, August 2013) for detail on duties by “Waste generator” and the “Waste Manager”

The solute seepage (organic and inorganic) does need to be calculated in accordance with prescribed Australian methods, as directed in the Regulations.

Although not a legal requirements as yet, it is prudent to classify waste-material in order to identify the necessary lining and capping system.

If the waste is not classified now, according to the regulations (634 of 2013), then it will possibly be a requirement to classify the waste within 180 days after the regulation has been gazetted. The waste material will then need to be re-classified every five years (See Part 6 of these Regulations).

Table 3-3: Excerpt from Regulation 634 of 2013, Section 10

10. Records of Waste Generation and Management

(1) Waste generators must keep accurate and up to date records of the management of the waste they generate, which records must reflect—

(a) the classification of the wastes;

(b) the quantity of each waste generated, expressed in tons per month;

(c) the quantities of each waste that has either been re-used, recycled, recovered, treated or disposed of; and

(d) by whom the waste was managed.

3.3.10 National Norms and Standards for the Storage of Waste: Government Notice 926 Gazette No. 37088 of 2013

The NEMWA requires the establishment of the NWMS that obliges holders of waste to take practical measures to implement the waste hierarchy whilst protecting the environment and public health. The function of standards for the storage of waste is to ensure best practice and provide a consistent national approach relating to the management of waste storage facilities and to provide minimum standards for the design and operation of new and existing waste storage facilities. The development of these standards is the foundation of the regulatory system established in terms of Section 7(1) (c) of the NEMWA.

The location of waste storage facilities must take consideration of the public health and environmental protection. The following design requirements are applicable for waste storage facilities during according to the National Norms and Standards for the Storage of Waste:

Construction and development of the waste storage facility must be carried out under the supervision of a registered professional engineer appointed and according to the approved civil engineering designs. The plan must only be amended and approved by a registered professional engineer.

The liquid waste storage area must have a firm, impermeable chemical resistant floors and a roof. Liquid waste containers that are not stored under a roofed area must be coated to prevent direct sunlight and rain water from getting in contact with the waste.

The storage area of hazardous waste must have an impermeable floor, chemical resistant floors.

The liquid waste storage facility must be surrounded by an interception trench with a sump for intercepting and recovering potential spills and must be lined in compliance with the requirements set out in paragraph (7) 2 of these standards.

The storage facility must be constructed to maintain on a continuous basis a drainage and containment system capable of collecting and storing all runoff water arising from the storage facility in the event of a flood. The system must under the said rainfall event, maintain a freeboard of half a meter.

The liquid waste storage area must have a secondary containment system (e.g. bund, drip tray) of sufficient capacity to contain at least 110% of the maximum contents of the storage facility. Where more than one container/tank is stored, the bund must be capable of storing at least 110% of the largest tank or 25% of the total storage capacity, whichever is greater (in the case of drums the tray/bund size must be at least 25% of total storage capacity).

4 WASTE ASSESSMENT

4.1 The UCG Process Principles

The project description should be taken from the Draft ESR and has not been included in this report.

The basic flow diagram for the entire process is presented in Figure 2.

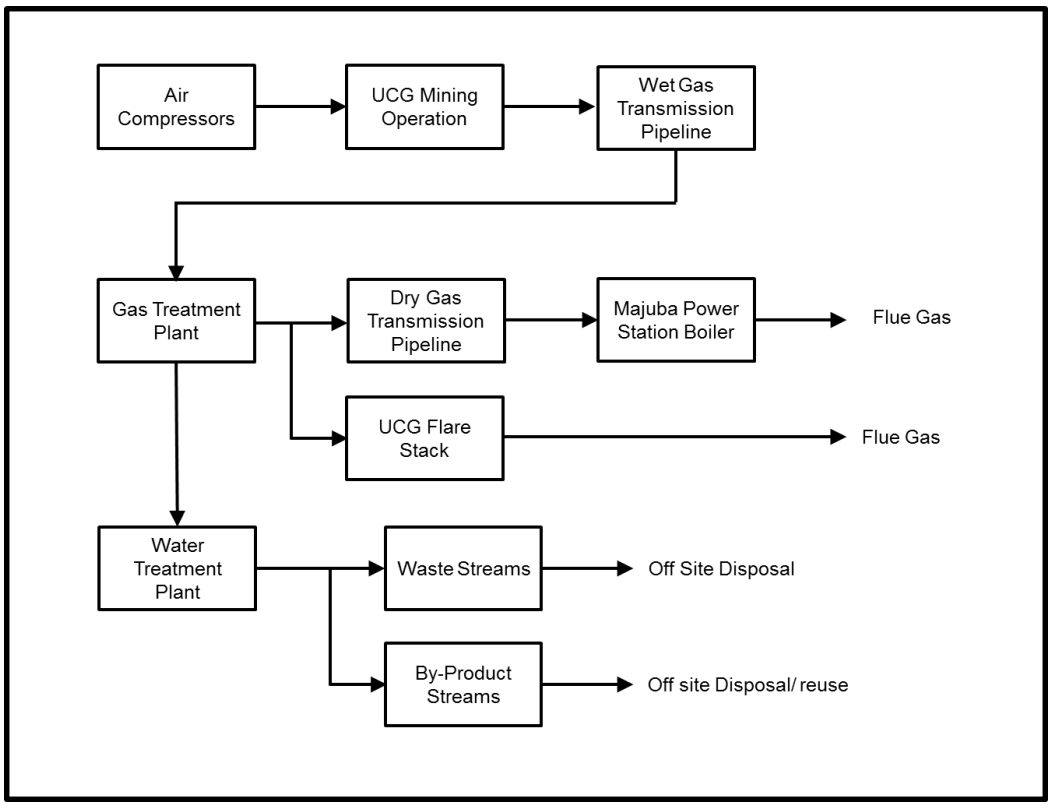

Figure 2: Block flow diagram for the 70000 Nm^3/hr pilot plant

The UCG process remains primarily a mining operation and the key components of the mining operation include the drilling, exploration and monitoring wells – also referred to as the gasfield (Photograph 1). The gasfield contains two major components namely the gasifier units and ancillary infrastructure such as access roads, pipelines, manifolds etc. The continuous linkage of wells in the gasifier to enable the process to access virgin coal and the monitoring and modelling of the geohydrological, rock mechanics and geological characteristics of the targeted coal seam.

Photograph 1: Representation of a gasfield as seen on the surface[8]

The implementation of gasifier units will be based on the gas input requirements for Phase 1B and 1C (production of 15000 and 70000 Nm^3/hr of syngas respectively). The gasifier unit has an approximate footprint of 50 ha with a maximum height of 15 m and will be operated independently from one another in order to control the gasification processes. A typical gasfier unit is made up of the following components:

- Above-ground air pipeline
- A network of above ground primary gas pipelines
- A secondary gas pipeline located at the border of the gasification unit
- Injection and production wells
- Water monitoring wells
- Air pressure unit
- Pressure measurement units
- One lane gravel assess road
- Wastewater pipeline

4.2 Construction phase waste material

Waste information has been supplied by the engineers from Eskom. It is based on data available from the USSR where UCG operations has been taking place for a number of years.

4.2.1 Waste generated during Construction, management and mitigation measures

Municipal Waste

Workers will generate municipal waste such as food wastes, packaging and wastepaper. It is estimated that this is approximately 1.07kg/employee/ day (Monitoring of Municipal Solid Waste 1996, EPD). It is proposed that the waste streams generated by characterised and accurate quantities are determined. Disposal of this waste to a general waste site must be ensured.

Waste Material from Construction of Surface Structures/Site Formation during Project Construction

The waste material such as boulders and construction and demolition materials will be generated. The volumes to be cleared will be progressive and this should be indicated on the operational plan which will then be integrated into the Environmental Management Programme. The extent of the Roodekopjes 67 HS is approximately 21000ha.

[8] Courtesy of Ergo Exergy Technologies Inc, Canada.

Clearance area and volumes will determine the extent and quantities of waste. A waste hierarchy plan can then be developed to ensure the waste management hierarchy is implemented.

The excavated material not intended for re-use needs to be stockpiled and disposed of in accordance with its classification.

Construction and demolition waste

These materials should be segregated and stored in different containers to other wastes to encourage the re-use or recycling of materials and their proper disposal.

Fuels, oils and other wastes

These must as far as possible be recycled through a number of options such as direct burning in boilers, furnaces and kilns, simple or complex reprocessing into industrial fuels, processing into blasting explosives, re-refining into lubricating oils as well as processing into cement kiln and lime kiln fuel. Accredited providers of such services in South Africa include FFS Refiners (www.ffs-refiners.com) and Green Mamba Oil Refinery (www.norasa.co.za). Should this not be possible, an accredited service provider should be engaged to dispose of these.

4.3 Waste Streams from the UCG Process

The waste information has been made available and can be found in Table 4. The current information which was shared is based on processes in the USSR. The potential waste and by-product streams produced by the UCG operations include:

Table 4: Waste streams and by-products produced by the UCG operations

Waste Stream	Quantity	Proposed Handling
Flue gas from flaring	190 tons/hr	Flare Stack or Majuba Power Station exhaust stack
Spent Activated carbon from particulates and heavy metal removal	3 m^3/annum	Off-site disposal at a hazardous waste facility
Sulphur Cake	140 kg/hr	Off-site disposal at a hazardous waste facility
UCG condensate	19.6 m^3/hr	Evaporation pond, treatment on site or treatment off-site.
Oil booms	22 kg/hr	Off-site disposal at a hazardous waste facility
Brine	10 m^3/hr	Evaporation pond or off-site disposal *Due to waste disposal restrictions, Brine or waste with high salt contents cannot be disposed after a period of eight years from date of publication of the Regulations (August 2013). Alternative solutions should be sought thereafter*
Phenol waste	1,000 kg/hr	Off-site disposal
Activated Sludge	1.1 m^3/hr	Off-site disposal
Spent Activated Carbon	8,400 tons per annum	Regeneration or off-site disposal

A concern at this stage is the condensate and the approach to managing this. It is imperative that a proper classification is carried out to confirm the exact components of the condensate. The proposed Table 4 indicates some approach to the handling of the waste streams. The precautionary approach should be undertaken to ensure that the protection of the environment is prioritised. Table 5 below highlights the constituents from Eskom. Table 6 endeavours to assess the most acceptable means of handling and disposing of the condensate streams. This is based on the new waste classification and management regulations published in August 2013. According to Regulation 4(3) published in Government Gazette number 36784, the waste must be reclassified every 5 years, or within 30 days of modification to the process or activity that generates the waste.

Generators of hazardous waste must ensure that a safety data sheet for the hazardous waste is prepared in according to SANS 10234.

Table 5: UCG pilot condensate specification

Description	Maximum	Minimum	Comparison with LCT in mg/l
Total per Nm^3	5	40	
Total Liquids per Nm^3 gas	25	75	
Benzene	10	22.5	0.0225
Toluene	1	4.25	0.00425
m, p - & o-Xylene	0.5	1.25	0.00125
Naphthalene	10	36.25	
Phenol	2000	4000	4.0000
2-Methylphenol	100	275	
4-Methylphenol	200	775	
Other Organics	10	50	
Ammonia	300	1000	
Ag		<0.01	
Al		0.0168	
As		0.468	0.000468
B		0.852	0.000852
Ba		0.0176	0.0000176
Be		<0.01	
Bi		<0.01	
Ca		0.306	
Cd		<0.01	0.00001
Co		<0.01	0.00001
Cr		0.0554	0.0000554
Cu		0.1132	0.0001132

Description	Maximum	Minimum	Comparison with LCT in mg/l
Fe		<0.01	
Hg		0.015	0.00015
K		0.302	
Li		<0.01	
Mg		<0.01	
Mn		<0.01	0.00001
Mo		<0.01	0.00001
Na		1.754	
Ni		0.0368	0.0000368
P		0.0948	
Pb		0.0374	0.0000374
S		15	
Sb		0.0696	0.0000696
Se		0.316	0.000316
Si		0.208	
Sr		<0.01	
Ti		<0.01	
Tl		0.1788	
V		<0.01	0.00001
Zn		0.1936	0.0001936
F		0.924	0.000924
Cl		130	0.13
NO_2		<0.01	
NO_3		0.05	0.00005
PO_4		0.05	
SO_4		0.3	

Where Green legend indicates “acceptable” and Red “unacceptable”

Table 6: DWAF Minimum Requirements classification and technology applicable

Component	Primary function	Applicability
Benzene	**Industrial group F(2) (Production of primary chemicals and feedstocks)**	**The requirement for pre-treatment and disposal are approximately set in accordance with the waste classification. Hazardous waste handling, transportation and storage are addressed. Please note that the classficaiton will have to be confirmed as per the SANS 10234.** **One of the objectives of "The Minimum Requirements for the disposal of hazardous waste" is to promote the avoidance, re-use, recycling and treatment of waste.** **Hazard rating: 3** **SANS 10228 Class: 3.2(II)** **Acceptable Environmental Risk ppm: 2.2** **Preferred Technology:** **Recovery and Incineration** **Allowed Technology:** **Encapsulation, landfill ashblend** **Unacceptable Technology: Landfilling without treatment**
Toluene (S)	**Industrial group F(2) (Production of primary chemicals and feedstocks)**	**The requirement for pre-treatment and disposal are approximately set in accordance with the waste classification as per DWAF Minimum requirements. Hazardous waste handling, transportation and storage are addressed. Please note that the classification will have to be confirmed as per the SANS 10234.** **One of the objectives of "The Minimum Requirements for the disposal of hazardous waste" is to promote the avoidance, re-use, recycling and treatment of waste.** **Hazard rating: 3** **SANS 10228 Class: 3.2(II)** **Acceptable Environmental Risk ppm: 1.3** **Preferred Technology:** **Recovery and Incineration** **Allowed Technology:** **Encapsulation, landfill ashblend** **Unacceptable Technology: Landfilling without treatment**

m, p - & o-Xylene (S)	**Industrial group C(2) (Petroleum & Gas Industry including Extraction & Refined Products).**	**The requirement for pre-treatment and disposal are approximately set in accordance with the waste classification. Hazardous waste handling, transportation and storage are addressed. Please note that the classficaiton will have to be confirmed as per the SANS 10234.** **One of the objectives of "The Minimum Requirements for the disposal of hazardous waste" is to promote the avoidance, re-use, recycling and treatment of waste.** **Hazard rating: 3** **SANS 10228 Class: 3.2(II)** **Acceptable Environmental Risk ppm: 1.1** **Preferred Technology:** **Recovery and Incineration** **Allowed Technology:** **Landfill ashblend** **Unacceptable Technology: Landfilling without treatment**
Naphthalene	**Industrial group F(3) (Production of fine chemicals)**	**The requirement for pre-treatment and disposal are approximately set in accordance with the waste classification. Hazardous waste handling, transportation and storage are addressed. Please note that the classification will have to be confirmed as per the SANS 10234.** **One of the objectives of "The Minimum Requirements for the disposal of hazardous waste" is to promote the avoidance, re-use, recycling and treatment of waste.** **Hazard rating:2/ 3** **SANS 10228 Class: 4.1(III)** **Acceptable Environmental Risk ppm: 0.38** **Preferred Technology:** **Recovery and Incineration** **Allowed Technology:** **Landfill Co-dispose** **Unacceptable Technology:**

Phenol	**Industrial group F(3) (Production of fine chemicals)**	**The requirement for pre-treatment and disposal are approximately set in accordance with the waste classification. Hazardous waste handling, transportation and storage are addressed. Please note that the classification will have to be confirmed as per the SANS 10234.** **One of the objectives of "The Minimum Requirements for the disposal of hazardous waste" is to promote the avoidance, re-use, recycling and treatment of waste.** **Hazard rating: 3** **SANS 10228 Class: 6.1(II)** **Acceptable Environmental Risk ppm: 2.3** **Preferred Technology:** **Recovery and Incineration** **Allowed Technology:** **Landfill co-dispose, landfill ashblend** **Unacceptable Technology:**
2-Methylphenol	**Not shown**	**Not shown**
4-Methylphenol	**Not Shown**	**Not shown**
Other Organics		**Specific breakdown of the constituents required.**
Ammonia	**Industrial group F(2) (Production of primary chemicals and feedstocks)**	**The requirement for pre-treatment and disposal are approximately set in accordance with the waste classification. Hazardous waste handling, transportation and storage are addressed. Please note that the classification will have to be confirmed as per the SANS 10234.** **One of the objectives of " The Minimum Requirements for the disposal of hazardous waste" is to promote the avoidance, re-use, recycling and treatment of waste.** **Hazard rating: 1** **SANS 10228 Class: 8(III)** **Acceptable Environmental Risk ppm: 0.0024** **Preferred Technology:** **Recovery** **Allowed Technology:** **Encapsulation, landfill ashblend** **Unacceptable Technology:**
Brine	**Not shown**	**Not shown**

This will enable a risk assessment to be determined for application during the subsequent EIA process steps.

5 WASTE IMPACT ASSESSMENT

The waste impact assessment for the operational phase was conducted on the basis of following the process flow from the point of gas extraction through to treatment and disposal. The key waste streams considered were that of the onsite waste water treatment plant and the condensate based effluent treatment plant. The assessment involved focusing on the key waste streams and considering the impact, mitigation and management measures. The assessment also focused on

- Waste classification
- Waste characterisation
- Waste quantification
- Waste management plan
- Monitoring and measurement of data

Four waste management strategies were considered as options from the water treatment plant. The first option involved supporting local irrigation activities in line with the South African Irrigation Standards (2009) and the River Water Quality Objectives for the Schulpspruit Tributary Catchment which forms part of the Vaal River System. Option 2 involved re-injection of the water to the coal seam aquifer, while option 3 entailed recovering water from the Reversed Osmosis Water Treatment Plant for usage as fire water or for supply to Majuba Power Station. The fourth option involved off-site disposal via the means of a truck (only an interim measure). These four were considered as possible options for the take-off of the pilot phase of the project. However, as research and development progresses, new options will be explored and conceptualized, which will thereafter be incorporated into the project to achieve higher levels of purification. At each stage of development, environmental and waste impact assessment needs to be conducted.

The key waste streams defined for the UCG process at 70 000 Nm^3/hr gas flow is outlined in Table 7: Impact Assessment . The corresponding treatment strategy and impact assessment is also tabulated.

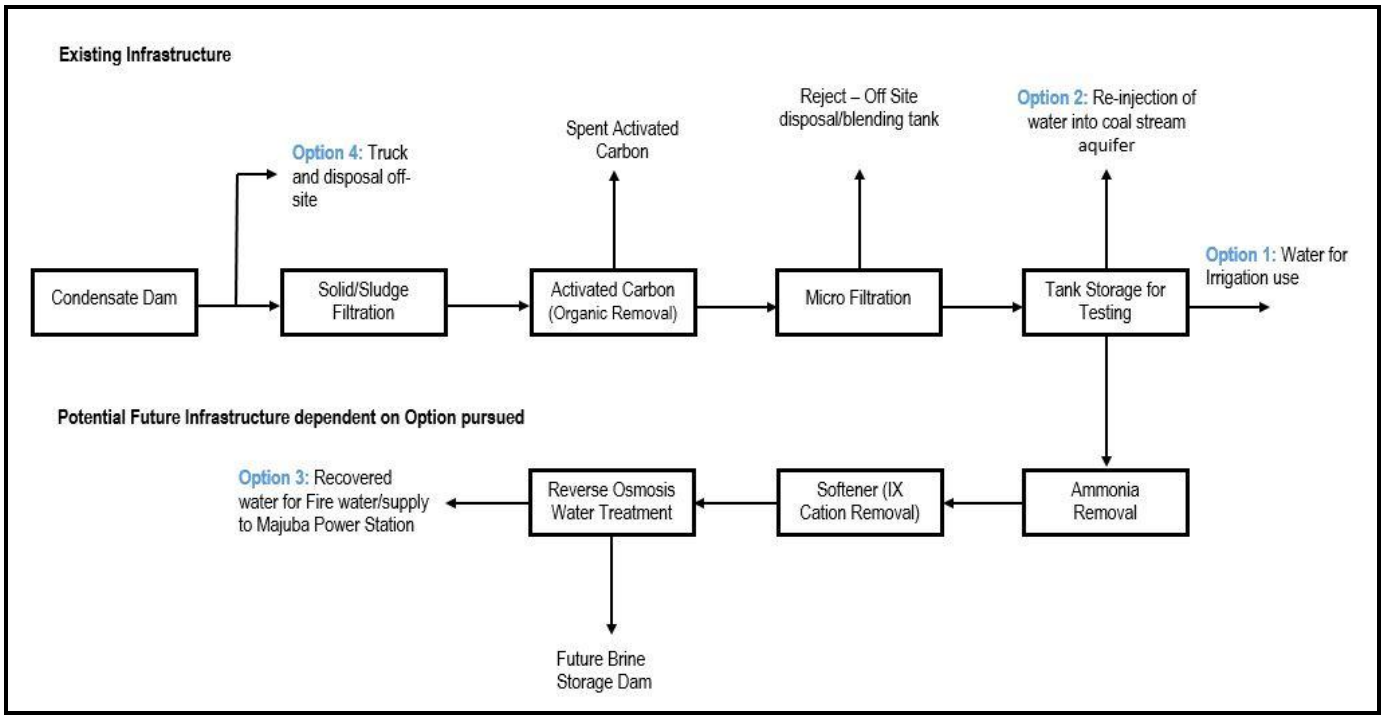

Figure 3: Block flow diagram for water treatment plant

Table 7: Impact Assessment

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
Construction	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 (rags), soils, gravel and water contaminated by hazardous substances (oil, fuel, grease, chemicals or bitumen).	**Extent:** Site (-1) **Duration:** Medium-term (-2) **Intensity:** High (-3) **Probability:** Highly probable (-3) **Significance: Medium (-9)**	• 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. Eskom must have a waste policy and waste management procedure and also engage a service provider who trains the operations staff on measures for implementing the plan as well as auditing. • General waste produced on site is to be collected in skips for disposal at the local municipal waste site. A waste disposal service provider must be appointed by Eskom to carry out disposal of waste on a weekly basis. 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 weekly basis by an appointed service provider to prevent any windblown waste and/or visual disturbance. • All general waste must be removed from the site at regular intervals and	**Extent:** Site (-1) **Duration:** Short-term (-1) **Intensity:** Low (-1) **Probability:** Possible (-2) **Significance: Low (-5)**

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
			disposed of in suitable waste receptacle. • Hazardous waste is to be disposed at a Permitted Hazardous Waste Landfill Site. The Environmental Manager 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). Labelling of hazardous substances must be done according to SANS 10233. • 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 and reduce bunding capacity. The bins and skips are to be emptied on weekly basis. Reporting of spills and mitigation done must be done in accordance with section 10 of the minimum requirements for the handling, classification and disposal of hazardous waste (3rd edition, 2005). Internal and external auditing must be carried on an annual basis.	
Operations	Leakage of combustion condensate onto land along pipeline route	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** High (-3) **Probability:** Possible (-2)	• Implement operation inspection protocol of gasfield pipe network • Regular groundwater monitoring programme.	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** Low (-1) **Probability:** Possible (-2)

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
		Significance: High (-10)	• Institute clean up protocol in accordance with section 10 of the minimum requirements for the handling, classification and disposal of hazardous waste (3rd edition, 2005) should there be a local leakage. • Ongoing raw gas transfer pressure measurement with pressure change alarm signal control.	**Significance: Medium (-8)**
	Untreated water discharge into environment	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** High (-3) **Probability:** Possible (-2) **Significance: High (-10)**	• The bulk of the water would be treated in the condensate pond which is used for storage purposes until the plant becomes operational. Condensate 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.	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** Moderate (-2) **Probability:** Possible (-2) **Significance: Medium (-9)**
	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.	**Extent:** Regional (-3) **Duration:** Long-term (-3) **Intensity:** High (-3) **Probability:** Highly probable (-3) **Significance: High (-12)**	• Contaminated wastewater including hydro-carbon 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. • Continue sampling and analysis of surface water quality in the targeted application area on a monthly basis	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** Low (-1) **Probability:** Possible (-2) **Significance: Medium (-8)**

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
			under normal operating conditions, including upstream and downstream. But if alarming trends are noticed, then the frequency of sampling and analysis should be increased to establish this is not the cause of the problem. Should in case something goes wrong with the analysis, daily sampling must be called for; root cause analysis must be carried out; and also pollution incidences must be investigated. • Continue sampling and analysis of the treated condensate stream for the target range of pollutants and water quality parameters. This must be done on a monthly basis under normal operating conditions. But if alarming trends are noticed, then the frequency of sampling and analysis should be increased to establish this is not the cause of the problem. Should in case something goes wrong with the analysis, daily sampling must be called for; root cause analysis must be carried out; and also pollution incidences must be investigated. • Irrigation be undertaken according to the South African Irrigation Standards (2009) and the River Water Quality Objectives for the Schulpspruit Tributary Catchment which forms part of the Vaal River System. These would help to take 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	

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
			measures to minimise and mitigate against any potential environmental impacts which may result from a spill. • Ongoing monitoring of the inputs and outputs for the treatment plant, Monthly reports on removal efficiencies of the pollutants of concern such as phenol and PAH.	
	Leakage of hydrocarbons in the gas treatment plant	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** High (-3) **Probability:** Possible (-2) **Significance: High (-10)**	• Storm and process water should be separated by design and operating protocols. • Process water shall be directed to the water treatment plant. • All major incidents shall be reported and a root cause analysis undertaken. • Preventative measures shall be instituted to avoid potential hydrocarbon spillages.	**Extent:** Site (-1) **Duration:** Long-term (-3) **Intensity:** Low (-1) **Probability:** Possible (-2) **Significance: Medium (-7)**
	Improper disposal of admin-based waste water, brine, solid sludge and particulates and spent activated carbon.	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** High (-3) **Probability:** Possible (-2) **Significance: High (-10)**	• 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. Regular monitoring of qualitative parameters in the solids. Waste	**Extent:** Site (-1) **Duration:** Short-term (-1) **Intensity:** Low (-1) **Probability:** Possible (-2) **Significance: Low (-5)**

Phase	Potential Aspect and or Impact	Significance rating of impacts before mitigation	Mitigation	Significance rating of impacts after mitigation
			manifest for solids to be documented. • Waste manifest for activated carbon to be documented.	
Decommissioning	Same as those wastes produced during construction.	**Extent:** Site (-1) **Duration:** Medium-term (-2) **Intensity:** High (-3) **Probability:** Highly probable (-3) **Significance: Medium (-9)**	• Refer to mitigation measures included for waste impacts during construction as well as the EMPr.	**Extent:** Site (-1) **Duration:** Short-term (-1) **Intensity:** Low (-1) **Probability:** Possible (-2) **Significance: Low (-5)**
	Ingress of upper groundwater into combustion void with consequent build-up of contaminants of concern (oils, salts and metals).	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** High (-3) **Probability:** Highly probable (-3) **Significance: High (-11)**	• 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.	**Extent:** Local (-2) **Duration:** Long-term (-3) **Intensity:** Moderate (-2) **Probability:** Highly probable (-3) **Significance: High (-10)**

CRITERIA	DESCRIPTION			
EXTENT	**National (4)** The whole of South Africa	**Regional (3)** Provincial and parts of neighbouring provinces	**Local (2)** Within a radius of 2 km of the construction site	**Site (1)** Within the construction site
DURATION	**Permanent (4)** Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient	**Long-term (3)** The impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter. The only class of impact which will be non-transitory	**Medium-term (2)** The impact will last for the period of the construction phase, where after it will be entirely negated	**Short-term (1)** The impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase
INTENSITY	**Very High (4)** Natural, cultural and social functions and processes are altered to extent that they permanently cease	**High (3)** Natural, cultural and social functions and processes are altered to extent that they temporarily cease	**Moderate (2)** Affected environment is altered, but natural, cultural and social functions and processes continue albeit in a modified way	**Low (1)** Impact affects the environment in such a way that natural, cultural and social functions and processes are not affected
PROBABILTY OF OCCURANCE	**Definite (4)** Impact will certainly occur	**Highly Probable (3)** Most likely that the impact will occur	**Possible (2)** The impact may occur	**Improbable (1)** Likelihood of the impact materialising is very low

Low impact **(4 - 6 points)**	A low impact has no permanent impact of significance. Mitigation measures are feasible and are readily instituted as part of a standing design, construction or operating procedure.
Medium impact **(7 - 9 points)**	Mitigation is possible with additional design and construction inputs.
High impact **(10 - 12 points)**	The design of the site may be affected. Mitigation and possible remediation are needed during the construction and/or operational phases. The effects of the impact may affect the broader environment.
Very high impact **(13 - 16 points)**	Permanent and important impacts. The design of the site may be affected. Intensive remediation is needed during construction and/or operational phases. Any activity which results in a “very high impact” is likely to be a fatal flaw.
Status	Denotes the perceived effect of the impact on the affected area.
Positive (+)	Beneficial impact.
Negative (-)	Deleterious or adverse impact.
Neutral (/)	Impact is neither beneficial nor adverse.

Table 8: Phenol Results of the Water Treatment Plant (Measured in µg/L)

Description	C0	C1	C15	C30	WFS 15:00	WFS 07:30	WFS 00:00
Phenol	235201	224159	349613	316290	<2	<2	12
2-Chlorophenol	<100	<100	<100	<100	<1	<1	<1
2-Nitrophenol	<100	<100	<100	<100	<1	<1	<1
2,4-Dichlorophenol	<100	<100	<100	<100	<1	<1	<1
2,6-Dichlorophenol	<100	<100	<100	<100	<1	<1	<1
2-Methylphenol (o-cresol)	57464	52955	87157	78346	<1	<1	<1
3&4-Methylphenol (m&p-cresol)	50230	46226	78064	70020	<1	<1	<1
2,4 Dimethylphenol	10997	9878	17463	15348	<1	<1	<1
2-Methyl-4,6-dinitrophenol	<100	<100	<100	<100	<1	<1	<1
2,4,6 Trichlorophenol	<100	<100	<100	<100	<1	<1	<1
2,4,5 Trichlorophenol	<100	<100	<100	<100	<1	<1	<1
4-Chloro-3-methylphenol	<100	<100	<100	<100	<1	<1	<1
2,3,4,6 Tetrachlorophenol	<100	<100	<100	<100	<1	<1	<1
Pentachlorophenol	<100	<100	<100	<100	<1	<1	<1

Table 9: Poly-aromatic hydrocarbons (PAH's) Results (Measured in µg/L)

Description	C0	C1	C15	C30	WFS 15:00	WFS 07:30	WFS 00:00
Napthalene	272	70	50	48	<0.1	<0.1	<0.1
Acenaphthene	162	69	92	86	<0.1	<0.1	<0.1
Acenaphthylene	<1	<1	<1	<1	<0.1	<0.1	<0.1
Flourene	1959	656	900	960	<0.1	<0.1	<0.1
Phenanthrene	4259	2175	2956	3009	<0.1	0.3	0.9
Anthracene	783	324	486	484	<0.1	<0.1	0.1
Flouranthene	1264	531	836	787	<0.1	0.7	1.6
Pyrene	760	510	798	728	<0.1	0.4	0.9
Benzo[a]anthracene	<1	<1	169	<1	<0.1	<0.1	0.3
Crysene	394	229	220	223	<0.1	<0.1	0.5
Benzo[k+b]fluoranthen	454	315	229	275	<0.1	<0.1	<0.1
Benzo[a]pyrene	110	82	67	76	<0.1	<0.1	<0.1
Benzo[g,h,i]perylene	<10	<10	<10	<10	<1	<1	<1
Dibenz[a,h]anthracene	<10	<10	<10	<10	<1	<1	<1

Indeno[123-cd]pyrene	<10	<10	<10	<10	<1	<1	<1

Table 10: Quantity of waste removed from the Condensate treatment Plant

Quantity of Waste Removed	Units	15 000 Nm^3/hr gas	75 000 Nm^3/hr gas
Phenol Removed via treatment	kg/d	0.81	40.5
PAH (Sum)	kg/d	0.27	1.35
Effluent Production	tpd	27	135
Filtered Waste Production	kg/day	14.4	72

Data reported for operating levels at 15000 and 70000 m^3/hr gas flow

6 ENVIRONMENTAL MANAGEMENT PROGRAMME

Findings and recommendations for construction as well as operational measures as outlined in Table 7 will be incorporated into the EMPr.

7 ASSUMPTIONS AND LIMITATIONS

The work undertaken for the waste impact assessment was based on information supplied by the client. In some areas assumptions were used based on best available information. Noting that this is an initial phase of the UCG process, it is considered that there is sufficient provision in the mitigation and EMPr measures to be protective of the environment and to conform with legislative and regulatory provisions.

8 CONCLUSION AND RECOMMENDATION

The containment, re-use and safe disposal of UCG waste streams has been considered in this assessment.

The UCG process has some inherent process benefits that is commensurate with the National Integrated Waste Management Strategy in terms of waste minimisation. The waste impact associated with traditional mining operations in terms of waste ore and ash is not existent due to the in-situ and underground coal gasification process. The extraction of gas and its conversion to energy has followed a process of least waste production. The waste stream of concern is related to the high total dissolved solids condensate stream. This stream also has concentration of hydrocarbon-based toxics that can pose a risk to the environment. This stream has been addressed in terms of the advanced wastewater treatment plant which results in a final treated effluent stream with low levels of TDS and toxic hydrocarbons such as polyaromatic hydrocarbons and phenols. The treatment is via an efficient route of activated carbon adsorption. The activated carbon is subsequently thermally oxidised and can be reused in the treatment process. The brine-rich residual waste stream will then be disposed to a designated licensed landfill site. However, Eskom will also consider other options such as recovery and re-use option for the brine stream going forward.

It is recommended that the monitoring, analysis and reporting for the various process and effluent streams continue so that there is an adequate database of objective information to fully comprehend the impact of the proposed development.