REPORT – VOLUME 4, STUDY 5

September 2017

CNOOC UGANDA LIMITED

KINGFISHER OIL PROJECT, HOIMA DISTRICT, UGANDA - WASTE MANAGEMENT SPECIALIST ASSESSMENT

Submitted to:
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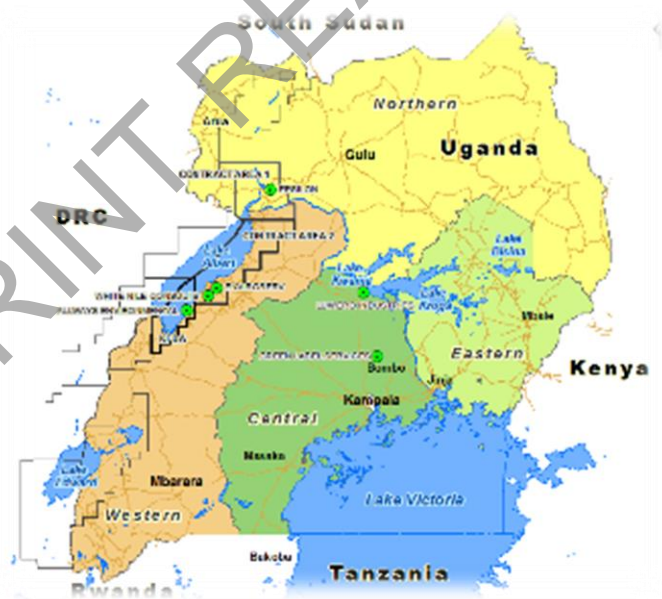

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ABBREVIATIONS AND ACRONYMS

ACGIH	by American Conference of Governmental Industrial Hygienists
BAT	Best Available Technology
BEI	Biological Exposure Indices
BOP	Blow-Out Preventer
BPEO	Best Practice Environmental Option
COD	Chemical Oxygen Demand
CNOOC	China National Offshore Oil Corporation
CPF	Central Processing Facility
C&D	Construction and Demolition
C&P	Construction and Production
DRC	Democratic Republic of Congo
EA	Exploration Areas
EH&S	Environmental, Health and Safety
ESP	Electrostatic Precipitators
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
E&A	Exploration and Appraisal
E&P	Exploration and Production
GNR	Government Notice Regulation
GTL	Gas to Liquids
H:H	Hazardous
HSE	Health and Safety Environment
IFC	International Finance Corporation
KDA	Kingfisher Development Area
LNG	Liquefied Natural Gas
NADF	Non-Aqueous Drilling Fluid
NEMA	National Environment Management Authority
NIOSH	National Institute for Occupational Health and Safety
NORM	Naturally Occurring Radioactive Materials
OSHA	Occupational Safety and Health Administration
O&P	Oil and Gas

PAH	Poly-aromatic Hydrocarbon
PVC	Polyvinyl Chloride
PPE	Personal Protective Equipment
Ref.	Reference
RoW	Right of Way
SBM	Synthetic Based Mud
SCR	Selective Catalytic Reduction
SOP	Standard Operating Procedure
t/T	Tonnes
TDS	Total Dissolved Solids
TLV	Threshold Limit Value
UK	United Kingdom
US	United States
WBDF	Water Based Drilling Fluid
WBM	Water Based Mud
WWTP	Waste Water Treatment Plant
YR	Year

1.0 INTRODUCTION

1.1 Background

CNOOC Uganda Limited (CNOOC), Tullow Uganda Operations Pty Ltd (Tullow) and Total E&P Uganda Ltd (Total) are planning to develop oilfields within the Albertine Graben in western Uganda. The three companies have formed a partnership with equal interests in three government-designated exploration areas (EAs) or "Blocks", with CNOOC operating in the Kingfisher Development Area (KDA) or EA3A, Tullow in Contract Area 2 and Total in Contract Area 1. The areas lie along the eastern border of Lake Albert, a 160 km-long, 35 km wide, natural lake forming the border between Uganda and the Democratic Republic of the Congo (DRC).

On the 16 September 2013, the first oil production licence in Uganda was awarded to CNOOC. The licence gave CNOOC the right to develop the KDA to full production. The Kingfisher oil field lies within the KDA, mostly beneath Lake Albert, in a 15 km by 3 km area.

1.2 Project Description

Details of the project location, process descriptions and proposed infrastructure are provided in the Environmental and Social Impact Assessment (ESIA) Project Description report.

The KDA comprises of five onshore well pads where all the development. The project will consist of the following components, located within two main areas:

- **The wells, flowlines, central processing facility (CPF) and supporting infrastructure**. These will be situated on the Buhuka Flats in the Kingfisher Development Area (KDA), along the south-eastern side of Lake Albert. The subsurface construction will include a total of 31 wells, made up of 20 production wells and 11 produced water injection wells. The CPF will also produce fuel gas, used to supply all of the project's power requirements in the first 10 years, and LPG, which will be sold into the local market.
- **The export pipeline,** which will transport the stabilised crude oil from the CPF to Kabaale, roughly 52 km to the northeast, to tie in at the site of a proposed oil refinery, planned by the Ugandan Government.

1.3 Context of the Report

This report presents the Waste Management Specialist Assessment for the proposed KDA Project and has been undertaken by Golder Associates Africa (Pty) Ltd (Golder) as part of the CNOOC ESIA.

This report provides the waste assessment for the proposed Project addressed in the following sections:

- Section 1: Introduction;
- Section 2: Terms of Reference;
- Section 3: Waste Baseline for the Lake Albert Oil Fields Area;
- Section 4: Waste Inventory for the KDA Project;
- Section 5: Waste Management for the KDA Project;
- Section 6: Impact Assessment;
- Section 7: Recommendations for mitigation/management and monitoring measures;
- Section 8: Limitations;
- Section 9: Conclusions; and
- Section 10: References

1.4 Waste Study Objectives

This assessment considers the potential waste impacts arising from the proposed CNOOC project (the Project) in the KDA on the shore of Lake Albert, Uganda. Waste impacts are considered in the context of appropriate guidelines and with reference to information provided by CNOOC in the study area.

In order to assess the waste impacts associated with the Project, multiple stages of its development have been considered. Where significant waste impacts have been identified, mitigation has been considered and specified in order to reduce the significance of predicted impacts.

The primary objectives of the waste assessment are as follows:

- To identify waste related legislation or frameworks from Uganda applicable to the project, as well as IFC and international best practice standards in the O&G field and waste management;
- To identify all potential waste streams associated with the project and compilation of a waste inventory, with, as far as possible, the chemical characteristics of each waste stream;
- To evaluate the identified impacts associated with the different waste streams in terms of their probability of occurring, duration, scale and magnitude of impact in order to determine the overall significance during the project phases from construction to decommissioning;
- To recommend mitigatory measures for each impact, where possible, or recommend additional investigations for those impacts where mitigation cannot be identified currently; and
- To incorporate the waste management mitigation measures into the overall Environmental and Social Management Plan (ESMP) for the project.

2.0 TERMS OF REFERENCE

2.1 Approach and Methodology

The methodology that was employed during this Study is outlined in the subsections below including:

- Data Collection and Review;
- Impact Assessment; and
- ESMP.

2.1.1 Data Collection and Review

Data for the project were collected from various sources discussed as discussed hereunder.

2.1.1.1 Desktop Review of Relevant Documentation

Data for this assessment was primarily collected from available legal sources, similar O&G projects known to Golder, information provided by the local sub-consultants, the three O&G companies operating in the Lake Albert region, and other relevant source material. The following main documents were reviewed in order to obtain further data on the waste management situation, and also to gain an understanding of the scope and context of the proposed KDA project:

- Legal Framework
  - Ugandan guidelines and legislation;
  - IFC Standards and other relevant documentation;
  - International Best Practice documents; and
  - CNOOC Waste Specifications and Policies.
- Waste Inventory and Waste Management

- Waste Inventory for KDA based on estimations provided by CNOOC;
- Hazardous Waste Study undertaken by Golder end 2016 to early 2017;
- Non-hazardous waste study undertaken by Atacama in mid-2017; and
- Final Scoping Report with the ESIA Project Description undertaken by Golder in mid-2017.

2.1.1.2 Interfacing with Ugandan Authorities and Sub-Consultants

In order to obtain a thorough understanding of waste management legislation, practices and issues in Uganda, the specialist waste team interacted with Eco Partners to obtain information about the Ugandan authorities, legislation and regulatory studies, private waste management companies and other waste management role-players. Information gleaned from Golder and Eco Partners formed part of the Hazardous Waste Study (undertaken through separate contract study in 2017) and is extracted where relevant in this report. The objectives of those consultations were as follows:

- To obtain a firm understanding of Ugandan legislative requirements;
- To obtain technical and procedural requirements for waste management such as landfill design, transport requirements, classification systems, etc., and
- To obtain an understanding of waste recycling and re-use opportunities, treatment and disposal facilities in the country.

2.1.1.3 International Standards and Best Practice Guidelines

In addition to obtaining a firm understanding of the Uganda regulatory requirements, the existing waste management framework and waste management practices, cognisance was given to the requirements of the IFC Sustainability Performance Standards and other international best practices in the O&G and waste management sector.

The above was used to develop a framework for managing waste at the KDA project facilities in order to ensure sustainability, and a Duty of Care which includes protection of human health and the environment.

2.1.1.4 Waste Inventory and Classification

Once an understanding was obtained from the regulatory requirements, the IFC's Social and Environmental Sustainability Performance Standards, best practice standards and guidelines, relevant General EH&S Guidelines and the applicable Industry Sector Guidelines, an inventory is developed providing the annual waste quantities expected to be generated with the hazardous class and best practice management options for the wastes at the proposed KDA.

The waste inventory considers the following:

- Providing baseline, background information pertaining to waste generation;
- Identifying the location(s) where wastes may be generated, storage, handled, treated and/or disposed;
- Identifying the proposed quantity and type of potential wastes generated at the KDA during construction, operation and decommissioning; and
- Classifying the above wastes as general or hazardous, in terms of Ugandan guidelines, IFC EHS Guidelines and international best practice.

APPENDIX B provides the waste inventory summary as provided by CNOOC (email correspondence on 17 August 2017). However, some waste quantities, hazardous ratings and proposed waste management options were not provided. This may be due to the inventory being an anticipated / expected waste inventory with hazardous contaminant concentrations unknown at this stage of the project development to determine the hazardous rating. However, based on Golder's understanding of the proposed KDA and past studies in

the O&G industry, general categorisation of suitable waste management options and best practice environmental and technical options have been provided in this report.

2.1.2 Impact Assessment

Once a firm understanding had been gained of each waste type and its proposed management, an impact assessment was undertaken. The impact assessment took cognisance of the following:

- The site specific conditions;
- Regulatory, IFC and other waste management requirements;
- Best practice guidelines; and
- Waste characteristics.

Each waste type and the most suitable treatment and/or disposal site were assessed in terms of:

- Risks posed to the environment and human health and safety in order to identify the potential impacts. The significance of the potential impacts was established by considering the probability of occurring, duration of occurrence, scale and magnitude of impact;
- Based on the above, the significance of each identified impact; and
- Once the potential impacts have been assessed and their significance had been established, mitigatory measures were developed. In the development of mitigatory measures, cognisance was taken of the relevance and use of the waste management hierarchy, which entails, waste avoidance, waste minimisation, re-use and recycling, waste treatment and lastly disposal.

The cumulative impact was also considered, for instance the impact of waste water and waste disposal sites on the groundwater regime or on surface water bodies in the area.

2.1.3 Environmental and Social Management Plan

Once the impact assessment phase is completed, an Environmental and Social Management Plan (ESMP) was developed to give effect to the recommended mitigation measures for the management of waste generated at the Project areas. The waste ESMP is integrated with the other specialist plans, and recommendations (particularly the Surface Waste and Soil Specialist Study reports) into the ESMP for the project.

2.2 Legal Framework and Guidance

2.3 Ugandan Regulatory Framework

The following section presents a broad review of the Ugandan regulatory framework governing the collection, transportation, storage and treatment/disposal of hazardous waste from the O&G sector, both current and in draft form, as well as the relevant IFC Guidelines and Standards, and CNOOC's own requirements.

Figure 1 below presents a flow chart of the relevant Ugandan acts, regulations and standards. Regulation or standards shown in light blue are still in draft form, while those shown in dark blue are referred to in the legislation that still need to be developed.

Table 1 below presents a broad overview of some relevant Ugandan acts, regulations and standards governing the collection, transport, treatment and disposal of hazardous waste from the O&G sector. It is noted that Uganda is a signatory to the Basel Convention.

2.4 IFC Guidelines and Standards

Table 2 below presents a broad overview of IFC Guidelines and Standards that may be applicable to the collection, transport, treatment and disposal of hazardous waste from the Ugandan O&G sector.

2.5 CNOOC's Standards and Requirements

Table 3 below presents a broad overview of CNOOC's own Waste Management Specification standard that is applicable to the collection, transport, treatment and disposal of hazardous waste from the O&G sector.

Furthermore, CNOOC have their own Health and Safety Environment (HSE) Handbook requirements, which all suppliers are expected to comply with.

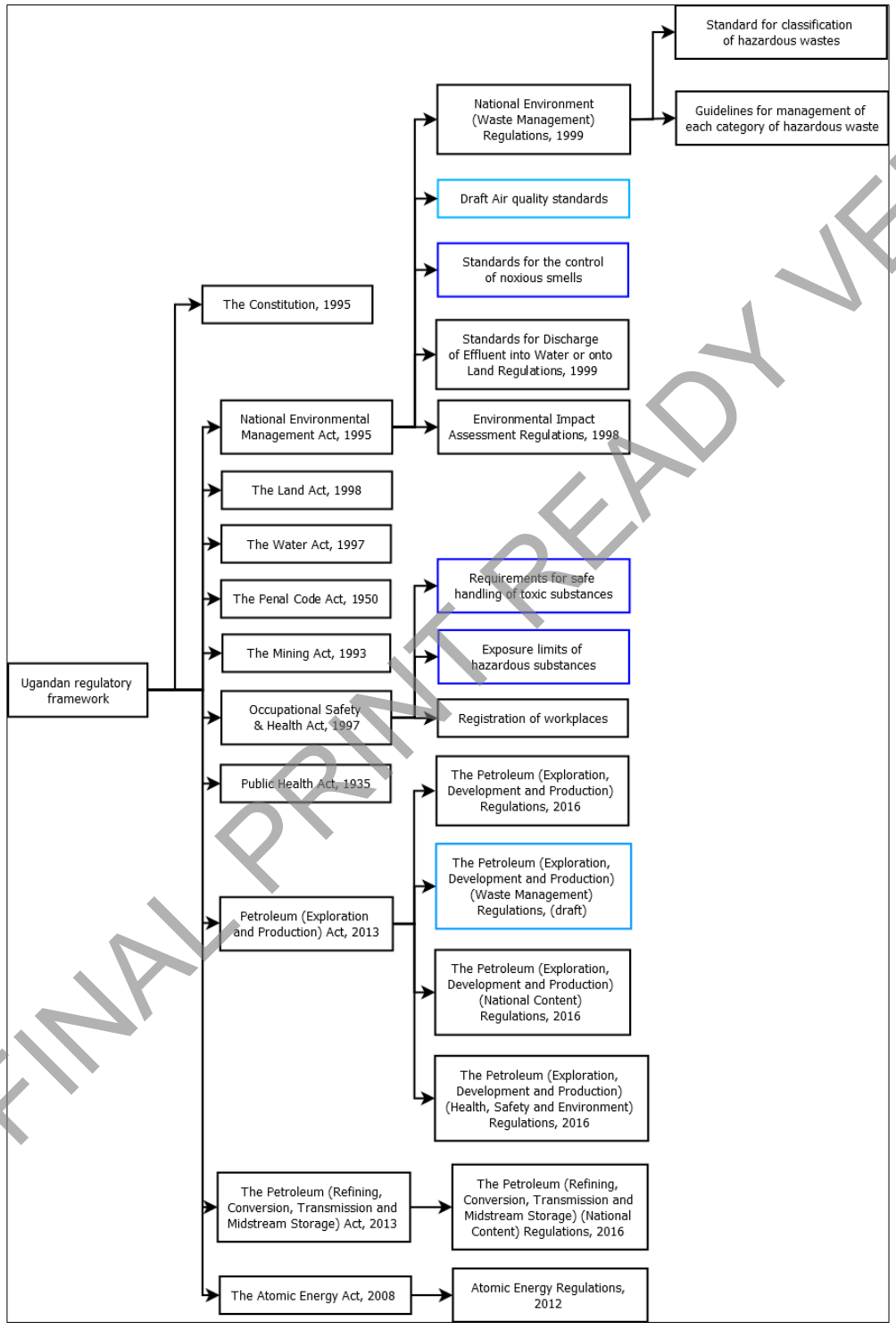

Figure 1: Flow Chart of the Ugandan Regulatory Framework

Table 1: Summary of Relevant Ugandan Legislation

Name	Year ratified	Relevant sections	Description
National Environment Management Act (Ref.4)	1995	52	Each person has a duty to manage and minimise any waste generated in such a manner that does not cause ill health to the person or damage to the environment, and in accordance with this Act. Any person who contravenes any provision of this Act commits an offence.
		53	Authority to establish a standard for the classification of hazardous wastes, and guidelines for the management of each category of hazardous waste. Any person who discharges any waste classified as hazardous without a licence or contrary to the said regulations commits an offence.
		56	No person is to discharge any hazardous substance, chemical, oil or mixture containing oil in any waters or any segment of the environment except in accordance with guidelines prescribed by the Authority. Any person who discharges a hazardous substance, chemical, oil or mixture containing oil in any waters contrary to these guidelines commits an offence. Upon conviction, the person may in addition to any other sentence, pay the cost of removal, including restoration, reparation, restitution, or compensation costs. The person shall mitigate the impact of the discharge by giving immediate notice to the authority, immediately beginning clean-up operations, and complying with directions the authority prescribes. Where the person fails to take the necessary measures, the Authority may seize the facility, vehicle or vessel, and after a reasonable time dispose of these to recover the costs of taking the necessary measures.
		57	No person shall pollute or lead any other person to pollute the environment contrary to any of the standards or guidelines of this Act.
		77	Any person who carries on activity which has or is likely to have a significant impact on the environment shall keep records relating to the amount of waste and by-products generated by the activity.
		97	Any person who fails to keep records of the activities, products, by-products and wastes required to be kept by this Act; or fraudulently alters any record required by this Act, commits an offence.
		98	Any person who contravenes any environmental standard or measure prescribed in this Act commits an offence.
		99	Any person who fails to manage any hazardous waste, disposes of any chemical or hazardous waste contrary to this Act, withholds information about the management of wastes, or aids or abets the illegal traffic in wastes is committing an offence.

Name	Year ratified	Relevant sections	Description
		Third Schedule	Projects to be considered for environmental impact assessment includes sites for hazardous waste disposal.
Petroleum (Exploration, Development and Production) Act (Ref. 11)	2013	3	A licensee shall ensure that the management of production, transportation, storage, treatment and disposal of waste arising out of petroleum activities is carried out in accordance with environmental principles and safeguards prescribed under the National Environment Management Act and other applicable laws. The licensee shall contract a separate entity to manage the transportation, storage, treatment or disposal of waste arising out of petroleum activities. The licensee shall remain responsible for the activities of the entity managing the transportation, storage, treatment or disposal of their waste. The relevant authorities may grant a licence for the management, transportation, storage, treatment or disposal of waste arising out of petroleum activities to an entity contracted by a licensee on terms and conditions prescribed in the licence. A person contracted by the licensee to handle their waste shall not carry out those activities without a licence issued by the relevant authorities. To do so without a licence or failing to comply with the conditions of the licence is committing an offence. The relevant authorities shall make regulations for the management of the production, transportation, storage, treatment and disposal of waste arising out of petroleum activities.
		88	The licensee shall take all reasonable steps necessary to secure the safety, health, environment and welfare of personnel engaged in petroleum activities in the licence area including: ■ Preventing the escape of any mixture of water or drilling fluid, and petroleum or any other matter; ■ Preventing the pollution of any water well, spring, stream, river, lake or reservoir by the escape of petroleum, water, drilling fluid, chemical additive, gas not being petroleum or any other waste product or effluent; and ■ Where pollution occurs, treating or dispersing it in an environmentally acceptable manner.
The Petroleum (Refining, Conversion, Transmission and Midstream Storage) Act (Ref. 12)	2013	3	A licensee shall ensure that the management of production, transportation, storage, treatment and disposal of waste arising out of petroleum activities is carried out in accordance with environmental principles and safeguards prescribed by the National Environment Management Act and other laws. The licensee shall contract a separate entity to manage the transportation, storage, treatment or disposal of waste arising out of petroleum activities. The licensee shall remain responsible for the activities of the entity managing the transportation, storage, treatment or disposal of their waste.

Name	Year ratified	Relevant sections	Description
			The relevant authorities may grant a licence for the management, transportation, storage, treatment or disposal of waste arising out of petroleum activities to an entity contracted by a licensee on terms and conditions prescribed in the licence. A person contracted by the licensee to handle their waste shall not carry out those activities without a licence issued by the relevant authorities. To do so without a licence or failing to comply with the conditions of the licence is committing an offence. The relevant authorities shall make regulations for the management of the production, transportation, storage, treatment and disposal of waste arising out of petroleum activities.
		26	The licensee shall take all reasonable steps necessary to secure the safety, health, environment and welfare of personnel engaged in petroleum activities in the licence area including: ■ Preventing the escape of any mixture of water or drilling fluid, and petroleum or any other matter; ■ Preventing the pollution of any water well, spring, stream, river, lake or reservoir by the escape of petroleum, water, drilling fluid, chemical additive, gas not being petroleum or any other waste product or effluent; and ■ Treating or dispersing it in an environmentally acceptable manner, where pollution occurs.
National Environment (Waste Management) Regulations (Ref. 15)	1999	3	These Regulations apply - a) to all categories of hazardous and non-hazardous waste; b) to the storage and disposal of hazardous waste and their movement into and out of Uganda; and c) to all waste disposal facilities, landfills, sanitary fills and incinerators.
		5	A person who owns or controls a facility or premises which generate waste shall minimise the waste generated by adopting the following cleaner production methods.
		6	Application for licence for transportation of or storage of waste: 1) A person intending to transport waste shall apply to the Authority for a licence in Form set out in the First Schedule. 2) A person intending to store waste on his or her premises shall apply to the Authority for a licence in Form III set out in the First Schedule. 3) An application under this regulation shall be accompanied by the appropriate fee prescribed in the Sixth Schedule. 4) A person intending to move waste from one district for disposal or storage in another district, shall, before applying for a licence under this regulation, notify, in writing, the District Environment Officers

Name	Year ratified	Relevant sections	Description
			of the district from which he or she intends to move the waste and the district to which he or she intends to move the waste. 5) A person who transports waste or stores waste on his or her premises without a licence issued under these Regulations commits an offence.
		7	Licence for transportation or storage of waste: 1) The Authority may issue a licence for transportation of waste or for storage of waste under this regulation where (all the requirements of these Regulations have been met). 2) A person granted a licence to transport waste shall ensure that it (meets the requirements of these regulations). 3) A person licenced to transport or store waste shall ensure that all employees involved in the collection, transportation or storage of waste undergo such medical check-up as may be commensurate with the risks faced by the employees and, on completion of the check-up, the licensee shall submit a medical report of fitness in respect of each employee to the Authority. 4) An environmental inspector may, at any time, subject the persons involved in the collection, transportation or storage of waste to a medical check-up and the costs of the examination shall be borne by the licensee. 5) The vehicles used for transportation, or other means of conveyance, and the premises or storage of wastes shall be labelled in such a manner as may be directed by the Authority. 6) The Authority may impose any conditions on a licence issued under this regulation which it may consider relevant to the transportation and storage of wastes.
		8	Duration and form of licence: 1) A licence for the transportation or storage of waste is valid for one year and may be renewed by the Authority on the application of the licensee. 2) The Authority may, where it deems it necessary, limit the validity of the licence to a specific number of transactions. 3) A licence for the transportation of waste shall be in Form II set out in the First Schedule. 4) A licence for the storage of waste shall be in Form IV set out in the First Schedule. 5) A licence under this Regulation shall be accompanied by the appropriate fee prescribed in the Sixth Schedule.
		10	Packaging of waste:

Name	Year ratified	Relevant sections	Description
			1) Upon application for a licence for storage of waste under Regulation 6, the applicant shall provide a sample of the containers or packaging material in which the waste is to be stored. 2) The container or packaging material referred to in sub-regulation (1) shall be suitable for the storage of the waste for which the licence is required and shall - a. not be reactive to the waste to be stored in it; b. be free from the possibility of leakage; and c. not cause harm to persons involved in handling the waste, the neighbouring community and the environment in general. 3) Every container or package used for the storage of hazardous waste shall be labelled in accordance with Regulation 11 and shall be disposed of in the manner prescribed by Regulation 16. 4) A person who sells or offers for sale a container which has been used for the storage of hazardous waste to be used for a purpose other than the storage of waste commits an offence.
		11	Labelling: 1) Each container or package of hazardous waste shall have attached to it a label, in easily legible characters, written in English and any other relevant local languages. 2) A label shall, at a minimum, contain the following information (listed in these Regulations). 3) A vehicle or other conveyance carrying hazardous wastes shall be labelled in accordance with sub-regulation 2(f) and the label shall not contain any warranties, guarantees or liability exclusion clauses inconsistent with this Statute or these Regulations.
		14	Licence to own or operate a waste treatment plant or disposal site: 1) The Technical Committee shall issue to an applicant a licence to own or operate a waste treatment plant or waste disposal site (if it meets the requirements of these Regulations). 2) A licence to own or operate a waste disposal site or plant shall be in Form VI set out in the First Schedule and shall be accompanied by the appropriate fee prescribed in the Sixth Schedule. 3) A person licenced to own or operate a waste treatment plant or disposal site shall ensure that it (has met all the requirements of these Regulations). 4) The Technical Committee may impose conditions on a licence for the operation of a waste treatment or disposal site as it considers necessary. 5) A licence to own or operate a waste treatment plant or disposal site is valid for one year and may be renewed: except that the Technical Committee may limit the duration of the licence for a period of less than one year, but not less than six months.

Name	Year ratified	Relevant sections	Description
			6) The Authority may, where it deems it necessary, issue a licence to an applicant under regulation 7 for the temporary storage of any waste pending final disposal of the waste: and the temporary storage shall meet the standards required for the disposal of that category of waste as required by these Regulations. 7) A person who (a) operates or owns a waste disposal site without a licence or (b) discharges waste onto a site or plant which is unlicensed commits an offence.
		15	Environmental Impact Assessment: 1) A waste treatment plant or disposal site shall not be licenced under these Regulations unless an environmental impact assessment has been carried out in accordance with Sections 19, 20 and 21 of the Act. 2) An operator of a waste treatment plant or disposal site shall carry out an annual audit of the environmental performance of the site or plant and shall submit a report to the Authority.
		16	Disposal of waste: 1) Where a disposer intends to dispose of or treat waste, the disposer shall, in addition to the matters required under Regulations 13 and 14, indicate in his or her application for a licence, the disposal operations he or she intends to carry out in accordance with the categories identified in the Fifth Schedule and shall enclose (the document requirements listed in the Regulations). 2) In issuing a licence for the disposal of waste, the Authority shall clearly indicate the disposal operation permitted and identified for the particular waste in accordance with the Fourth Schedule. 3) A person who disposes of waste in contravention of this regulation commits an offence.
		17	Prevention of pollution from treatment plant and disposal site: 1) Every person who operates a waste treatment plant or disposal site shall take all necessary measures to prevent pollution from the site or plant, including the erection of necessary works and instituting of mitigation measures. 2) In taking measures to prevent pollution under sub-regulation (1), the operations of a waste treatment plant or disposal site shall comply with any directions given by an environmental inspector under Section 81 of the Statute. In taking measures to prevent pollution under sub-regulation (1), the operations of a waste treatment plant or disposal site shall comply with any directions given by an environmental inspector under Section 81 of the Statute.
		22	Insurance:

Name	Year ratified	Relevant sections	Description
			1) An applicant for a licence under Regulations 6, 13 and 18 shall satisfy the Authority that he or she has subscribed to an insurance policy covering the risks likely to arise out of the activity for which the licence is required. 2) A generator of waste which has been characterised as hazardous under the Fifth Schedule shall, upon written instructions from the Executive Director, subscribe to an insurance policy to cover risks caused by that waste.
		23	Reporting procedures: 1) A person licenced to carry out any activity under these Regulations shall submit bi-annual reports on the conduct of the licenced activity to the Authority. 2) Where special reporting procedures are made the condition of a licence granted under these Regulations, those procedures shall take precedence over the submission of bi-annual reports under sub-regulation (1).
		24	Duty to keep records: 1) The holder of a licence under these Regulations shall keep a record of the licenced activity and all transactions related to it and submit the record to the Authority every six months from the commencement of the licenced activity. 2) The Authority may order the licensee install metering devices at the expense of the licensee, and take samples and analyse them as the Authority may direct.
		26	Improvement notice: 1) Where an environmental inspector has reasonable cause to believe that any person is violating these Regulations, he or she may issue against that person an improvement notice.
		27	Cancellation of licence: 1) The Authority may, on the advice of the Technical Committee, suspend or revoke a licence issued under these Regulations if it is satisfied that the conditions of the grant of the licence have not been complied with or the continued operation of the waste treatment plant or disposal site will be injurious to the health of the neighbouring community or to the environment in general.
		28	Penalties: 1) A person who commits an offence under these Regulations is liable, on conviction, to imprisonment for a term of not less than thirty six months or to a fine of not less than three hundred and sixty thousand shillings and not more than thirty six million shillings or both.

Name	Year ratified	Relevant sections	Description
		29	Fees: 1) The fees prescribed in the Sixth Schedule shall be paid for the various applications and licences under these Regulations.
National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations (Ref. 17)	1999	3	The standards for effluent or waste water before it is discharged into water or on land is prescribed in the Schedule to these Regulations.
		4	Every industry or establishment shall install at its premises, anti-pollution equipment, for the treatment of effluent chemical discharge emanating from the industry or establishment. The equipment shall be based on the best practicable means environmentally sound practice or other guidelines determined by the authorities.
		5	The person must keep a record of the amount of waste generated and of the parameters of the discharges, and submit these records to the authorities every three months from the commencement of the activity for which the permit was issued.
		Schedule	Prescribes the standards for discharge of waste water.
The Environmental Impact Assessment Regulations (Ref. 18)	1998	3	These Regulations apply to all projects, including major repairs, extensions, or routine maintenance to an existing project which is included in the Third Schedule of the National Environment Act, 1995 (i.e. sites for hazardous waste disposal).
		5	A developer shall prepare a project brief stating the possible products and by-products, including waste generation of the project.
Petroleum (Exploration, Development and Production) Regulations (Ref. 19)	2016	42	The licensee shall, before drilling any well, submit to the relevant authority, a well proposal and drilling programme, which includes the methods to be adopted for the disposal of waste including spent mud, cuttings and camp waste, from the location of the well.
Petroleum (Waste Management) Regulations (Ref. 20)	*Draft form*	*2*	*These Regulations apply to a person involved in-* *a) the production, transportation, storage, treatment or disposal of waste arising out of petroleum activities or midstream operations; and* *b) the construction and operation of petroleum waste management facilities.*

Name	Year ratified	Relevant sections	Description
			In addition, a person must also with the National Environment Act, the Petroleum (Exploration, Development and Production) Act, 2013, the Petroleum (Refining, Conversion, Transmission and Midstream Storage) Act, 2013, the National Environment (Waste Management) Regulations, the Occupational Safety and Health Act, 2006 and any other applicable law; *Waste not classified as petroleum waste shall be managed in accordance with the National Environment (Waste Management) Regulations.*
		4	*The licensee and the petroleum waste handler shall apply the principles as set out in these Regulations to the management of petroleum waste.*
		5	*The licensee shall contract a separate entity to be licensed by the Authority in accordance with these Regulations as a petroleum waste handler to manage the transportation, storage, treatment or disposal of waste arising out of petroleum activities or midstream operations. The separate entity shall not include any affiliate or subsidiary of the licensee.* *The licensee shall remain responsible for the management of petroleum waste by the petroleum waste handler;* *The licensee shall remain liable for future pollution costs resulting from the petroleum waste managed under these Regulations; and* *The licensee shall provide a financial security, in the form of an on-demand bank guarantee to cover the cost of managing the licensee's petroleum waste by the petroleum waste handler in the event of non-compliance with the requirements of any applicable law or conditions of a licence, closure or bankruptcy.*
		6	*The licensee and the petroleum waste handler have a duty of care and shall take all reasonable and applicable measures:* *a) to ensure that petroleum waste is managed appropriately and securely;* *b) to ensure that any leakage or spillage of petroleum waste is quickly and reliably detected and handled; and* *c) ensure that spillages which may cause pollution are notified to the Authority and other relevant authorities.* *The petroleum waste handler shall, within a period of 30 days of grant of a licence under regulation 16, provide a financial security to cover the cost of decommissioning and restoration, including closure, monitoring and after-care for landfills in the event of non-compliance, closure or bankruptcy.*
		7	*The licensee and the petroleum waste handler shall manage waste through the application of hierarchical waste management practices:*

Name	Year ratified	Relevant sections	Description
			When applying the waste management hierarchy, the licensee and petroleum waste handler shall take measures to encourage the options that deliver the least impact to the environment and human health.
		8	*The licensee and the petroleum waste handler shall, where the production of intractable petroleum waste is not preventable and where there are no recycling, treatment or disposal options within Uganda, ensure that the waste is exported for proper disposal.*
		9	*The licensee and the petroleum waste handler shall:* *a) ensure that the different types of petroleum waste are segregated at source and at the petroleum waste management facility by way of waste stream and classification, to facilitate their appropriate handling and traceability;* *a) ensure that the classification of waste and the further handling and treatment of petroleum waste is not distorted by mixing or dilution of waste; and* *b) continuously improve the petroleum waste management practices as technology advances.*
		10	*The licensee and the petroleum waste handler shall establish, follow up and further develop a waste management system designed to ensure compliance with the requirements of these Regulations and any other applicable laws;* *The licensee and petroleum waste handler shall ensure that the personnel managing the petroleum waste understand and comply with the waste management system and waste management plans; and* *The waste management system and waste management plans shall be documented, implemented and regularly updated and made available to the Authority and other relevant lead agencies on request.*
		11	*The licensee shall identify all petroleum waste streams with respect to volumes and any significant risks that they may pose to human health and the environment.* *The waste streams identified shall be quantified, characterized and documented in order to develop the best petroleum waste management options.* *The licensee shall continuously evaluate the processes that generate petroleum waste streams in order to comply with these Regulations.*
		12	*A person or entity shall not manage petroleum waste without a licence issued by the Authority under these Regulations;* *An application for a licence to manage petroleum waste shall be made to the Authority in the form set out in these Regulations, and shall attach a copy of an environment impact assessment certificate or environmental risk certificate granted for the activity;*

Name	Year ratified	Relevant sections	Description
			An application under this regulation shall be accompanied by the appropriate fee prescribed in these Regulations.
		15	*An application for a licence to manage petroleum waste shall be processed expeditiously, but in any case not later than ninety days from the date of receipt of complete application.*
		16	*The Authority shall, before grant of a licence, require the applicant to submit to the Authority an insurance policy covering the environmental risks likely to arise out of the waste management activity for which the licence is required.*
		17	*The Authority may impose conditions in a licence issued under these Regulations which it may consider relevant for petroleum waste management.*
		18	*A licence for the transportation of petroleum waste shall be valid for a period of one year.* *A licence for the storage, treatment or disposal of petroleum waste shall be valid for a period of three years.* *Notwithstanding the above, the Authority may suspend or revoke a licence issued under these Regulations.*
		19	*The Authority may suspend or revoke the licence where:* *a) information or data given by the applicant in the application or during consultations was false, substantially incorrect or intended to mislead;* *b) information leading to approval of the application was hidden or concealed and gave rise to a wrong decision;* *c) the licence was issued in error;* *d) there is non-compliance with these Regulations or the conditions set out in the licence with the effect of undermining the integrity of the environment;* *e) it is necessary to protect human health or to prevent harm or further harm to the environment, a situation that was not foreseen during the process for grant of the licence;* *f) there is a substantial change or modification of the petroleum waste management activity for which the licence was granted, which may lead to adverse environmental impacts or endanger human health or safety; or* *g) there is a substantive undesirable effect not contemplated during the approval of the application for grant of the licence.*
		20	*A person who, before the commencement of these Regulations was carrying on the business of petroleum waste management shall apply to the Authority for a licence in accordance with these Regulations within*

Name	Year ratified	Relevant sections	Description
			twelve months after the commencement of these Regulations or at the expiration of an existing licence, where the remaining licence period is less than twelve months.
		21	*Where a licence is suspended or revoked, the petroleum waste handler shall stop any further operations and undertake any remedial activities required by the Authority.*
		22	*A person granted a licence under these Regulations may apply to the Authority for renewal of the licence within ninety days before the expiration of the licence.*
		23	*Where the petroleum waste handler wishes to transfer the licence, he or she shall notify the Authority within sixty days before the date of the intended transfer.* *Where the Authority is not satisfied that the proposed new owner or operator meets the requirements for the management of petroleum waste under these Regulations, the Authority may reject the transfer of the licence.*
		24	*The licensee and the petroleum waste handler shall classify and characterise petroleum waste streams in accordance with these Regulations;* *The licensee and petroleum waste handler shall use laboratories which are designated by the Authority or certified for provision of laboratory services for the characterization of petroleum waste;* *The licensee shall not hand over to a petroleum waste handler petroleum waste that is not classified and characterized in accordance with this regulation.* *The licensee and petroleum waste handler shall use the information on classification and characterisation of petroleum waste under this regulation together with the waste manifest to guide the subsequent management of the petroleum waste.*
		25	*The licensee shall provide the petroleum waste handler with a waste manifest in accordance with these Regulations;* *The licensee and petroleum waste handler shall each enter details in the relevant part of the waste manifest;* *The waste manifest shall be kept by the licensee and petroleum waste handler in hard copy and in electronic form for a period of at least five years from the date of first movement of the waste, thereafter the waste manifest shall be kept and be available in electronic form;* *The waste manifest shall be available to the Authority, environmental inspectors and other authorized officers on request;* *The petroleum waste handler shall not accept the petroleum waste that is not accompanied by a manifest; or does not match the description on the accompanying waste manifest;*

Name	Year ratified	Relevant sections	Description
			Where any person attempts to transport or deliver petroleum waste to the petroleum waste management facility contrary to these Regulations, the petroleum waste handler shall reject the waste; immediately notify the licensee, the Authority and any other relevant government authority; and direct the transporter to return the waste to the licensee, unless otherwise instructed by the Authority.
		26	*A petroleum waste handler shall not manage petroleum waste at a waste management facility without taking reasonable measures to identify all hazards associated with the petroleum waste;* *The petroleum waste handler shall inquire into and ascertain the composition of petroleum waste wherever the petroleum waste handler has reason to believe that a process or operation producing the petroleum waste delivered to the waste management facility has changed; or the description of a petroleum waste received at the facility does not match the description of the petroleum waste on the accompanying waste manifest;*
		27	*The licensee or petroleum waste handler shall not store or transport in the same container two or more types of petroleum wastes which are not compatible; or a petroleum waste which is not compatible with any substance placed in the container;* *The licensee or petroleum waste handler who uses a container to store or transport hazardous waste shall do so in accordance with these Regulations; and* *A person shall not place petroleum waste in an unwashed container that previously held a material which is incompatible with that petroleum waste; or use a container which contains residues of petroleum waste to store, hold or transport food, animal feed or a product which may directly or indirectly become part of food for human consumption.*
		28	*A container or package containing petroleum waste shall have attached to it a label in accordance with these Regulations, written in English in easily legible characters as determined by the Authority;* *The English label shall be permanently fixed to the package and may have a translation in a relevant local language; and* *All primary containers for petroleum waste containing hazardous chemicals and substances shall be packaged with up-to-date material safety data sheets with directions for handling of petroleum waste, including safety precautions.*
		29	*The licensee or petroleum waste handler shall ensure that vapours emitted during filling, cleaning or storage of petroleum waste containers or operation of petroleum waste management facilities do not expose a person to offensive odours at the vicinity of the waste handling facility; or cause the concentration of the vapours to exceed permissible levels of exposure.*

Name	Year ratified	Relevant sections	Description
		30	*The licensee may, with the approval of the Authority, store petroleum waste generated on-site for a period not exceeding three months to accumulate quantities of waste material that can be transported for recycling, treatment or disposal where the petroleum activity or midstream operation is undertaken intermittently;* *The quantities temporarily stored on site shall not exceed one thousand kilogrammes;* *Short-term storage shall be done in appropriate facilities in accordance with these Regulations;* *The licensee and the petroleum waste handler shall keep logs of the waste stored under this regulation.*
		31	*The licensee or petroleum waste handler shall designate and manage waste storage areas in accordance with these Regulations.* *The waste storage areas shall be indicated on the facility layout drawing of licensee or petroleum waste handler, including the storage capacity, petroleum waste types to be stored, and operating practices.* *Storage of petroleum waste shall be based on environment risk assessment performed in accordance with the National Environment Act.* *The licensee and the petroleum waste handler shall establish adequate measures to the satisfaction of the Authority for the security of storage facilities so that corrective measures can be taken in the event of accidents or leakages.* *Access to waste storage areas shall be controlled and documented to the extent to the extent that is necessary.*
		32	*The licensee and petroleum waste handler shall ensure that any petroleum waste containing radioactive materials is managed in accordance with the Atomic Energy Regulations, 2012;* *The licensee and the petroleum waste handler shall, in accordance with a permit or licence obtained from the Atomic Energy Council, regulate the use of radioactive materials, to prevent exposure or contamination and accumulation of petroleum waste containing radioactive material and to provide for safe dispose of the waste.* *The licensee shall be liable for any exposure of persons to petroleum waste containing radioactive material and related wastes in the licensee's control in a petroleum activity or midstream operation.*
		33	*A petroleum waste handler holding a licence to transport petroleum waste shall ensure that:* *a) the collection and transportation of waste is conducted in a manner that does not cause leakage, scattering or littering of the waste or the emitting of noxious smells or harmful odours;* *b) the vehicle or vessel used for transportation of petroleum waste is labelled with the words "HAZARDOUS WASTE" in permanent, fluorescent and legible characters determined by the Authority, and placed on either side of the vehicle or vessel in a colour contrasting with the background;*

Name	Year ratified	Relevant sections	Description
			c) the vehicles or vessels for transportation of petroleum waste and other means of conveyance of petroleum waste follow the approved scheduled routes from the point of collection to the disposal site or plant; *d) a waste manifest, and a material safety data sheet for waste containing hazardous chemicals, accompany the waste to enable the tracking of each batch of waste from its source to its final disposal; and* *e) the personnel involved in the collection and transportation of petroleum waste are provided with:* *i) adequate protective and safety clothing;* *ii) adequate appropriate equipment or facilities for handling the waste;* *iii) safe and secure sitting facilities in the vehicles used for transporting waste; and* *iv) proper training, information and instructions, including on how to handle emergency situations.* *A petroleum waste handler shall not permit unauthorized access to the vehicle or vessel used for the transportation of the waste.*
		34	*The petroleum waste handler with a licence to transport petroleum waste shall put in place a journey management plan before commencement of operations for the transportation of petroleum waste and shall make it available to the Authority and lead agency on request;* *A copy of the journey management plan shall at all times be present in the vehicle or vessel transporting the petroleum waste;* *The petroleum waste handler shall install electronic tracking systems for vehicles used in the transportation of petroleum waste;* *The Authority and relevant lead agency may require the petroleum waste handler to provide the tracking information generated under this sub-regulation.*
		35	*The petroleum waste handler shall treat petroleum waste and petroleum contaminated soils in accordance with the treatment methods and environmental standards approved by the Authority;* *Where there are no environmental standards, the licensee and petroleum waste handler shall, with the approval of the Authority, use internationally recognised standards where available;* *The petroleum waste handler shall have quality control and quality assurance protocols to ensure that the treatment of petroleum waste and petroleum contaminated soils is in compliance with this regulation; and* *A person who contravenes this regulation commits an offence and is liable on conviction to a fine or imprisonment or both.*

Name	Year ratified	Relevant sections	Description
		36	*A person who wishes to utilise treated petroleum waste which is not classified or characterised as hazardous shall apply to the Authority;* *The Authority may, in consultation with the relevant lead agency, approve utilisation of treated petroleum waste; and* *The petroleum waste handler and the person utilising the treated petroleum waste u shall be responsible for any pollution or health impacts that may arise from the utilisation of treated petroleum waste.*
		37	*The petroleum waste handler may dispose of petroleum waste by methods approved by the Authority in consultation with the lead agency and subject to environment assessments carried out by the petroleum waste handler; and* *Where secondary waste is generated by any of the methods referred to in this sub-regulation, the petroleum waste handler shall ensure that the secondary waste is disposed of at designated waste sites licensed by the Authority.*
		38	*The petroleum waste handler with a licence to landfill petroleum waste, shall –* *a) construct an engineered landfill in accordance with environmental standards and guidelines;* *b) ensure that the engineered landfill is located in an area which has been identified after undertaking research and studies and found to be suitable for the purpose and has been subjected to environment assessment;* *c) provide an approved secure buffer zone surrounding the active area of the engineered landfill in accordance with environmental standards;* *d) apply appropriate and effective practices and techniques that prevent leakage of hazardous elements into the ground water systems and soil, so as to prevent the risk of environmental pollution; and* *e) conduct regular monitoring of air, water and soil quality in the surrounding environment to establish the levels of contaminants arising from the landfill operations and submit reports to the Authority on a half yearly basis.* *Where there are no environmental standards, the licensee and petroleum waste handler shall, with the approval of the Authority, use internationally recognised standards, where available.*
		39	*A petroleum waste handler with a licence to incinerate petroleum waste shall ensure that the incinerator is designed to ensure that its operation is in compliance with environmental standards; and is adopted to the specific type of petroleum waste to be incinerated.* *Where there are no environmental standards, the licensee and petroleum waste handler shall, with the approval of the Authority, use internationally recognised standards where available.*

Name	Year ratified	Relevant sections	Description
			A petroleum waste handler shall ensure that any residual material arising from the incineration process under this regulation is handled in accordance with the National Environment (Waste Management) Regulations.
		40	*A person shall not establish, construct or operate any petroleum waste management facility within the buffer zone distances as set out these Regulations;* *A petroleum waste management facility shall maintain buffer zone distances as permitted by the Authority in accordance with these Regulations.*
		41	*The licensee and the petroleum waste handler shall ensure that the petroleum waste treatment or disposal methods do not cause adverse effects to human health or on the environment through emissions, discharges, emissions or other contamination.*
		42	*The licensee and the petroleum waste handler shall ensure that they have emergency response plans that sufficiently addresses emergences relating to petroleum waste management in place; and their employees are provided with instructions on how to handle emergency situations and are regularly trained in handling the situations in accordance with the instructions.*
		43	*A petroleum waste handler shall put in place and maintain at a petroleum waste management facility appropriate warning and safety systems; and measures to prevent fire or explosions, or uncontrolled releases of hazardous substances or damage to the structural integrity of the petroleum waste management facility.*
		44	*The petroleum waste handler shall prepare and submit to the Authority for approval a comprehensive decommissioning plan for the waste management facility at least twenty four months prior to the commencement of the decommissioning.* *The decommissioning process shall be undertaken in accordance with the approved decommissioning plan and relevant environmental standards and international best practice. Where there are no environmental standards, the decommissioning shall be undertaken in accordance with internationally recognised standards, where available.* *On completion of the decommissioning, the petroleum waste handler shall submit a report stating the end of the decommissioning process, achievements and issues for follow up.*
		45	*A petroleum waste handler shall handle all remaining petroleum waste and other waste produced during decommissioning in accordance with these Regulations and the National Environment (Waste Management) Regulations.*

Name	Year ratified	Relevant sections	Description
		46	*A Petroleum waste handler shall in respect of the petroleum waste handled and in accordance with these Regulations, maintain at the waste management facility an operating record or inventory record; and an inspection record, including information from the waste manifest.* *The licensee and petroleum waste handler shall by the 31st of January of each year, submit to the Authority an annual report.* *Where the petroleum waste handler has decommissioned a petroleum waste management facility he or she shall, for such a period as is determined by the Authority, submit to the Authority an annual report on the condition of the decommissioned site or facility after the initial report.*
		47	*The licensee and petroleum waste handler shall immediately and in any case not later than twenty four hours after the occurrence of the event, notify the Authority where:* *a) there are any incidents or accidents leading to spillage or harm to the environment or human health;* *b) radioactivity has been detected in the petroleum waste;* *c) the petroleum waste delivered does not meet the description in the petroleum waste manifest;* *d) the petroleum waste cannot be traced and has not reached its destination; or* *e) the petroleum waste has been mixed up or otherwise tampered with.*
		48	*The Authority or authorised officer may conduct regular inspections and monitoring of the petroleum waste management facilities.*
		50	*A person who:* *a) transports, treats, stores, disposes or otherwise handles petroleum waste without a licence issued under these Regulations;* *b) fails to comply with any direction given under these Regulations;* *c) fails to permit any inspection or monitoring authorized under these Regulations;* *d) fails to submit any report, data or documentation required under these Regulations;* *e) wilfully or recklessly makes a report required under these Regulations, or furnishes information which is in any respect false;* *f) refuses to grant the Authority or authorised officer access to the petroleum waste management facility for purposes of taking samples,* *g) disposes off petroleum waste from vessels including lorries and boats to an un approved disposal site or into the water;*

Name	Year ratified	Relevant sections	Description
			h) dumps petroleum waste that is rejected by the petroleum waste handler commits an offence and is liable on conviction to a fine or imprisonment or both.
		51	*Where a person is convicted of an offence under these Regulations, the court may, in addition to any other penalty imposed, make an order for the forfeiture of any funds, money instruments, documents, facilities, vehicles, crafts, vessels or equipment used in the commission of the offence.*
The Petroleum (Exploration, Development and Production) (National Content) Regulations (Ref. 21)	2016	10	Every licensee operator, contractors and subcontractors shall reserve the contracts for goods and services specified in the Schedule (includes waste management) to be supplied by Ugandan companies, Ugandan citizens and registered entities.
The Petroleum (Refining, Conversion, Transmission and Midstream Storage) (National Content) Regulations (Ref. 22)	2016	11	Every licensee operator, contractors and subcontractors shall reserve the contracts for goods and services specified in the Schedule (includes waste management) to be supplied by Ugandan companies, Ugandan citizens and registered entities.
The Petroleum (Exploration, Development and Production) (Health, Safety and Environment) Regulations (Ref. 23)	2016	13	A licensee shall prepare and retain a written major accident prevention policy to ensure a high level of protection of human health and the environment, which is reviewed in accordance with this Act.
		29	The licensee shall handle, store, transport or dispose of hazardous substances in accordance with standards approved by the relevant authority, best petroleum industry practices, regulations made under section 3(8) of the Act, the National Environment Act and the Occupational Safety and Health Act, 2006. The licensee shall ensure that containers for transportation and storage of hazardous substances are colour-coded and labelled in accordance with standards approved by the relevant authority and best petroleum industry practices to ensure easy identification. The licensee shall avoid using hazardous substances in the work place and where practicable, substitute the hazardous substance with another substance of less risk to human health and the environment.

Name	Year ratified	Relevant sections	Description
			The licensee shall keep a record of all hazardous substances contained at the facility or during petroleum activity including information on physical, chemical and hazardous properties; preventive safety measures and first aid treatment.
		30	The licensee a shall ensure that warning signs are displayed at appropriate distance about the presence of hazardous substances every area where hazardous substances are present or could cause a hazard to a person. The licensee shall, as far as practicable, provide automated warning and detection systems in areas where there is a likelihood of exposure to a hazardous substance. The licensee shall manage safety hazards related to handling and storage of liquid or gaseous substances depending on the quantities and type where the liquid or substances are accidentally released. The licensee shall minimise the conditions for reactive or catastrophic events related to liquid or gaseous substances, including fire and explosion.
		38	The licensee shall ensure that each facility has a process safety system.
		126	The licensee shall actively contribute to the exchange of information with neighbouring activities and facilities within a geographic area to ensure that the people affected by the petroleum activities and facilities have a full overview at all times of the amounts of hazardous substances being handled.
		157	The licensee shall report promptly an accumulation, spill or leak of a hazardous substance.
		160	The licensee notify the relevant authority of the spillage of any hazardous substance inside the facility or during a petroleum activity.

Table 2: Summary of Relevant IFC Guidelines and Standards

Name	Year ratified	Relevant sections	Description
EHS Guidelines (Ref. 24)	2007	Introduction	■ Provides examples of good international industry practice; ■ Intended to be read together with Industry Specific EHS Guidelines; and ■ Includes measures that should be achievable in new facilities by existing technology at reasonable costs.
		1.6 General Waste Management	■ Applicable to both non-hazardous and hazardous waste; and ■ Provides recommendations for establishing a waste management system that addresses waste prevention, recycling and reuse, and treatment and disposal.
		Hazardous Waste Management	■ Sets out additional practices for the management of hazardous waste. This includes waste storage, transportation, treatment and disposal, and monitoring.
		3.5 Transport of Hazardous Materials	■ Sets out the requirements for the transport of hazardous materials; and ■ To be read in conjunction with the United Nations (UN) Model Regulations, and host country commitments under the Basel and Rotterdam conventions.
		3.7 Emergency Preparedness & Response	■ Sets out the basic elements to be included in an Emergency Preparedness and Response Plan.
Industry Sector EHS Guidelines for Onshore O&G Development (Ref. 25)		Introduction	■ Provides measures specific to onshore O&G facilities that should be implemented in addition to General EHS Guidelines; and ■ Guidelines should be used when host country regulations are less stringent.
		1.1 Environment	■ Sets out the environmental issues to be taken into consideration to address project-specific risks and potential impacts of an O&G facility.
		Wastewater	■ Provides information on wastewater management, water conservation and reuse, along with wastewater and water quality monitoring programmes.
		Produced water	■ Options to reduce the volume of produced water include adequate well management during well completion activities, recompletion of high water producing wells, use of downhole fluid separation techniques, where possible, and water shutoff techniques; ■ In order to minimise environmental hazards. production chemicals should be selected, taking into account their volume, toxicity, bioavailability, and bioaccumulation potential;

<table>
<tr><th>Name</th><th>Year ratified</th><th>Relevant sections</th><th>Description</th></tr>
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Main disposal options include in reinjection into the well to enhance oil recovery or injection into a dedicated disposal well drilled into a suitable geological formation. Other options include irrigation, dust control or use by another industry. Disposal into evaporation ponds is another disposal option; and
Discharge produced water should be treated to the below limits:

<table>
<tr><td>Produced water</td><td>Treatment and disposal as per guidance in Section 1.1 of this document
For discharge to surface waters or to land:
○ Total hydrocarbon content: 10 mg/L
○ pH: 6 - 9
○ BOD: 25 mg/L
○ COD: 125 mg/L
○ TSS: 35 mg/L
○ Phenols: 0.5 mg/L
○ Sulfides: 1 mg/L
○ Heavy metals (total)*: 5 mg/L
○ Chlorides: 600 mg/l (average), 1200 mg/L (maximum)</td></tr>
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<tr><td></td><td></td><td>Hydrostatic testing water</td><td>

Main options for disposal of hydrostatic test water includes injection into a disposal well or discharge to surface waters or land surface;
If hydrostatic test water is to be discharged to surface water or land, the following pollution prevention measures should be considered:

Use the same hydrotest water for multiple tests;
Reduce the need for chemicals by minimising the time that test water remains in the equipment or pipeline;
Carefully select chemical additives in terms of dose concentration, toxicity, biodegradability, bioavailability, and bioaccumulation potential;
Conduct toxicity testing as necessary using recognised test methodologies;
If significant quantities of chemically treated hydrostatic test waters are required to be discharged to a surface water body, water receptors both upstream and downstream of the discharge should be monitored;
If discharged to water, the volume and composition of the test water, as well as the stream flow or volume of the receiving water body, should be considered in selecting an appropriate discharge site;

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<tr><th>Name</th><th>Year ratified</th><th>Relevant sections</th><th>Description</th></tr>
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Use break tanks or energy dissipaters (e.g. protective riprap, sheeting, tarpaulins) for the discharge flow;
Use sediment control methods (e.g. silt fences, sandbags or hay bales) to protect aquatic biota, water quality and water users from the potential effect of discharge;
If discharged to land, the discharge site should be selected to prevent flooding, erosion, or lowered agriculture capability of the receiving land; and
Water discharge during cleaning pig runs and pre-test water should be collected in holding tanks and should be discharged only after water quality testing.

Discharge of hydrostatic test water should be discharged to the below limits:

<table>
<tr><td>Hydrotest water</td><td>Treatment and disposal as per guidance in section 1.1 of this document.
For discharge to surface waters or to land, see parameters for produced water in this table.</td></tr>
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<tr><td></td><td></td><td>Tank bottom waters</td><td>

The accumulation of tank bottom waters should be minimised by regular maintenance of tank roofs and seals to prevent rainwater infiltration;
Tank bottom waters can potentially be routed to the produced water stream for treatment and disposal, if available; and
Tank bottom sludges should also be periodically removed and recycled or disposed of as a hazardous waste.

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<tr><td></td><td></td><td>Generally oily water</td><td>

Oily water from drip trays and liquid slugs from process equipment and pipelines should be routed to the closed drainage system.

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<tr><td></td><td></td><td>Surface storage or disposal pits</td><td>

Surface storage or disposal pits should be constructed outside environmentally sensitive location;
Wastewater pit construction and management measures should include:

Installation of a liner so that the bottom and sides of the pit have a coefficient of permeability of no greater than 1 x 10 - 7 cm per second (cm/sec);
Liners should be compatible with the material to be contained and of sufficient strength and thickness to maintain the integrity of the pit. Typical liners may include synthetic materials, cement/clay type or natural clays, although the hydraulic conductivity of natural liners should be tested to ensure integrity;

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Name	Year ratified	Relevant sections	Description
			▪ Construction to a depth of typically 5 m above the seasonal high water table; ▪ Installation of measures (e.g. careful siting, berms) to prevent natural surface drainage from entering the pit or breaching during heavy storms; ▪ Installation of a perimeter fence around the pit or installation of a screen to prevent access by people, livestock and wildlife (including birds); ▪ Regular removal and recovery of free hydrocarbons from the pit contents surface; ▪ Removal of pit contents upon completion of operations and disposal in accordance with the waste management plan; and ▪ Reinstatement of the pit area following completion of operations.
		Waste Management	■ Sets out waste management guidelines for wastes streams specific to onshore O&G facilities; ■ Waste materials should be segregated into non-hazardous and hazardous wastes for consideration for reuse, recycling, or disposal; ■ Waste management planning should establish a clear strategy for wastes that will be generated including options for waste elimination, reduction or recycling or treatment and disposal, before any wastes are generate; and ■ A waste management plan documenting the waste strategy, storage (including facilities and locations) and handling procedures should be developed and should include a clear waste tracking mechanism to track waste consignments from the originating location to the final waste treatment and disposal location.
		Drilling fluids and drilled cuttings	■ The following should be considered to reduce the volume of drilling fluids and drill cuttings requiring disposal: ▪ Use of high efficiency solids control equipment to reduce the need for fluid change out and minimising the amount of residual fluid on drilled cuttings; and ▪ Use of slim-hole multilateral wells and coiled tubing drilling techniques. ■ Feasible options for the treatment and disposal of drilling fluids and drilled cuttings, may include one, or a combination, the following: ▪ Injection of the fluid and cuttings mixture into a dedicated disposal well; ▪ Injection into the annular space of a well; ▪ Storage in dedicated storage tanks or lined pits prior to treatment, recycling, and/or final treatment and disposal;

Name	Year ratified	Relevant sections	Description
			▪ On site or off-site biological or physical treatment to render the fluid and cuttings non-hazardous prior to final disposal. This may include thermal desorption, bioremediation, land farming, or solidification with cement and/or concrete; ▪ Final disposal options for non-hazardous drill cuttings may include the use in road construction material, construction fill, or disposal through landfill including landfill cover and capping material where appropriate; and ▪ Recycling of spent fluids back to the vendors for treatment and reuse. ■ For drilling pits, pit closure should be completed as soon as practical, but no longer than 12 months, after the end of operations. If the drilling waste is to be buried in the pit following operations (the Mix-Bury-Cover disposal method), the following minimum conditions should be met: ▪ The pit contents should be dried out as far as possible; ▪ If necessary, the waste should be mixed with an appropriate quantity of subsoil (typically three parts of subsoil to one part of waste by volume); ▪ Topsoil should not be used but it should be placed over the subsoil to fully reinstate the area; ▪ A minimum of one meter of clean subsoil should be placed over the mix; and ▪ The pit waste should be analysed and the maximum lifetime loads should be calculated. A risk based assessment may be necessary to demonstrate that internationally recognised thresholds for chemical exposure are not exceeded. ■ Pollution prevention and control measures for spent drilling fluids and drilled cuttings should include: ▪ Careful selection of the fluid system; ▪ Careful selection of fluid additives taking into account technical requirements, chemical additive concentration, toxicity, bioavailability and bioaccumulation potential; and ▪ Monitoring and minimising the concentration of heavy metal impurities (mainly mercury and cadmium) in barite stock used in the fluid formulation.
		Completion and well work-over fluids	■ Feasible options for the treatment and disposal of completion and well work-over fluids ay include one, or a combination, the following:

<table>
<tr><th>Name</th><th>Year ratified</th><th>Relevant sections</th><th>Description</th></tr>
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Collection of the fluids if handled in closed systems and shipping to the original vendors for recycling;
Injection to a dedicated disposal well, where available;
Inclusion as part of the produced water waste stream for treatment and disposal. Spent acids should be neutralised before treatment and disposal; and
On site or off-site biological or physical treatment at an approved facility.

Completion and well work-over water should be treatment and disposed of in accordance with the following guidelines:

<table>
<tr><td>Completion and well work-over fluids</td><td>Treatment and disposal as per guidance in Section 1.1 of this document.
For discharge to surface waters or to land: :
○ Total hydrocarbon content: 10 mg/L.
○ pH: 6 – 9</td></tr>
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</td></tr>
<tr><td></td><td></td><td>1.2 Occupational health and safety</td><td>

The design of the onshore facilities should reduce exposure of personnel to chemical substances, fuels, and products containing hazardous substances; and
For each chemical used, a Material Safety Data Sheet should be available and readily accessible on the facility.

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<tr><td></td><td></td><td>2.0 Performance indicators and monitoring</td><td>

Sets out effluent and waste guidelines for onshore O&G development (see Table 1 on page 22 of the guidelines);
Environmental monitoring programmes should be implemented to address all activities identified as having the potential to impact on the environment, during normal operations and upset conditions;
Monitoring frequency should be sufficient to provide representative data for the parameter being monitored;
Monitoring should be conducted by trained individuals following monitoring and record-keeping procedures and using properly calibrated and maintained equipment; and
Monitoring data should be analysed and reviewed at regular intervals and compared with the operating standards so that any necessary corrective actions can be taken.

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<tr><td></td><td></td><td>2.2 Occupational</td><td>

Occupational health and safety performance should be evaluated against internationally published exposure guidelines. This includes, but is not limited to the following:

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</table>

Name	Year ratified	Relevant sections	Description
		health and safety	▪ Threshold Limit Value (TLV®) occupational exposure guidelines and Biological Exposure Indices (BEIs®) published by American Conference of Governmental Industrial Hygienists (ACGIH); ▪ The Pocket Guide to Chemical Hazards published by the United States National Institute for Occupational Health and Safety (NIOSH); ▪ Permissible Exposure Limits published by the Occupational Safety and Health Administration (OSHA) of the United States; and ▪ Indicative Occupational Exposure Limit Values published by European Union member states.
EHS Guidelines for Waste Management Facilities (Ref. 26)	2007	Introduction	■ Provides measures specific to new waste management facilities that should be implemented in addition to General EHS Guidelines; ■ Applicable to all facilities that manage industrial waste, including waste collection and transport, waste receipt, unloading, processing, and storage; landfill disposal; physio-chemical and biological treatment; and incineration projects; and ■ Guidelines should be used when host country regulations are less stringent.
		1.1.2 Industrial Hazardous Waste	■ Applicable to wastes defined as 'hazardous' by local regulations or international conventions, based on the origin of the waste and its inclusion in hazardous waste lists.
		Waste Collection & Transport	■ Sets out general measures to prevent spills and releases during waste transport and to facilitate emergency response if an accident does occur. Also includes recommendations specifically for hazardous waste collection and transport.
		Waste Receipt, Unloading, Processing and Storage	■ Sets out general measures to control waste receipts and general measures to mitigate risks at industrial hazardous waste management facilities.
		Spills and Releases	■ Sets out mitigation measures to address spills and releases resulting from overfills, vehicle accidents, and tank and piping failures.
		Air Emissions	■ Sets out mitigation measures to minimise releases of particulate matter and volatile organic compounds from storage and waste processing facilities.

<table>
<tr><th>Name</th><th>Year ratified</th><th>Relevant sections</th><th>Description</th></tr>
<tr><td></td><td></td><td>Waste Effluents</td><td>■ Sets out mitigation measures to prevent, minimise and control water effluents.</td></tr>
<tr><td></td><td></td><td>Biological and Physio-Chemical Treatment</td><td>■ Sets out recommended procedures to prevent, minimise, and control potential environmental impacts from chemical treatment; and
■ Also sets out specific measures for air emissions, water effluents, and waste residuals.</td></tr>
<tr><td></td><td></td><td>Hazardous Waste Incineration</td><td>■ Sets out measures to manage air emissions, water effluents, and ash and residues; and
■ Includes air emission standards for hazardous waste incinerators in the EU and US-
Table 2. Air Emission Standards for Hazardous Waste Incinerators in the EU and US
<table>
<tr><th>Parameter</th><th>EU</th><th>US[a]</th></tr>
<tr><td>Particulate Matter</td><td>See Table 1</td><td>1.5 mg/dscm</td></tr>
<tr><td>Carbon Monoxide (CO) or Hydrocarbons (HC)</td><td>See Table 1</td><td>100 (CO) ppmv
10 (HC) ppmv</td></tr>
<tr><td>Total Chlorine (HCl, Cl2)</td><td>See Table 1</td><td>21 ppmv</td></tr>
<tr><td>Mercury (Hg)</td><td>See Table 1</td><td>8.1 µg/dscm</td></tr>
<tr><td>Semi-Volatile Metals (Pb, Cd)</td><td>See Table 1</td><td>10 µg/dscm</td></tr>
<tr><td>Low Volatile Metals (As, Be, Cr)</td><td>See Table 1</td><td>23 µg/dscm</td></tr>
<tr><td>Dioxins and Furans</td><td>See Table 1</td><td>0.11 dry APCD or WHB
0.20 other sources
(ng TEQ/dscm)</td></tr>
<tr><td>Destruction and Removal Efficiency</td><td>See Table 1</td><td>99.99% – 99.9999%</td></tr>
</table>
Source:
US EPA National Emission Standards for Commercial and Industrial Solid Waste Incineration Units, 40 CFR Part 63 Subpart EEE.
Notes:
a All values corrected to 7% oxygen
TEQ = toxicity equivalent; APCD = air pollution control device; WHB = waste heat boiler; mg/m3 = milligrams per cubic meter; mg/dscm = milligrams per dry standard cubic meter; ppmv = parts per million by volume;</td></tr>
</table>

<table>
<tr><th>Name</th><th>Year ratified</th><th>Relevant sections</th><th>Description</th></tr>
<tr><td></td><td></td><td>Landfilling</td><td>

Sets out additional measures to prevent, minimise, and control potential environmental impacts from landfilling, including leachate generation, groundwater and leachate monitoring, landfill gas, and closure and post-closure; and
Includes effluent standards for hazardous waste landfills in the EU and US–

Table 4—Effluent Standards for Landfills in the US
<table>
<tr><th rowspan="2">Parameter</th><th rowspan="2">Units</th><th colspan="4">Guideline[a]</th></tr>
<tr><th colspan="2">Hazardous Waste Landfills</th><th colspan="2">MSW Landfills</th></tr>
<tr><th></th><th></th><th>Daily Max</th><th>Monthly Avg.</th><th>Daily Max</th><th>Monthly Avg.</th></tr>
<tr><td>BOD5</td><td></td><td>220</td><td>56</td><td>140</td><td>57</td></tr>
<tr><td>pH</td><td></td><td>6-9</td><td>6-9</td><td>6-9</td><td>6-9</td></tr>
<tr><td>Total Suspended Solids</td><td>mg/L</td><td>88</td><td>27</td><td>88</td><td>27</td></tr>
<tr><td>Ammonia (as N)</td><td>mg/L</td><td>10</td><td>4.9</td><td>10</td><td>4.9</td></tr>
<tr><td>Arsenic</td><td>mg/L</td><td>1.1</td><td>0.54</td><td></td><td></td></tr>
<tr><td>Chromium</td><td>mg/L</td><td>1.1</td><td>0.46</td><td></td><td></td></tr>
<tr><td>Zinc</td><td>mg/L</td><td>0.535</td><td>0.296</td><td>0.20</td><td>0.11</td></tr>
<tr><td>a-Terpineol</td><td>mg/L</td><td>0.042</td><td>0.019</td><td>0.033</td><td>0.016</td></tr>
<tr><td>Aniline</td><td>mg/L</td><td>0.024</td><td>0.015</td><td></td><td></td></tr>
<tr><td>Benzoic Acid</td><td>mg/L</td><td>0.119</td><td>0.073</td><td>0.12</td><td>0.071</td></tr>
<tr><td>Naphthalene</td><td>mg/L</td><td>0.059</td><td>0.022</td><td></td><td></td></tr>
<tr><td>p-Cresol</td><td>mg/L</td><td>0.024</td><td>0.015</td><td>0.025</td><td>0.014</td></tr>
<tr><td>Phenol</td><td>mg/L</td><td>0.048</td><td>0.029</td><td>0.026</td><td>0.015</td></tr>
<tr><td>Pyridine</td><td>mg/L</td><td>0.072</td><td>0.025</td><td></td><td></td></tr>
</table>
Source: U.S. EPA Effluent Guidelines for Centralized Waste Treatment, 40 CFR Part 437.
</td></tr>
<tr><td></td><td></td><td>Occupational Health & Safety</td><td>

Sets out additional mitigation measures to prevent, minimise, and control accidents and injuries, chemical exposure and exposure to pathogens and vectors.

</td></tr>
</table>

Table 3: Summary of CNOOCs Own Policies, Guidelines and Standards

JVP	Name	Year ratified	Description
CNOOC	Waste Management Specification CUL-QHSE-L3(GE)-053 (Ref. 27)	N/A	■ CNOOC policy to properly and safely manage all hazardous and non-hazardous waste from its generation to ultimate disposition, to prevent/minimize risks to human health and the environment. ■ The policy applies to all wastes generated from operations focusing on exploration operations (seismic surveys and exploration drilling), field development, camp activity, as well as office activities.
	Health, Safety & Environment Handbook (Ref. 28)	N/A	■ Sets out the "5 DONT's until DOs" safety rules in the workplace; ■ Identifies 10 high risk activities; ■ Sets out the HSE requirements for each of these 10 high risk activities.
	CNOOC, Kingfisher Field Development Project, Waste Management Study Report KF-FD-RPT-GEN-SA-1027 REVB (Ref. 35).	2017	■ Kingfisher Field Development Project regarding: ▪ Types of Waste and Generation Source, ▪ Estimates of quantities, ▪ Mitigation methods and waste management, and ▪ Waste management execution plan.

3.0 WASTE BASELINE IN THE LAKE ALBERT OIL FIELDS AREA

3.1 Waste Generation

Section 3.0 provides background to the waste specialist study of the KDA area for CNOOC based on the development of the Lake Albert oil fields area by all three O&G companies. It provides the background information about amounts and types of non-hazardous waste (source: Atacama report dated July 2017, Ref. 30) and hazardous waste (source: Golder report 1546406, Ref. 31) expected to be generated during the different phases of field development.

3.1.1 Non-Hazardous Waste

3.1.1.1 Waste Quantification

The table below provides the summary findings of the non-hazardous waste quantities expected to be generated by the development of the Lake Albert oil fields area.

Table 4: Waste Quantification of the Lake Albert Oil Fields Area (Ref. 30)

	Waste Category	Quantities	Additional Description
Construction (2017 - 2021)	Solid Waste	94,500 mT	Majority of which will be construction and demolition (C&D) wastes with lesser quantities of municipal wastes.
	Liquid Waste	2,040,000 l (2,040 m^3)	Estimated grey water quantities
Operations Phase (2021 – 2045)	Solid Waste	400,000 mT	Will mainly be composed of municipal solid waste - mainly food waste, and industrial solid waste
	Liquid Waste	1,632,000 l (1632 m^3)	Estimated grey water quantities
		-	Boiler blowdown water
		-	Storm-water from Non-process areas

3.1.1.2 Waste Characterisations

For the non-hazardous waste streams expected to be generated, below is a summary of each waste stream across the development.

Table 5: Summary of waste streams and constituent non-hazardous waste composition expected to be generated from the Lake Albert Oilfield Development (Ref. 30)

Waste Stream	Non-hazardous waste composition per waste stream	Overall Non-hazardous waste types
Industrial Solid Wastes	Plant and vegetative materials	■ Food and vegetative wastes ■ Plastics ■ Paper ■ Metal ■ Glass ■ Rubber
	Plastics	
	Paper (including cardboard)	
	Metal (including scrap metal and offcuts)	
	Glass	
	Rubber	
	Wood	
	Construction and Demolition (C&D) wastes	
	Miscellaneous wastes (e.g. insulation, used tyres)	

Waste Stream	Non-hazardous waste composition per waste stream	Overall Non-hazardous waste types
Municipal Solid Wastes (MSW)	Food Wastes	■ Wood ■ C&D wastes ■ Grey water ■ Boiler blowdown water ■ Storm water from non-process areas ■ Miscellaneous wastes (e.g. insulation, used tyres, used parts, hoses, textile and leather)
	Plastics	
	Paper	
	Metal (including metal cans)	
	Glass (including bottles and containers)	
	Wood	
	Miscellaneous wastes (e.g. textile and leather)	
Transport and Automotive Wastes	Plastics	
	Paper (including cardboard)	
	Scrap Metal	
	Miscellaneous wastes (e.g. used parts, used tyres, hoses)	
Industrial & Municipal Wastewater and Sewage	Grey Water	
	Boiler blowdown water	
	Storm water from non-process areas	

Based on previous waste characterisations done in the CNOOC KDA; it is expected that the relative composition of the different non-hazardous solid wastes generated in the Lake Albert Oilfield will approximately be as provided in the table below.

Table 6: Expected Non-hazardous Solid Waste Composition (Ref. 30)

Waste Type	Estimated Composition
Food &Vegetative wastes	43%
Plastics	27%
Paper	20%
Metal	4%
Glass	1%
Rubber	1%
Wood	1%
Miscellaneous wastes	3%

Additionally, based on previous waste generation forecasts done for the CNOOC KDA, it is expected that the highest quantities of non-hazardous wastes will be generated during peak construction; higher quantities generated during post-construction phase; high quantities generated during early operations; and low quantities generated during the post-closure of the facilities (Ref. 30).

3.1.2 Hazardous Waste

The table below shows of the main types of hazardous waste that was generated during the exploration and appraisal phase (E&A) or is likely to be generated during the construction and production (C&P), and decommissioning phases for the Lake Albert oil fields area development by the three O&G companies.

Table 7: Hazardous Wastes at the Phases of Oil Field Development

Waste category	Waste type	Activity/Source	Phase		
			Exploration and appraisal	Construction and production	Decommissioning
Drill cuttings	-	Development drilling	✓	✓	
Drilling fluids	Water Based Drilling Fluids (WBDFs)	Development drilling	✓	✓	
	Non-Aqueous Drilling Fluids (NADFs)	Development drilling	✓	✓	
Associated Hazardous Wastes	Batteries (wet and dry)	Offices, workshop	✓	✓	✓
	Chemicals residue	Equipment and material preparation	✓	✓	
	Completion and well work-over fluids	Development drilling	✓	✓	
	Contaminated containers (e.g. oil drums)	Liquid handling (including water and oil/chemicals)	✓	✓	✓
	Contaminated hydrotest water	Pre-commissioning and Commissioning	✓	✓	
	Contaminated personal protective equipment	Staff	✓	✓	✓
	Contaminated scrap metal	Various activities	✓	✓	✓
	Electrical/electronic waste	Electrical wiring	✓	✓	
	Foam	Pipe insulation	✓	✓	
	Medical waste	Temporary and permanent medical facilities	✓	✓	✓

Waste category	Waste type	Activity/Source	Phase		
			Exploration and appraisal	Construction and production	Decommissioning
	Naturally Occurring Radioactive Materials (NORM)	Development drilling	✓	✓	
	Oil contaminated soil	General maintenance	✓	✓	
	Oily rags, filters, etc.	General maintenance	✓	✓	
	Oily sludges (from the bottom of vessels)	General maintenance	✓	✓	
	Pigging wastes	Pre-commissioning, Commissioning and general pipeline maintenance	✓	✓	
	Paint residue (solid and liquid)	General maintenance	✓	✓	
	Pipe dope	Pipe stringing and bending	✓	✓	
	Sewage	Sewage treatment plant, welfare units and portable toilets	✓	✓	✓
	Spent fluorescent tubes and lamps	General maintenance	✓	✓	✓
	Spent welding rods, epoxy coatings, grinder wheels, visors, shot blast, etc.	Welding, inspection and coating	✓	✓	✓
	Used aerosol cans	General maintenance	✓	✓	
	Used fabrication material (e.g. paint, cement, insulation)	Fabrication	✓	✓	
	Used lubricating/hydraulic oil, grease, solvents	General maintenance and chemical injection	✓	✓	

Waste category	Waste type	Activity/Source	Phase		
			Exploration and appraisal	Construction and production	Decommissioning
	and absorbent materials				

It can be seen that the wastes have been grouped into three broad categories; namely drill cuttings, drilling fluids and associated hazardous wastes. These categories are primarily based on the technologies used to treat and/or dispose of these types of waste, and are described in the sub-sections below.

3.1.2.1 Drill Cuttings

Drill cuttings refer to the particles of crushed rock produced by the action of the rotary drill bit as it digs into the earth (IOGP, 2016, see Ref. 29). The rotation of the drill bit at the bottom of the hole breaks off small chips of rock, deepening the hole. Drilling fluid (see Section 3.1.2.2), which exits the drill bit is used to remove the cuttings, allowing the drill bit to proceed. It does this by suspending the cuttings and carrying them up the annulus to the surface where they are separated from the drilling fluid by the solids control equipment on the drill rig.

The drill cuttings are therefore a mixture of the natural rock and soil material, and the drilling fluid (e.g. base fluid, brine, barite and emulsifiers). The hydrocarbon content of the cuttings is referred to as the oil on cuttings. The retention of drilling fluids on cuttings represents a financial loss as new fluids must be purchased to replace those disposed of as waste.

The physical and chemical characteristics of the drill cuttings is dependent on the formations drilled, and the type and quantity of any retained drilling fluid (Ref. 29). Drill cuttings range in size from clay-sized particles (~0.002 mm) to coarse gravel (>30 mm) and are irregular and angular. The chemical and mineral composition of cuttings reflects that of the rock layers being penetrated by the drill.

The choice of treatment and final disposal of the drill cuttings is dependent on a number of factors, including the type of drilling fluids used, local regulations, treatment/disposal facility limitations, environmental considerations, and cost–benefit analysis (Ref. 29).

3.1.2.2 Drilling Fluids

Drilling fluids are often referred to as ‘muds’, and are mixtures of fine-grained solids, inorganic salts, and organic compounds dissolved or dispersed/suspended in the base fluid (Ref. 29).

As shown in Figure 2 below, the drilling fluid is pumped from the mud tanks on the rig, down the drill pipe, exiting through holes in the drill bit, and returns to the surface via the annulus, which is the space between the drill pipe and the drill casing or rock wall of the drilled hole.

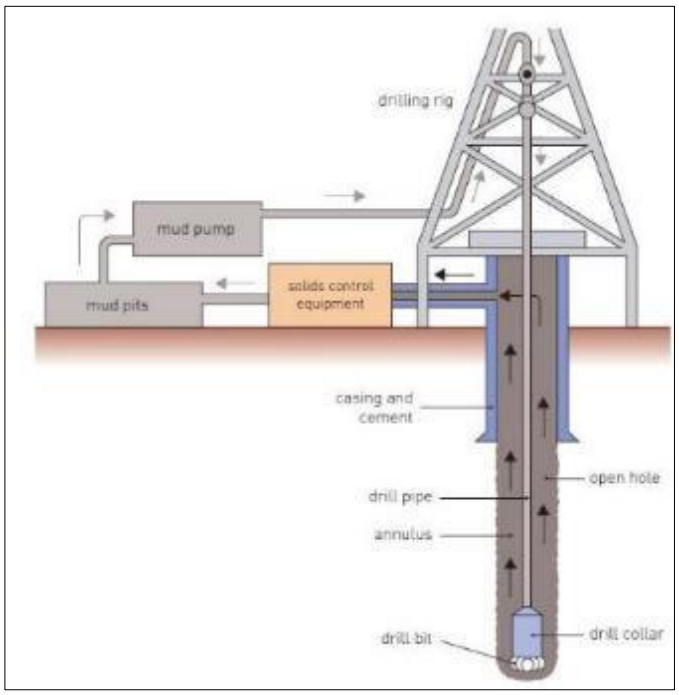

Figure 2: Drilling Fluids Circulating System of a Drilling Rig and Well (Ref. 29)

Drilling fluids are normally reused until their properties become unsuitable for the particular phase of the drilling operation. The two most commonly used drilling fluids are:

- Water based drilling fluids (WBDFs); and
- Non-aqueous drilling fluids (NADFs).

Water-Based Drilling Fluids

Water-based drilling fluids (WBDFs), also referred to as water-based muds (WBMs), are the most widely used, and are generally less expensive than other fluids (Ref. 29).

WBDFs are formulated mixtures of clays, natural and synthetic organic polymers, mineral weighting agents, and other additives dissolved or suspended in fresh water, brine, saturated brine, or a formatted brine. The type of fluid used is dependent on the anticipated well conditions.

Table 8 below presents a number of functional categories of additives available for modifying the physical/ chemical properties of a Water-based drilling fluid to solve specific downhole problems, enabling it to function optimally during drilling of a well.

Table 8: Functional Categories of Additives Sometimes Used in Water-Based Drilling Fluids (Ref. 29 Section 11)

Category	Example
Weighting materials	Barite, calcium carbonate, ilmenite or hematite
Viscosifiers	Clay, organic polymers
Filtrate reducers	Starch, clay, lignite, polymers
pH control	Inorganic acids and bases, most often caustic soda
Shale control	Soluble salts such as potassium chloride, amines, glycols)
Lost circulation materials	Inert insoluble solids such as calcium carbonate, ground nut shells, graphite, mica and cellulose fibres
Lubricants	Water-based lubricants, glycols and beads

Category	Example
Emulsifiers, surfactants	Detergents, soaps, organic fatty acids
Thinners	Lignite, lignosulfonates, polymers
Flocculants	Inorganic salts, acrylamide polymers
Bactericides	Glutaraldehyde, triazine disinfectants
Pipe-freeing agents	Water-based lubricants, enzymes, surfactants
Defoamers	Alcohols, silicones, aluminium stearate, alkyl phosphates
Calcium reducers	Sodium carbonate, bicarbonate, polyphosphates
Corrosion inhibitors	Amines, phosphates
Temperature stability	Acrylic or sulfonated polymers, lignite, lignosulfonate

WBDFs rarely contain more than ten of the above additives, with most added in small amounts. Furthermore, the composition of the water-based drilling fluids may also vary during drilling of a single well because different additives may be required to drill different well sections through varying geologic formations. As shown in Figure 3 below, water-based drilling fluids typically comprise mostly water (or brine) (76%), a weighting material such as barite (14%), and a mud viscosifier, such as bentonite clay or biologically derived organic polymer (6%).

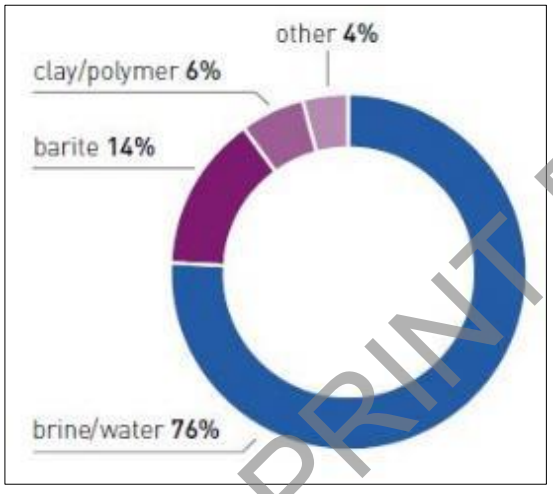

Figure 3: Typical Composition (by weight percentage) of Water-Based Drilling Fluid (IOGP, 2016: 12)

Non-Aqueous Drilling Fluids

Non-aqueous drilling fluids (NADFs), also referred to as synthetic-based muds (SBMs) are drilling fluids with an oil or synthetic base fluid (Ref. 29).

NADFs are used in some drilling operations where WBDFs are not well suited (Ref. 29). For example, as NADFs are intrinsically lubricous, they are better suited to the drilling of highly deviated, extended reach, and horizontal wells than WBDFs. NADFs are also more stable than WBDFs and therefore better suited to deep, high pressure/high temperature wells.

NADFs are typically formulated using diesel, mineral oil, or low-toxicity olefins, paraffins and esters (Ref. 29).

The olefins, paraffins and esters are often referred to as ‘synthetics’. In a NADF, the ratio of the non-aqueous percentage to the water percentage in the liquid phase is referred to as the oil/water ratio. This typically ranges between 70/30 and 80/20.

As with WBDFs, chemicals are added to non-aqueous drilling fluids to provide the same or similar functions as Water-based drilling fluid additives. In Figure 4 below, it can be seen that NADFs typically comprise

mostly non-aqueous fluid (46%), a weighting material, such as barite (33%), brine (18%), and emulsifiers (2%).

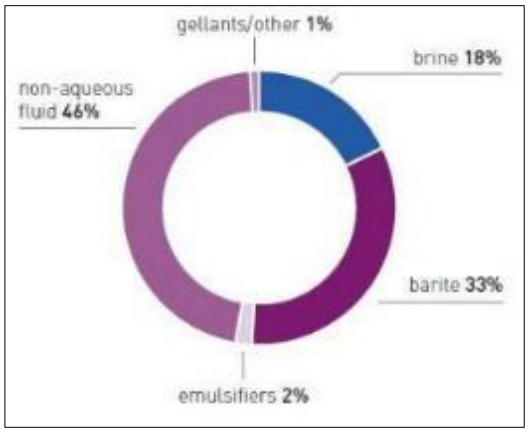

Figure 4: Typical Composition (by weight percentage) of non-aqueous drilling fluids (Ref. 29, Section 12)

The toxicity of the drilling fluid can be determined by the aromatic hydrocarbon concentrations. According to the IOGP, NADFs can be classified into three groups, namely I, II and III (see Table 9 below).

Table 9: Classification of non-aqueous drilling fluids (Ref. 29, Section 14)

Category	Properties
Group I: High Aromatic Content	■ Group I non-aqueous drilling fluids are defined as containing more than 5% by weight aromatic hydrocarbons, with polycyclic aromatic hydrocarbons (PAHs) concentrations greater than 0.35% by weight; ■ These were the first NADFs used and include crude oil, diesel and conventional mineral oils. Diesel and mineral oils are refined from crude oil and are complex mixtures of liquid hydrocarbons, including paraffins, aromatic hydrocarbons, and PAHs; and ■ Due to concerns about toxicity, Group I non-aqueous drilling fluids are generally only used where safe onshore disposal or reinjection of cuttings is possible.
Group II: Medium Aromatic Content	■ Group II non-aqueous drilling fluids are also developed from refining crude oil, but the distillation process is controlled to the extent that total aromatic hydrocarbon concentrations (between 0.5% and 5%) are less than those of Group I non-aqueous drilling fluids and PAH content is less than 0.35%, but greater than 0.001%; and ■ These fluids were developed to address concerns over the potential toxicity of diesel-based fluids.
Group III: Low to Negligible Aromatic Content	■ Group III non-aqueous drilling fluids contain less than 0.5% by weight total aromatics and less than 0.001% by weight PAH; ■ These fluids are produced either through more extensive refining of petroleum stock or by the synthesis of a specific, well defined organic fluid from non-petroleum precursors; and ■ The most frequently used synthetic hydrocarbons are esters, polymerised olefins, and synthetic branched and normal paraffins.

3.1.2.3 Associated Hazardous Wastes

In addition to the drill cuttings and drilling fluids, a wide range of small volume waste streams associated with the exploration and appraisal, and construction and production phases are also generated. This includes following types of hazardous waste (see Table 10).

Table 10: Associated Hazardous Waste Inventory

Waste type	Description
Batteries (wet and dry)	Wet-cell batteries (lead acid) are typically used in vehicles, and contain a liquid electrolyte, such as sulfuric acid, which may be hazardous. In contrast, dry cell batteries do not contain a liquid. These batteries may contain alkaline, lithium, mercury, silver oxide, zinc, lithium ion, nickel-cadmium, or nickel metal hydride, which are also hazardous.
Spent chemicals and residue	Chemical hazardous wastes are solids, liquids, or gases that display either a hazardous characteristic or are listed specifically by name as hazardous. The four hazardous waste characteristics include ignitability, corrosivity, reactivity, and toxicity.
Contaminated containers	Containers, such as oil drums that have been used for the storage and transport of hazardous substances, such as chemicals or oily waste.
Contaminated hydrotest water	Hydrotest waster is used for the pressure testing of equipment and pipelines. Chemical additives, corrosion inhibitors, oxygen scavengers, and dyes) may be added to the water to prevent internal corrosion or to identify leaks.
Contaminated personal protective equipment	Personal protective equipment contaminated by hazardous substances, such as chemicals or oily waste.
Contaminated scrap metal	Scrap metal contaminated by hazardous substances, such as chemicals or oily waste.
Completion and well work-over fluids	Completion and well work-over fluids are typically used to clean the wellbore and stimulate the flow of hydrocarbons, or simply used to maintain downhole pressure. Once used these fluids may contain contaminants including solid material, oil, and chemical additives.
Electrical/electronic waste	Electrical/electronic waste, such as mobile phones, computers, and laboratory equipment, contain hazardous substances such as heavy metals.
Foam	Water, surfactants, and air are combined to create a stiff foam which is circulated as a drilling fluid.
Medical waste	Certain types of medical wastes are classified as a biohazard as these could potentially lead to the spread of infectious disease.
Oil contaminated soil	Soils (including produced sands) contaminated by oily waste.
Oily rags, filters etc.	Rags, filters and other consumables contaminated by oily waste.
Oily sludges (from the bottom of vessels)	Oily sludges that collect at the bottom of vessels.
Pigging wastes	Wastes resulting from the removal or recovery of residual oils in the pipelines.
Paint residue (solid and liquid)	Residual paints which may contain hazardous substances.

Waste type	Description
Pipe dope	Pipe dope is used as a pre-connecting pipe conditioner, which may contain high levels of lead.
Sewage	Sewage is classified hazardous as it can contain (infectious) pathogens which pose risk to the environment and human health.
Spent fluorescent tubes and lamps	Fluorescent tubes and lamps contain mercury which is classified as hazardous.
Spent welding rods, epoxy coatings, grinder wheels, visors, shot blast etc.	Workshop consumables that may contaminated by hazardous substances, such as chemicals or oily wastes.
Used aerosol cans	Aerosol cans may contain paint, lubricants, glues, pesticides, and many other chemicals that are classified as hazardous.
Used fabrication material (e.g. paint, cement, insulation)	Certain fabrication materials contained by hazardous substances such as paints, cements or insulation.
Used lubricating/hydraulic oil, grease, solvents and absorbent materials	Residual lubricating/hydraulic oil, grease, solvents and absorbent materials which pose risk to the environment and human health.
Naturally Occurring Radioactive Materials (NORM) – not expected	NORM can be carried up to the surface by the produced fluids and/or form scale on the inside of piping

3.2 Waste Inventory during Phases of Project Development

This section presents the estimated quantities of the three hazardous waste categories that will be generated in the construction and production, and decommissioning phases based on information provided by the three O&G companies.

These estimates will be cross-referenced with the carrying capacity of the waste transporters and treatment/disposal capacity of the treatment/disposal facilities in the sections to follow to determine if there is sufficient capacity to collect, transport and treat/dispose of the petroleum waste streams from the construction and production, and decommissioning phases.

Table 11 below presents estimates of the total quantity of drill cuttings, drilling fluids, and associated hazardous wastes that may be generated in the construction and production, and decommissioning phases.

Table 11: Estimated Quantities of Hazardous Waste

Waste type	Exploration & appraisal		Construction & production		Decommissioning	
	Low	High	Low	High	Low	High
Drill cuttings	56 011[1]	77 900[2]	300 000[3]	344 755[4]	nominal	nominal

[1] Based on information provided by the technical working group representative (Total) via email on 17/01/2017, the technical working group representative (Tullow) via email on 27/01/2017, and information provided in the Terms of Reference (CNOOC), Page 7.

[2] Based on information provided in the Terms of Reference, Page 7.

[3] Based on information provided in the Terms of Reference, Page 7.

[4] Extrapolated using information provided for the exploration and appraisal phase (i.e. average drill cuttings per well in the exploration and appraisal phase multiplied by the total number of wells in the construction and production phase).

Waste type	Exploration & appraisal		Construction & production		Decommissioning	
	Low	High	Low	High	Low	High
Drilling fluids	9 413[5]	12 300[6]	57 938[7]	128 500[8]	nominal	nominal
Associated hazardous wastes	-	34 528[9]	-	-	-	181 185[10]

3.3 Waste Management Facilities

3.3.1 Hazardous Waste Management Facilities

Table 12 below lists the hazardous waste companies that were surveyed as part of Golder's recent study on hazardous waste management in the Lake Albert oil fields development area (Golder project: 1546406, Ref. 31). At the time of surveys (November 2016) some of these companies were not licenced to transport, store and/or treat/dispose of hazardous waste. These companies were however still included in the study as they have or will the capacity, subject to obtaining the necessary licence(s) to manage hazardous waste.

Table 12: Hazardous Waste Companies Surveyed

Company	Transport		Treatment / Disposal	
	Licenced	*Not Licenced*	*Licenced*	*Not Licenced*
Allways Environmental				✓
Bemuga Forwarders		✓		
De Waste (U)	✓			
EnviroServ Uganda Ltd			✓	
Epsilon (U) Ltd		✓	✓	
Global Network Ltd	✓			
Green Label Services Ltd		✓	✓	
Luwero Industries	✓		✓	
Swift Waste Masters Ltd	✓			
White Nile Consults			✓	

3.3.1.1 Hazardous Waste Transporters

Five waste companies transport hazardous waste in the oil field development area, namely:

- Bemuga Forwarders (Pty) Ltd[11] (Bemuga);
- De Waste (U) Ltd (De Waste);
- Green Label Services Ltd (Green Label);

[5] Based on information provided by the technical working group representative (Total) via email on 17/01/2017 and the technical working group representative (Tullow) via email on 27/01/2017, and information provided in the Terms of Reference (CNOOC), Page 7.

[6] Based on information provided in the Terms of Reference, Page 7.

[7] Extrapolated using information provided for the exploration and appraisal phase (i.e. average drilling fluids per well in the exploration and appraisal phase multiplied by the total number of wells in the construction and production phase.

[8] Based on information provided in the Terms of Reference, Page 7 (i.e. 30% of waste not being drill cuttings).

[9] Based on information provided by the technical working group representative (Total) via email on 17/01/2017 and the technical working group representative (Tullow) via email on 27/01/2017, and information provided in the Terms of Reference (CNOOC), Page 7.

[10] Extrapolated using information provided for the exploration and appraisal phase (i.e. average general hazardous waste per well in the exploration and appraisal phase multiplied by the total number of wells in the construction and production phase.

- Global Networks Ltd (Global Networks); and
- Swift Waste Masters Ltd (Swift).

Table 13 below provides an overview of these waste companies, including the number of vehicles, the average carrying capacity of the vehicles, the average price paid for these vehicles and the combined carrying capacity of the vehicles for each type of waste. It can be seen that in total, there is capacity to transport 880 tonnes of drill cuttings, 581 kilolitres of drilling fluids, and 134 tonnes of general hazardous waste.

It is understood (from workshops held in mid-May with hazardous waste management companies including hauliers) that once the Lake Albert oil fields area moves from the exploration and appraisal phases to the construction and production phases of field development, that Ugandan waste transporters will invest in the additional vehicles required to appropriately transport the waste types to the various waste managed facilities in Uganda to accommodate any current shortfall in current carrying capacity to deal with the waste types anticipated.

Table 13: Overview of Uganda Hazardous Waste Transporters

Type of waste	Type of vehicle	Number of vehicles	Average capacity of vehicles	Combined capacity of vehicles (tonnes)
Drill cuttings	Modified dump truck	56[12]	15 t	880
Drilling fluids	Vacuum tanker	27	19 kl	581
General hazardous waste	Box-body truck	21	6.5 t	134

Figure 5 below presents examples of some of the vehicles used to transport the 'legacy waste' from the generators to the treatment/disposal facilities.

Figure 5: Examples of Modified Dump Truck (left), Vacuum Tanker (centre) and Box-body Truck (right)

3.3.1.2 Hazardous Waste Treatment/Disposal Facilities

Only five waste companies own/operate a hazardous waste treatment/ disposal facilities in the oil fields development area.[13] Figure 6 shows the location of these facilities. The companies are as follows:

- EnviroServ Uganda Ltd (EnviroServ);
- Epsilon (U) Ltd (Epsilon);
- Green Label Services Ltd (Green Label);
- Luwero Industries Ltd (Luwero);

[12] Note that Bemuga's vehicles have largely been repurposed for use in the construction industry, but were included in the analysis as these vehicles can, if required be modified to transport to transport drill cuttings.

[13] The other 12 licensed waste handlers have been excluded from the assessment as their treatment / disposal facilities are exclusively for their own waste.

- White Nile Consultants Ltd (White Nile); and
- Allways Environmental Services (Allways).

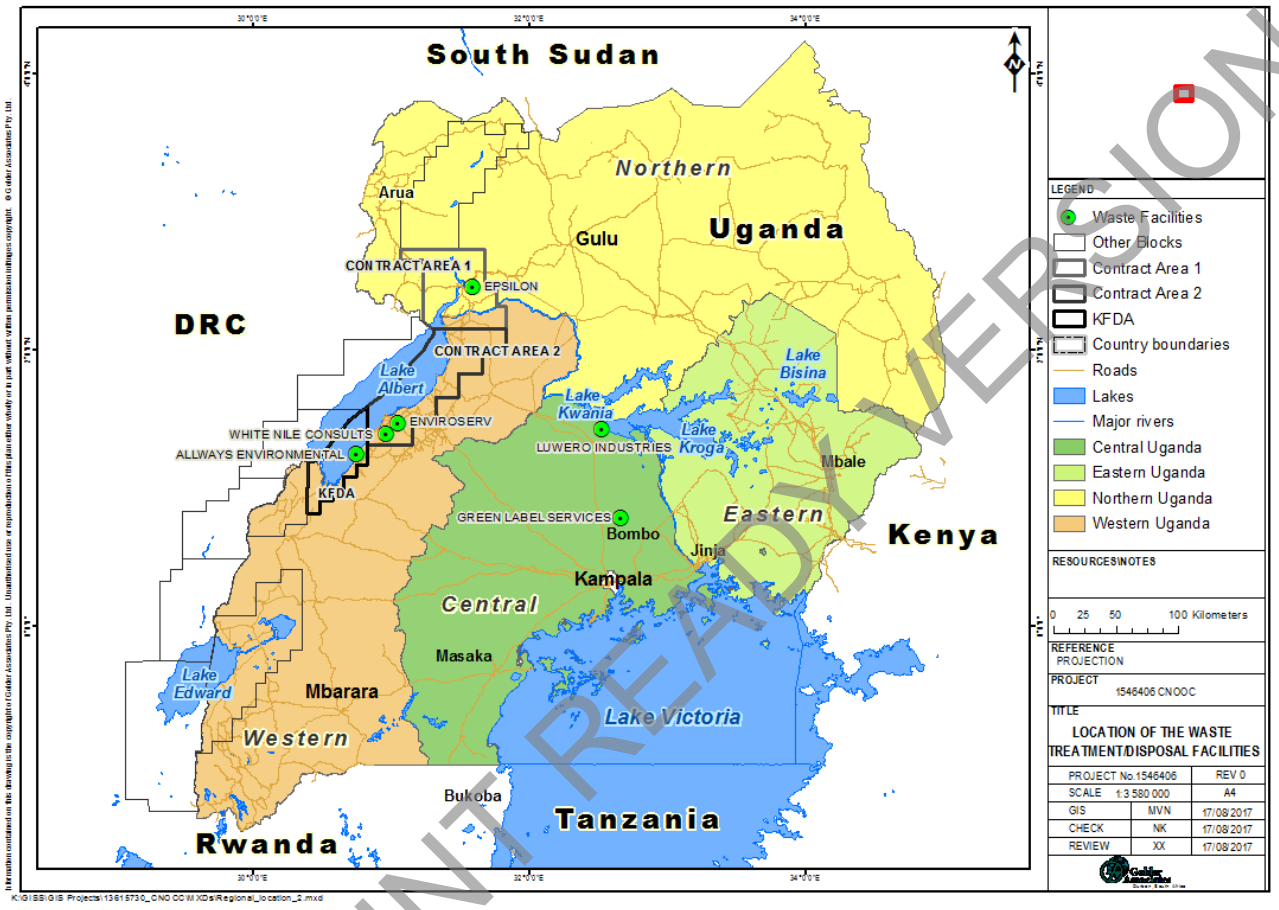

Figure 6: Location of Existing Treatment/Disposal Hazardous Waste Facilities

The following sections presents the current capacity of these treatment/disposal facilities to handle the main types of hazardous wastes including drill cutting, drilling fluids and associated hazardous wastes from the O&G sector.

It is understood (from workshops held in mid-May with hazardous waste management companies including treatment and landfill disposal companies) that once the Lake Albert oil fields area moves from the exploration and appraisal phases to the construction and production phases of field development, that Ugandan waste management companies will invest in the additional infrastructure and facilities. These waste facilities include those required to appropriately recycle, treat and dispose the waste types to the various waste managed facilities in Uganda to accommodate any current shortfall in current capacity to deal with the waste types anticipated. This will not only include those currently involved in hazardous waste management but also the larger domestic waste companies that are interested in entering the hazardous waste management sector.

3.3.1.2.1 Drilling Cuttings

Currently the drill cuttings are treated in two ways, namely biodegradation and landfilling.

Biodegradation

Biodegradation is the use of microorganisms (bacteria and fungi) to biologically degrade hydrocarbon contaminated waste into a non-toxic, beneficial product. There one existing biodegradation facility and one under construction. These facilities are owned/operated by the following two waste companies:

2) White Nile Consultants Ltd (White Nile); and

3) Allways Environmental Services (Allways).

Figure 7 below presents an overview of the biodegradation process used to treat drill cuttings from the E&A phase. This process comprises three main steps; pre-processing, biodegradation and preparation for disposal. In the pre-processing step involves screening and crushing. The drilling waste is offloaded into a temporary storage bund. From the storage bund the waste is put through a screen to remove non-biodegradable materials, such as plastics. The unwanted materials are then collected in a container for disposal at another facility. If required, the drill cuttings are passed through a crusher to break the material into more manageable pieces. The screened waste is then transferred to the biodegradation platform where it is mixed with blending material (to increase porosity and aeration) and culturing microbes (to speed up the biological processes). The leachate from the platform is collected and treated together with the drilling fluids in the liquid treatment plant (see section 3.3.1.2.2). The biodegradation platform is continuously monitored to ensure optimum conditions are present. The aggregate material is then cured to improve its condition and tested to ensure that it is safe. A relatively small percentage of the aggregate product is currently used for brick making, while the bulk of the material is landfilled.

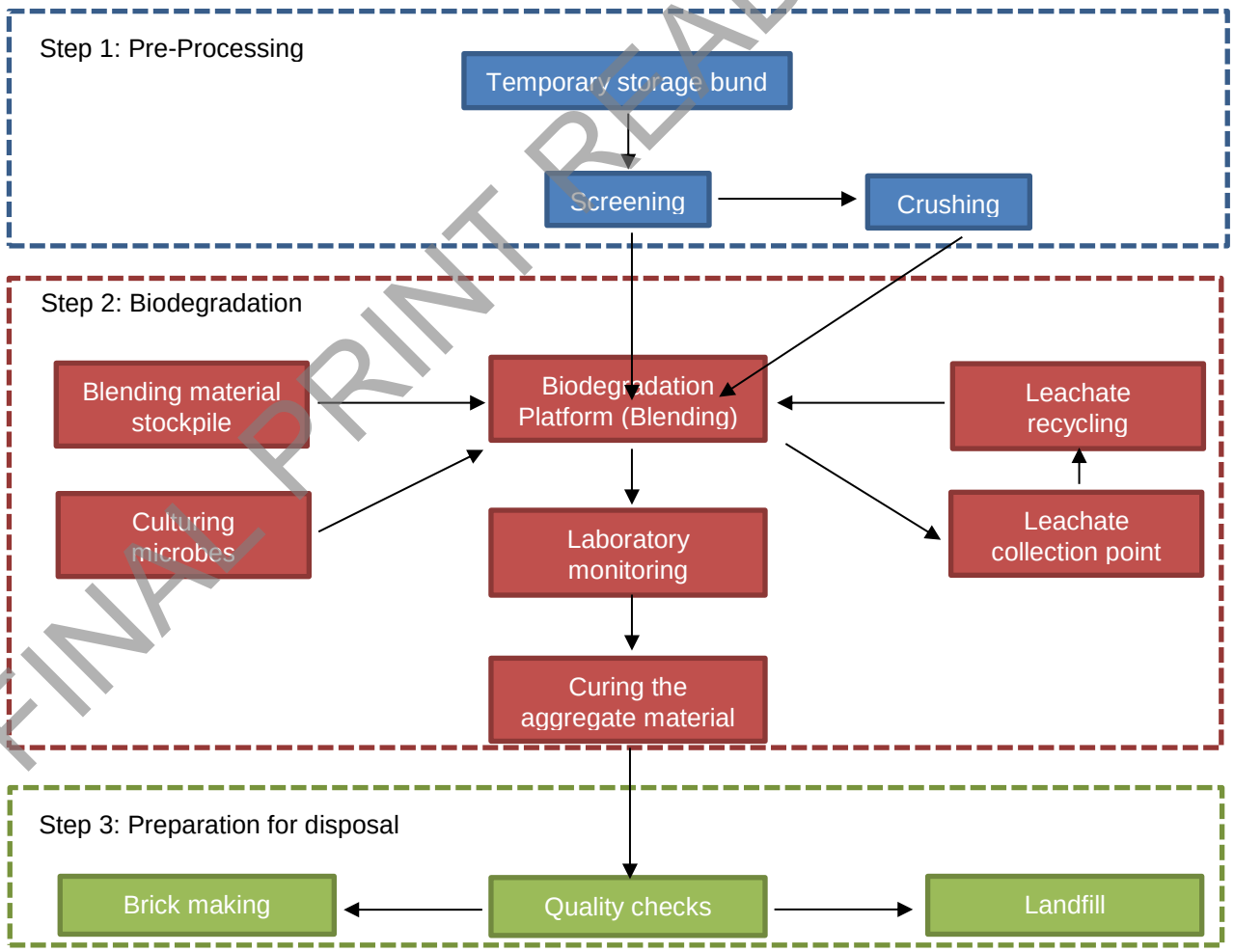

Figure 7: Flowchart of the Biodegradation Process

Table 14 below presents a summary of the key characteristics of the two biodegradation facilities (existing and under construction).

Table 14: Key Characteristics of the Existing Biodegradation Facility

Technology	Company	Year commissioned	Total Design capacity (t/yr)	Capacity used (t/yr)	Remaining capacity (t/yr)
Biodegradation	White Nile Consultants Ltd	2015	50 000	0	50 000
Biodegradation	Allways Environmental Services	Under construction	7 000	0	7 000
TOTAL			**57 000**	**0**	**57 000**

The current biodegradation process may require some modifications to extract heavy metals should they exceed acceptable levels for normal biodegradation. There are many options to extract heavy metals from drill cuttings, such as the use of acids, but this is dependent on the types and concentrations of heavy metals, and cost considerations. A number of companies now offering specialised products and services in this regard (e.g. Dispersion by Chemical Reduction). The most appropriate option is however dependent on a number of factors (e.g. types, concentrations, and state of heavy metals, cost of technology etc.), which would require detailed investigations.

Landfilling

There are currently three landfill sites used for the disposal of hazardous waste, and one under construction. These sites are owned/operated by:

- EnviroServ Uganda Ltd (EnviroServ);
- Luwero Industries Ltd (Luwero) - see Figure 8;
- White Nile Consultants Ltd (White Nile); and
- Allways Environmental Services (Allways).

Figure 8: One of the Open Cells at the Luwero Landfill Site

A summary of the key characteristics of the hazardous waste landfill sites is presented in Table 15 below. It can be seen that the remaining capacity of these landfill sites is 1 031 200 m^3. Note however that this does not take into account the free land available for the future expansion at the Luwero and White Nile facilities.

Table 15: Key Characteristics of the Hazardous Waste Landfill Sites

Design standard	Company	Year commissioned	Total Design capacity (m^3)	Capacity used (m^3)	Remaining capacity (m^3)
H:H/Class A (South African)	EnviroServ Uganda Ltd	2014	1 000 000	20 000	980 000
Unknown	Luwero Industries Ltd	1999	50 000 (Free land available for future expansion)	25 000	25 000
H:H/Class A (South African)	White Nile Consultants Ltd	2015	15 000 (Free land available for future expansion)	TBC	15 000
Basel Convention Technical Guidelines on Specially Engineered Landfill (D5) /	Allways Environmental Services	Under construction	11 200	0	11 200
Total			**1 076 200**	**45 000**	**1 031 200**

It can be seen that two of the existing facilities have been designed in accordance with the South African engineering requirements for a Class A landfill site (i.e. high risk level wastes that have a high potential to contaminate the environment). Figure 9 below presents the minimum engineering design requirements for this type of landfill (GN R. 636 National Norms and Standards for Disposal of Waste to Landfill, 23 August 2013).

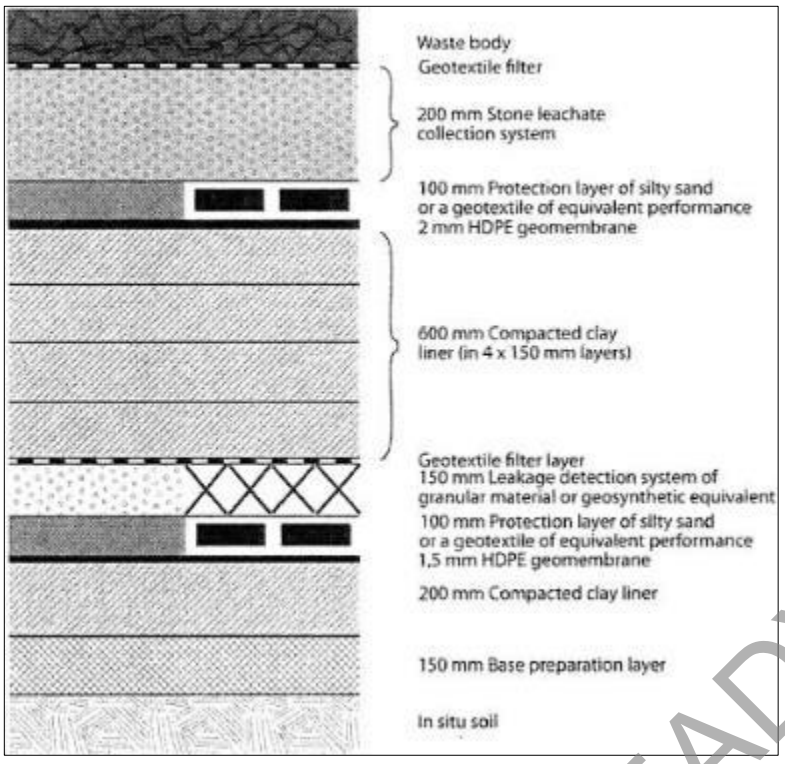

Figure 9: Minimum Engineering Design Requirements for Class A Landfill Site (South Africa, GN R. 636 norms and standards)

3.3.1.2.2 Drilling Fluids

There are currently two facilities used to treat drilling fluids from E&A phase, and are capable of treating drilling fluids from the C&P phases. These facilities are owned/operated by:

- EnviroServ Uganda Ltd (EnviroServ) - see Figure 10; and
- White Nile Consultants Ltd (White Nile).

It is our understanding that Luwero Industries Ltd also has a treatment plant, but there is currently no proposal to use this plant for the treatment of drilling fluids.

Figure 10: Leachate Treatment Plant at EnviroServ

A summary of the key characteristics of the two liquid hazardous waste treatment facilities is presented in Table 16 below. At present, these facilities are predominately used to treat leachate from the landfill sites and therefore have sufficient capacity to treat approximately 82 500 kilolitres of drilling fluids per annum. It is our understanding that the facility using ultrafiltration and reverse osmosis has been designed to be modular, and could be expanded if required.

Table 16: Key characteristics of the drilling fluids treatment facilities

Technology	Company	Year commissioned	Total Design capacity (kℓ/yr)	Capacity used (kℓ/yr)	Remaining capacity (kℓ/yr)
Ultrafiltration & reverse osmosis	EnviroServ Uganda Ltd	2014	36 500	0	36 500
Flocculation & coagulation	White Nile Consultants Ltd	2015	48 000	2 000	46 000
Total					**82 500**

The EnviroServ treatment facility was designed to treat drilling fluids, contaminated stormwater and leachate from their landfill to river discharge standards (Malan, 2016). In selecting the appropriate technology, a number of options were evaluated, as shown in Table 17.

Table 17: Comparison of treatment technologies (adapted from Malan, 2013)

Technology	TDS treatment	COD treatment	Capital expenditure	Operating expenditure	River discharge standards
Chemical treatment	X	✓	Low	Medium	X
Biological treatment	X	✓	Medium	Medium	X
Evaporation	✓	✓	High	High	✓
Freeze crystallisation	✓	✓	High	Medium	✓
Membranes	✓	✓	Medium	Medium	✓
Ion exchange	✓	X	High	High	X
Natural processes	X	✓	Medium	Low	X

Membrane technology, comprising ceramic ultrafiltration and reverse osmosis, was ultimately selected for the following reasons:

- It would be able to meet the requirements in terms of total dissolved solids (TDS), chemical oxygen demand (COD), and river discharge standards;
- The technology is relatively robust;
- Capital and operating costs are not as high as the other technologies; and
- Local expertise is available.

Table 18 shows that the discharge from the treatment plant meets the required river discharge standards.

Table 18: Treated Effluent Discharges in comparison to the River Discharge Standards (adapted from Malan, 2013)

Parameter	Units	Feed	Stage 1: pH correction and solids precipitation	Stage 2: Ceramic ultrafiltration	Stage 3: Single pass reverse osmosis	River discharge standards
pH		10.05	9.96	9.95	7.47	6 – 8
Conductivity	mS/cm	23.20	22.7	22.7	0.347	1.8
TDS	mg/ℓ	48 730	44 428	30 879	58	1 200
COD	mg/ℓ	71 233	69 260	56 033	-	-
Alkalinity	mg/ℓ	0.627	0.596	0.485	0.543	500

Similarly, the White Nile treatment facility was also designed to treat drilling fluids, contaminated stormwater, and leachate from the biodegradation platform and their landfill site to Ugandan river discharge standards.

Figure 7 below presents an overview of the treatment process used to treat drilling fluids and other hazardous liquid waste at the White Nile facility. This process comprises three main steps; liquid separation, de-watering, and de-oiling.

In the first step, the liquid waste is discharged into the liquid waste storage pit. The waste is then pumped to the shale shaker which separates cuttings and other large solids from the liquid waste. If these cuttings and other large solids are covered in mud, the dryer can be used to recover the excess moisture, returning it to the buffer tank. The centrifuge removes the finer solids from the liquid waste.

In the second step, a gel breaker, organic flocculants, and inorganic flocculants are added to the liquid waste in the mixing tank, causing the flocculation of the finer solids which can then be removed by the centrifuge.

In the final step, a coagulant is added to the floating oil removal tank, to separate the oils from the liquid waste. The treated liquid waste is then tested to ensure that it meets river discharge standards. Currently, the treated liquid waste in used onsite in the biodegradation process.

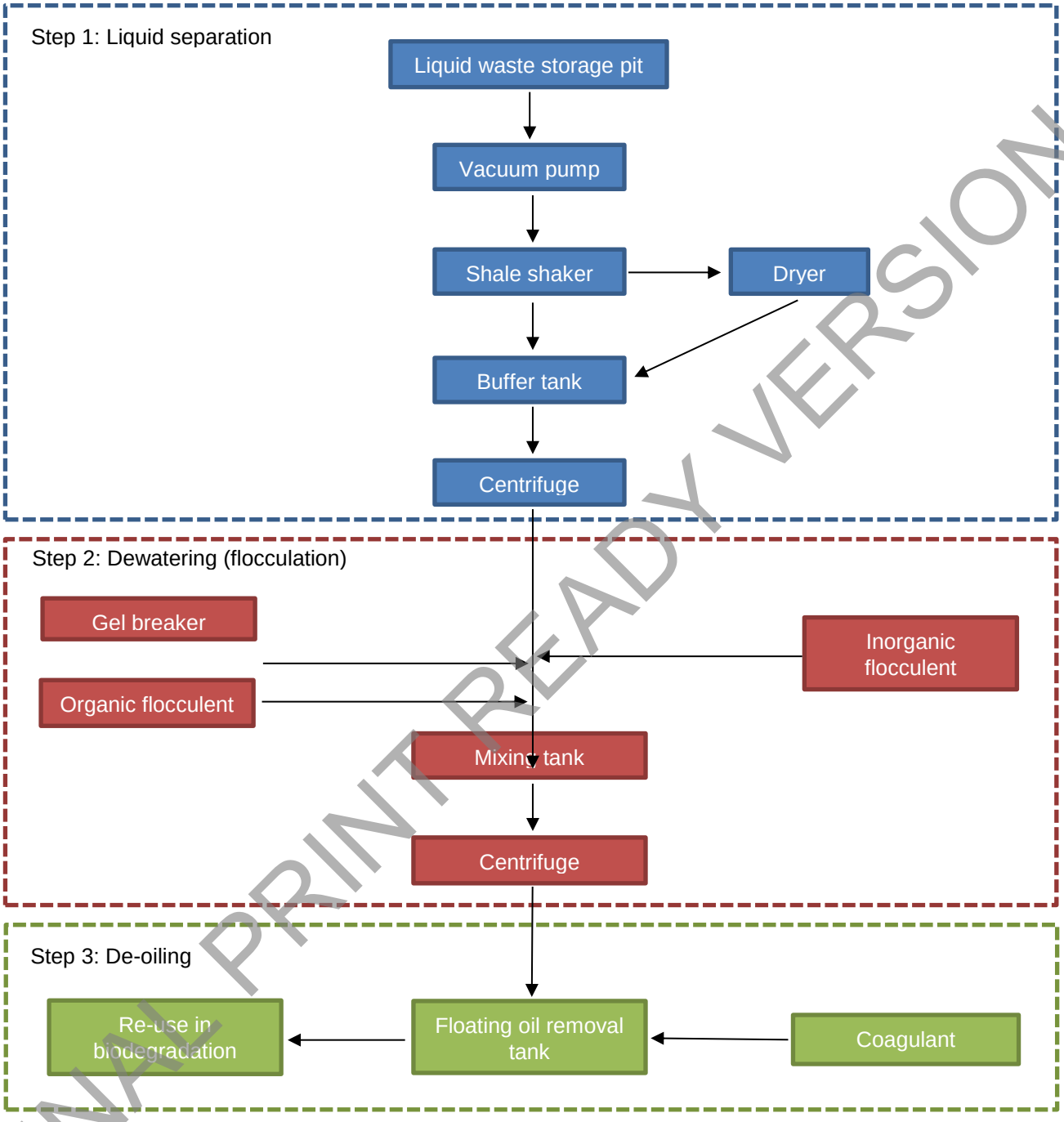

Figure 11: Flowchart of the Liquid Hazardous Waste Treatment Process

Both flocculation-coagulation and ultrafiltration-reverse osmosis are accepted as international best practice technologies for the treatment of drilling fluids. However, due to the complexity of the composition of WBDFs and in particular NADFs, it is very difficult to formulate general recommendations. Further to this, each of the technologies offers advantages and disadvantages, with no single technology addressing all facets of the problem.

As a result of the drawbacks of individual treatment technologies, and more stringent discharge standards, a trend is emerging of using a combination of treatment technologies. In this context, the suitable treatment technology (or combination of technologies) is dependent on its ability to meet Ugandan river discharge standards.

3.3.1.2.3 Associated Hazardous Wastes

In addition to drill cuttings and drilling fluids, other types of hazardous waste associated with drilling operations are also generated by the O&G sector. This includes for example, oily filters and rags, chemicals residue, and medical waste (see section 3.1.2.3).

There are currently three facilities licenced to treat associated hazardous wastes. These facilities are owned/operated by:

- Epsilon (U) Ltd (Epsilon);
- Green Label Services Ltd (Green Label); and
- Luwero Industries Ltd (Luwero).

While incineration is accepted as an option for the treatment of drill cuttings and drilling fluids, it is generally not recommended as there is no recovery of oil and/or due to the energy-intensity of the process.

A summary of the key characteristics of the three facilities for the treatment of associated hazardous wastes is presented in Table 19 below. These facilities, which are predominately used to treat medical and chemical wastes, have approximately 4 484 tonnes spare capacity per annum.

Table 19: Key Characteristics of the General Hazardous Waste Treatment Facilities

Technology	Company	Year commissioned	Total Design capacity (t/yr)	Capacity used (t/yr)	Remaining capacity (t/yr)
Dual-chamber pyrolytic incinerator	Epsilon (U) Ltd	2016	156[14]	52	104
Multiple chamber incinerator	Green Label Services Ltd	2012	8 760[15]	8 760	0
Dual-chamber rotary kiln	Luwero Industries Ltd	2017 (est.)	4 380[16]	0	4 380
TOTAL			**13 296**	**8 812**	**4 484**

All three facilities use incineration technology to treat general hazardous waste. Incineration is essentially a high temperature (200 °C to 1 000 °C+), dry oxidation process that reduces organic and combustible waste to inorganic, incombustible matter, resulting in a reduction in waste volume and weight (Chartier *et al.* 2014). While incineration can also be used to treat drill cuttings, it is considered to be a very inefficient use of resources, and will therefore not be considered further in this study.

These facilities currently use three incinerator technologies, namely a multiple chamber incinerator, dual-chamber rotary kiln, and dual-chamber pyrolytic incinerator.

Multiple Chamber Incinerators

Multiple chamber incinerators, such as the one depicted in Figure 12 were more common in the past. This technology has however been phased out in many countries due to their high volumes of airborne emissions.

These incinerators are typically rectangular in design and have a large primary chamber with a moving grate, as well as a secondary chamber to burn off volatile organic compounds in the flue gas. The incinerators

[14] Based on design capacity of 4 tonnes / week for 52 weeks.

[15] Based on design capacity of 1 tonne / hour for 24 hours per day for 365 days.

[16] Based on design capacity of 500 kg per hour for 24 hours per day for 365 days.

operate in the excess-air mode and use supplementary fuel to reach temperatures of around 800°C to 1 000°C.

Multiple chamber incinerators are typically used to treat infectious waste (e.g. sharps), chemical and pharmaceutical wastes, and general health care waste. These types of incinerators should however not be used to incinerate pressurised containers, halogenated plastics (e.g. PVC), and wastes with high content of heavy metals (e.g. thermometers, batteries).

Figure 12: Multiple chamber Incinerator at Green Label's Facility (www.greenlabelservices.com)

Internationally, the use of multiple-chamber incinerators has been decreasing in recent years due to increasingly stringent air emissions standards. While there are a number of flue-gas treatment technologies available to reduce the concentration of pollutants, the cost of these options can be prohibitive. This includes the following technologies[17]:

- Scrubber systems are used to reduce the acid components (e.g. CL, S) in the flue-gases;
- Electrostatic Precipitators (ESPs) are used to decrease the amount of heavy metals in the flue gases;
- Bag-house filters are used to reduce the amount of dust in the flue gases; and
- Activated carbon or Selective Catalytic Reduction (SCR) are used to reduce the release of dioxins to the air.

Dual-Chamber Rotary Kiln

Dual-chamber rotary kilns, such as the one depicted in Figure 13 are essentially a rotating oven with a post-combustion chamber. They are specifically designed to burn chemical wastes, but are also suitable for infectious waste (e.g. sharps) and pharmaceutical wastes, and general health care waste.

As with multiple chamber incinerators, pressurised containers, radioactive waste, and wastes with high content of heavy metals (e.g. thermometers, batteries) should not be incinerated. Incineration temperature is typically between 950°C and 1 300°C.

[17] European Union (2006), Reference Document on the Best Available Techniques for Waste Incineration,

Figure 13: Dual-chamber Rotary Kiln under Construction at Luwero's Facility

Dual-Chamber Pyrolytic Incineration

Pyrolytic incineration (also known as controlled air incineration) is reliable and the most commonly used treatment process for industrial hazardous waste and health care risk waste (Chartier *et al.* 2014). It comprises a pyrolytic chamber and a post-combustion chamber. In the pyrolytic chamber, the waste is thermally decomposed through an oxygen-deficient, medium-temperature combustion process (800 °C to 900 °C), producing solid ashes and gases. In the post-combustion chamber, the gases are burned at high temperature (900 °C to 1 200 °C) by a fuel burner using an excess of air to minimise smoke and odours.

As mentioned previously, these facilities are all located outside of urban centres due to the nature of the activities. The facilities are typically situated in sparsely populated areas and far from sensitive receptors, such as residences.

In general, the sites are relatively large (10 ha - 40 ha), with only a small portion of the site actually used for the treatment/disposal of waste. Site ownership is typically freehold, with only one facility leasing the site from the land owner. The facilities are all fenced, with manned access control.

All the facilities have established community forums to engage with the surrounding local community, keeping them updated and addressing any complaints. These forums typically convene on a monthly basis.

The incinerators mainly accept medical waste, chemicals, and other types of general hazardous waste. Prohibited types of waste include electronic and radioactive wastes.

Some of the facilities have or are considering implementing recycling operations on site. For example, the one facility is permitted to use 100 tonnes of treated drill cuttings to manufacture bricks. These bricks are however only permitted to be used on site. Another facility is in the process of investigating technologies for the recovery of oils and solvents from the waste. Another facility is recycling plastic onsite.

4.0 WASTE INVENTORY FROM KDA PROJECT PHASES

The KDA project will involve three main phases: a preparation (design) phase, a construction and drilling phase and an operational phase. Each phase will generate wastes. This section of the report will discuss the wastes generated at these phases as follows:

- Drilling Phase Wastes (WBDMs and NADFs);
- Construction and Operational Phase Wastes; and
- Decommissioning Phase Wastes.

4.1 Drilling Phase Wastes

The KDA project is expected to consist of 20 production wells (producers) and 11 water injection wells (injectors) drilled from four well pads on the eastern shores of Lake Albert. The bulk of the waste generated on a well pads will consist of drilling cuttings and clear liquids. Figure 14 provides a drilling circuit process that shows the two main waste streams (cuttings and clear liquids).

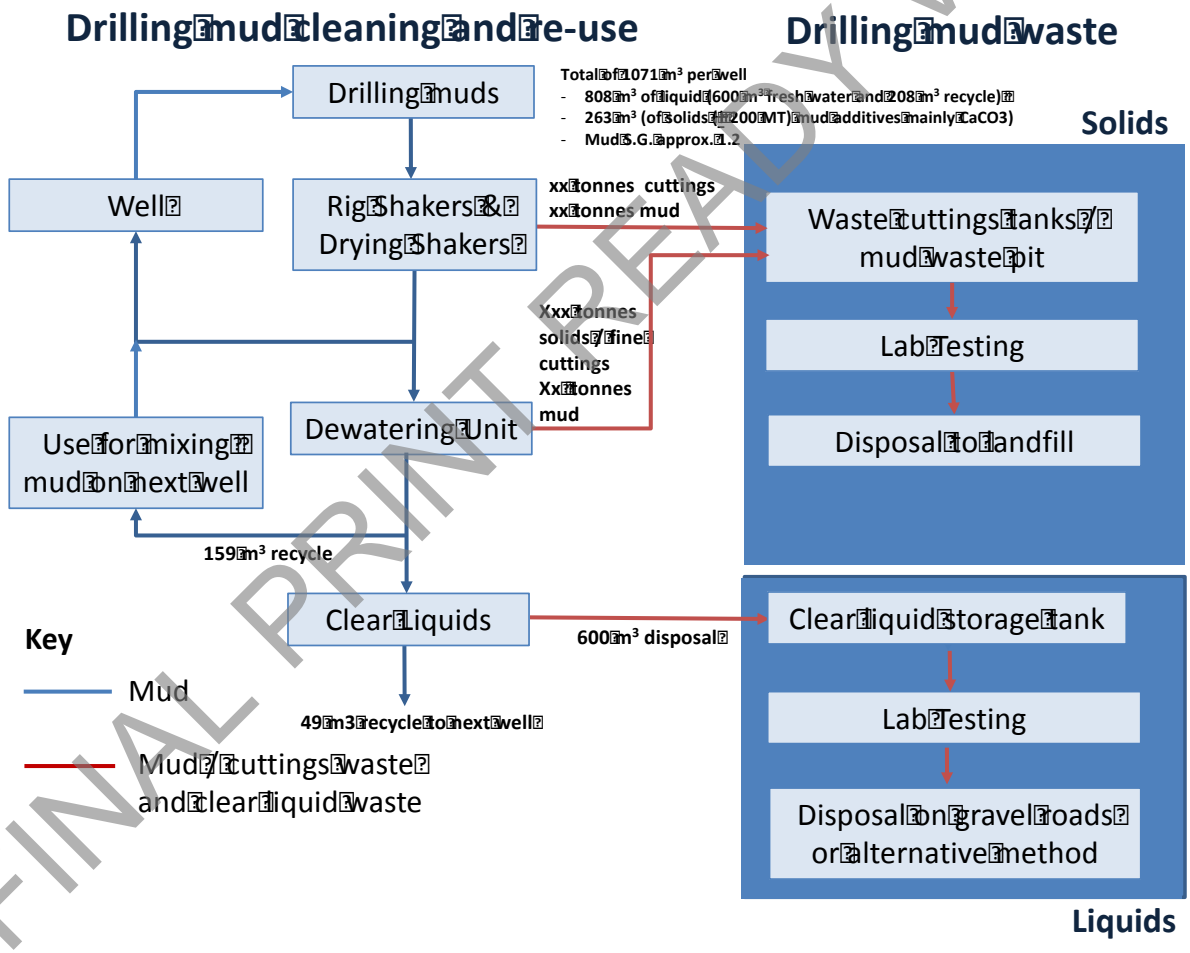

Figure 14: Process for the Generation of Drilling Waste

Table describes the waste streams, estimated quantities and disposal options for drilling and other wastes from the well pad during the drilling of wells. The bulk of the waste generated on the well pads will consist of drilling cuttings and clear liquids. While there will be some variability between the wells, and the quantity of drilling waste will depend on final decisions about dewatering equipment, typical cuttings volumes will be in the order of 600 m^3/well, with one third water based mud cuttings and the balance synthetic mud cuttings.

Liquids for disposal are expected to be in the order of 1,000 m^3 per well, dependent on how much is evaporated from the evaporation ponds.

Further details about the BPEO for the waste management during the project phases is provided in Sections 5.0 and 5.2.2.

Table 20: Wastes generated on the KDA well pads during the drilling phase

Waste Stream	Estimated quantity (total per well)	BPEO for Waste Management
Hazardous Solids (used chemical containers, fuel storage containers, oil-contaminated rags, used batteries, used filters, fluorescent tubes, power unit/transport maintenance wastes, paint waste,)	0.1 t (minimal)	Options include recovery / recycling, disposal (with or without pre-treatment) to an appropriately licensed landfill to receive hazardous waste.
Hazardous solids (potentially contaminated cement slurry)	4 t	Disposed to landfill licensed to receive hazardous waste.
Hazardous Liquids (used oil, waste chemicals, rinsate, thinners, viscofiers, solvents, acids, treating chemicals, other used chemicals in drums)	0.07 t	Options include recovery / recycling, disposal (with or without pre-treatment) to landfill licensed to receive hazardous waste.
Non Hazardous Liquids (sewage effluent, grey water)	N/A	Conservancy tanks. Domestic effluent removed by tanker to the sewage treatment plant at the drilling camp. Unmanned wellpad, portable sewage tank and treatment unit to be provided during drilling (Ref. 35).
Non Hazardous Solids (construction materials, packaging wastes, paper, scrap metal, plastics, glass)	66 - 96 t (Ref.35)	Waste minimization, separation, re-use and recycling where possible. Domestic refuse disposed to landfill licensed to receive non-hazardous domestic waste.
Drilling Cuttings (solids), coarse and fine particles - aqueous (water based)	205 m^3	Separation from drilling fluids in varying degrees, depending on dewatering equipment installed on the well pad. Disposal to landfill licensed to receive the waste by a certified waste contractor. Landfill site options to be assessed in the ESIA. Landfills include: ▪ Enviroserv Uganda Ltd. ▪ White Nile Consultants Ltd; and. ▪ Allways
Drilling Cuttings (solids), coarse and fine particles - synthetic	422 m^3	Biodegradation or as above.
Drilling Liquids (including clear liquids from dewatering of aqueous drill cuttings)	500 m^3	Recycled as much as possible. May also be reduced by evaporation ponds. Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation. The final disposal option is by disposal to landfill licensed to receive the waste. Quantity will depend on extent of evaporation in evaporation ponds. Landfill site options to be assessed in the ESIA (see above).
Completion Fluids (solids, residual drilling fluids, hydrocarbons, acids, glycol, methanol, other)	TBC	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation. Pre-treatment and/or disposal to landfill licensed to receive the waste. Preferred landfill site to be determined by the ESIA (see above).

Calculation based on

Quantities provided in the table above are estimated and will depend on a number of factors, including the extent to which dewatering equipment is used on site and liquids are recycled. A rule of thumb is that roughly 0.5 m^3 of drilling mud id generated per metre of well drilled.

Drilling is anticipated to take approximately 5 years, over which time approximately 31 wells from four well pads will be drilled (see Figure 15)

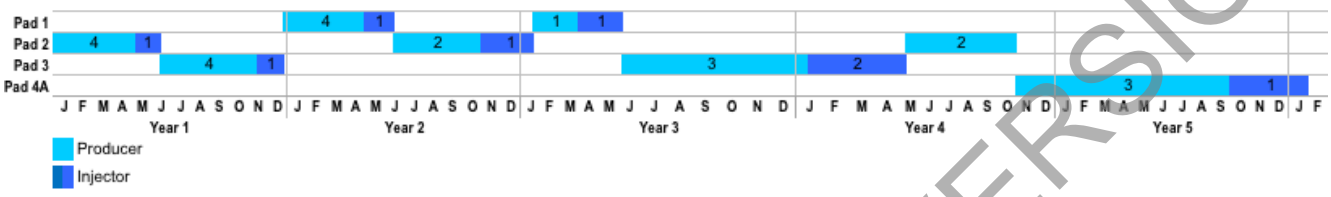

Figure 15: Schedule of drilling of Producer and Injector wells

Most of the waste streams that will be generated cannot be pre-classified. Only once the wastes have been generated may they be sent for analytical testing to determine their classification. It is understood that the drilling wastes from various wells in Uganda have been found to contain substances capable of polluting the environment, mainly traces of heavy metals in addition to residual hydrocarbons. There are no specific Ugandan Standards for solid waste disposal. The drilling wastes from the drilling wells will be dealt with in the same manner, i.e. as capable of polluting the environment due to heavy metals and hydrocarbons, until they may be sent for appropriate testing to determine their classification

4.2 Construction Phase Wastes

Various types of materials and equipment associated with the construction industry will be imported to the KDA for the roads, CPF, upgrade of existing facilities and camps during the project construction phase. The construction of Project infrastructure will be completed prior to the commencement of drilling.

The construction phase will involve the following general activities:

- Clearing, levelling and terracing;
- Foundations and civil construction works;
- Installation of Equipment;
- Electrical and other tie ins;
- Commissioning and testing of plant and equipment.

Areas will be cleared of overgrowth and the soil leveled, which are minimal and excavated as required for the construction of project infrastructure. The excavated materials, mostly soil is not regarded as waste and will be stored at strategic areas. Some of this material will be used for backfilling and the rest will be used for landscaping and future rehabilitation purposes.

Construction solid waste is calculated based on the building area or structure volume multiplied by a factor of expected waste tonnage (0.05 and 0.03 respectively for area and volume); as such it is expected to be about 1,530 to 1,720 tons from the CPF, permanent and temporary camps, supply base, safety check station, lake water intake pump station, and infield lines (Ref. 35).

Non Hazardous Waste

Non-hazardous waste will be collected, bagged and transported back to the camp for sorting, recycling and disposal. Non-hazardous waste includes plastic, scrap metal, wood, lunch cartons, water bottles, packaging and other incidental waste. It is expected that 2 kg of domestic non-hazardous waste will be generated per person per day (Ref. 35).

Sufficient provision for staff ablutions will be provided by ventilated chemical toilets generating sanitation sewage waste water. Based on previous waste characterisations done in the KDA, it is expected that the relative composition of the different non-hazardous solid wastes generated in the Lake Albert Oilfield will be as shown in Table 6.

A maximum of 300 m^3 per day of domestic sewage waste from 800 people from accommodation and the office areas is expected to be generated from the temporary camp (Ref. 35).

Hazardous Waste

Hazardous waste generation is generally limited to waste oil and grease from vehicle maintenance, which will be undertaken at the Kingfisher camp site. Table 22 shows the anticipated composition and quantity of hazardous waste generated during construction of the CPF.

Table 21: Expected Hazardous Solid Wastes generated during Construction of the CPF (34 months)

Waste Type	Main Source	Possible Environmentally Significant Constituents	Mass (tonnes)
Empty chemical drums, drum rinsate and containers	Metal, glass, plastic containers	Heavy hydrocarbons, solvents	117 t
Cement slurries	Cement slurries	Heavy metals, thinners, viscosifiers, pH, salts	3,679 t
Paint materials	Paints，thinners，coatings	Heavy metals, solvent, hydrocarbon	4.2 t
Maintenance wastes	Sandblast (grits), greases, fuel oils，filters	Heavy metals, hydrocarbons, solids, solvents	3.4 t
Industrial waste	Batteries，transformers，capacitors	Acid, alkali, heavy metals, PCBs	1.4 t
Scrap metals	Used piping，cables, drums, casing etc.	Heavy metals, scales	7.1 t

The proposed KDA project is situated in a remote area where few suitably licensed waste management facilities for waste disposal are available. General and hazardous waste generated during the construction of KDA project infrastructure will not be mixed, but stored separately (in a fashion as to mitigate against potential pollution) on the site before removal by a private contractor for disposal at approved waste facilities. Waste will be recycled as far as possible to give effect to the waste management hierarchy.

Road upgrade and construction in the KDA, along with associated extraction of rock from the borrow pits and crushing at the crushing plant will be completed prior to the commencement of the Project and were considered in the road ESIA. These activities have therefore been excluded from this assessment.

4.3 Operational Phase Wastes

Operations at the CPF have been assumed to commence immediately following completion of the infrastructure construction, in order to process product from reactivated exploration wells. The production stage is anticipated to be approximately 25 years lifespan.

The CPF is designed for a throughput of 120,000 barrels of well fluid per day. The CPF will comprise the following items of fixed plant and assemblages of plant:

- Oil Separation Flash Gas facilities;
- Gas Treatment & Compression facilities;

- Produced Water Treatment & Injection facilities;
- Oil Storage & Export facilities;
- Ground flare;
- Power Generation plant;
- Electrical substation;
- Water treatment plant;
- Fire water and pumps;
- Plant Utilities area;
- Control room and administrative buildings;
- Maintenance workshop;
- Gatehouse; and
- Perimeter fencing, lighting and internal access road system.

The four production well pads will comprise the following items of fixed plant:

- Production well heads and manifolds;
- Water injection wells and manifolds;
- Utility Systems;
- Production and test flow meters;
- Pig Launcher/Receiver;
- Chemical injection system;
- Closed drain system; and
- Equipment room to accommodate instrumentation, telecom, and electrical equipment etc.

Non-Hazardous Waste

A description of typical non-hazardous wastes and their quantities expected at the CPF including wastes from the permanent camp is provided in the table below.

Table 22: Non-Hazardous waste from the CPF during the Operational Phase

Waste Type	Activity (Source)	Mass per year (t)	Recycling / Disposal
Plastic	Bottles, waste packings	1,560	Mostly recycled
Paper / packaging	Packaging, office paper waste		Recycled
Wood	Packaging		Recycled
Rubber	Vehicle tyres		Recycled
Glass	Bottles		Recycled
Food and vegetable waste	Kitchens		Composted
Metal	Cold drink cans, processed food, other non-hazardous products, electrical metal scrap		Steel disposed to landfill. Aluminium recycled. Copper recycled

Waste Type	Activity (Source)	Mass per year (t)	Recycling / Disposal
Miscellaneous	General office and personnel camp scrap		Disposed to landfill

*Calculation based on 2 kg of waste/person/day for 120 people at the CFP over 25 years (0.002 x 120 x 5 days x 52 weeks x 25 years).

The following maximum amounts of domestic sewage waste are expected during the operational phase (Ref. 35):

- 30 m^3 per day from 120 people working in the CFP and office areas;
- 40 m^3 per day from 135 people from accommodation and the training office areas from the permanent camp;
- 5 m^3 per day from 20 people from the supply base; and
- 2.5 m^3 per day from 10 people from the safety check station.

Hazardous Waste

A description of typical wastes and their quantities expected at the CPF is included Table 23.

Table 23: Hazardous production wastes generated at the CPF during the operational phase

Waste Type	Activity / Source	Potential Contaminants	Mass per year (t)
Contaminated soil/hydrocarbon bearing soil	Spill/leaks	Hydrocarbons, heavy metals, salts, treating chemicals	5 t
Pigging sludge	Pipeline cleaning operations	Hydrocarbons，solids, production chemicals, phenols, aromatics	10 t
Waste oil sludge (from produced water treatment)	Produced water treatment system	Hydrocarbons	200 t
Produced sand	Removal from well fluids	Hydrocarbons	145 t
Pipe scale, hydrocarbon solids, hydrates, and other deposits	Cleaning piping and equipment	Hydrocarbons, heavy metals	20 t
Solid wastes generated by crude oil and tank bottom reclaimers	Separation tank sediments	Hydrocarbons，solids, production chemicals, phenols, aromatics	5 t
Empty chemical drums, drum rinsate and containers	Chemical injection, water treatment, cleaning agents	Heavy hydrocarbons, solvent	65 t
Cement slurries	Cement slurries	Heavy metals, thinners, viscosifiers, pH, salts	5 t
Paint materials	Unused paints, used thinners	Heavy metals, solvent, hydrocarbons	0.5 t
Maintenance wastes	Sandblast (grits)，greases, fuel oils，filters, paint scale	Heavy metals, hydrocarbons, solids, solvents	5 t
Industrial waste	Batteries，transformers，Capacitors	Acid, alkali, heavy metals, PCBs	3 t

Scrap metals	Used piping，cables, drums, casing etc.	Heavy metals, scales	2 t
Sewage sludge	Domestic water treatment	Pathogens	137.5 m^3*

*Calculation based on quantities given in section above (77.5 days x 5 days x 52 weeks x 3 years)

Most of the waste streams that will be generated cannot be pre-classified. Only once the wastes have been generated may they be sent for analytical testing to determine the classification and final treatment and/or disposal.

4.4 Decommissioning Phase Wastes

Decommissioning activities are anticipated to comprise dismantling, decontamination and removal of process equipment and facility structures and remediation activities. The following works have been identified for this stage of the Project:

- Removal of production/injection wells and well pads;
- Excavation and removal of field flow lines;
- Decommissioning, demolition and removal of CPF;
- Demolition and removal of accommodation; and
- Removal of other infrastructure.

The decommissioning phase is anticipated to include activities and plant items similar to those used in the construction phase. If the Project infrastructure cannot be utilised for any alternative purposes, buildings, materials and all other infrastructure related equipment will be dismantled and recycled as far as possible. Buildings will be demolished and the building rubble either recycled if possible or disposed of in an environmentally friendly manner, possibly as part of the land levelling.

Decommissioning solid waste is calculated based on the building area or structure volume multiplied by a factor of expected waste tonnage (1.3 and 1.6 respectively for area and volume); as such it is expected to be about 39,790 to 91,800 tons from the CPF, permanent and temporary camps, supply base, safety check station, lake water intake pump station, and infield lines (Ref. 35).

A maximum of 40 m^3 per day of domestic sewage waste from 135 people from accommodation and the training office areas is expected to be generated from the permanent camp during the decommissioning phase (Ref. 35).

5.0 WASTE MANAGEMENT FOR THE KDA PROJECT

5.1 The Waste Management Hierarchy

One of the key principles of waste management is the application of the waste hierarchy (E&P Forum, 1993), as shown in Figure 16. Furthermore, there is a Duty of Care for any producer that discards waste, to ensure that there is no harm to the environment or human health, and that the waste is suitably handled by licensed waste transporters and treatment/disposal companies from cradle to grave.

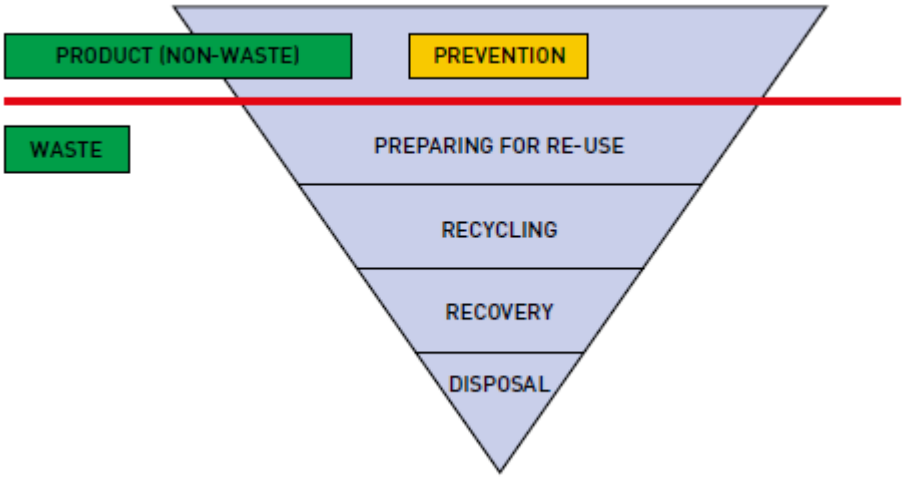

Figure 16: The Waste Management Hierarchy (Ref. 29)

In the context of this study, responsible waste management can be accomplished through hierarchal application of the practices of source reduction, reuse, recycling, recovery, treatment and responsible disposal. This may include for example the following elements:

- Source reduction – the generation of less waste through efficient practices such as:
  - Waste minimisation or material elimination;
  - Inventory control and management;
  - Material substitution;
  - Process modification; and
  - Improved housekeeping.
- Reuse – the use of materials or products that are reusable in their original form such as:
  - Chemical containers;
  - Drilling fluids for road construction and stabilisation; and
  - Burning waste oil for energy.
- Recycling/recovery – the conversion of wastes into usable materials and/or extraction of energy or materials from wastes. Examples include:
  - Recycling drilling fluids;
  - Using cleaned drill cuttings for road construction material; and
  - Recovering oil from tank bottoms and produced water.
- Treatment – the destruction, detoxification, and/or neutralisation of residues through process such as:
  - Biological methods (e.g. land spreading/farming, biodegradation etc.);
  - Thermal methods (e.g. incineration, thermal desorption etc.);
  - Chemical methods (e.g. precipitation, extraction, neutralisation, stabilisation etc.); and
  - Physical methods (e.g. gravity separation, filtration, centrifugation etc.).

- Responsible disposal – depositing wastes on land or in water using methods appropriate for a given situation. Disposal methods include:
  - Landfilling;
  - Burial;
  - Surface discharge;
  - Land spreading or land farming; or
  - Underground injection.

5.2 Best Practice Waste Management for the KDA Project

5.2.1 Non-Hazardous Waste Management

Recommendations for the best available technologies (BAT) for each non-hazardous waste type are outlined in the table below taking into account the waste management hierarchy, as provided by the Atacama study done for the three O&G companies in the oil fields development area (study report dated July 2017, Ref. 30).

Table 24: Best Available Technology for Non-Hazardous Waste Types

Non-hazardous Solid Wastes	
Food & Vegetative Wastes	1. Avoid, Reduce, Reuse, Source-segregate and collect all food wastes generated. Also source-segregate any hazardous waste from the food and vegetative wastes. 2. Preferentially treat all food, kitchen and vegetative wastes via Anaerobic Digestion using low cost, high-tech fabric. Where this is not possible, composting should be applied. 3. Use the digestate slurry from anaerobic digester for landscaping, or direct to the wastewater treatment plant. Direct the biogas generated from the anaerobic digester to the camp kitchen for use as a cooking fuel.
Plastics	1. Avoid, Reduce, Reuse, Source-segregate and collect all plastic wastes generated. Also source-segregate any hazardous waste from the plastic wastes. 2. Recycle all the readily recyclable plastics. 3. Incinerate any residual plastics via a NEMA certified waste contractor, or dispose at a NEMA certified non-hazardous landfill if incineration is not possible.
Paper	1. Avoid, Reduce, Reuse, Source-segregate and collect all paper wastes. Also source-segregate any hazardous waste from the paper wastes. 2. Recycle all the dry, non-blue paper. Incinerate any residual wet or blue paper via a NEMA certified waste contractor or dispose at a NEMA certified non-hazardous landfill if incineration is not possible.
Metal	1. Avoid, Reduce, Reuse, Source-segregate and collect all metal wastes generated Also source-segregate any hazardous waste from the metal wastes. 2. Recycle all the readily recyclable metal.
Glass	1. Avoid, Reduce, Reuse, Source-segregate and collect all glass waste generated. Also source-segregate any hazardous wastes from the glass waste. 2. Dispose any residual glass waste at non-hazardous landfill.
Rubber	1. Avoid, Reduce, Reuse, Source-segregate and collect all rubber waste generated. Also source-segregate any hazardous waste from the rubber wastes. 2. Incinerate any residual rubber waste via a NEMA certified waste contractor, or dispose at a NEMA certified non-hazardous landfill if incineration is not possible.

Wood	1. Avoid, Reduce, Reuse, Source-segregate and collect all wood waste generated. Also source-segregate any hazardous waste from the wood wastes. 2. Recycle all the readily recyclable. 3. Incinerate any residual wood waste via a NEMA certified waste contractor, or dispose at a NEMA certified non-hazardous landfill if incineration is not possible.
C&D wastes	1. Source-segregate any hazardous waste from the C&D wastes. 2. Recycle all the readily recyclable C&D waste. 3. Dispose any residual C&D waste at a NEMA certified non-hazardous landfill.
Miscellaneous wastes (e.g. used insulation, used tyres, hoses, textiles)	1. Source-segregate any hazardous waste from the assorted wastes. 2. Reuse and Recycle any readily reusable/recyclable wastes. 3. Incinerate any residual incinerable wastes via a NEMA certified waste contractor, or dispose at a NEMA certified non-hazardous landfill if incineration is not possible.
Non-Hazardous Liquid Wastes	
Grey Water	1. Avoid /Reduce. 2. Reuse/Recycle. 3. For the waste water that cannot be reused without prior treatment, treat via Physico-chemical and Biological Effluent Treatment Plant. Additionally, because currently, some of the facilities already have Physico-chemical Effluent Treatment Plants, it is advisable to develop a Constructed Wetland for further (tertiary) polishing of the effluent prior to reuse/recycle/disposal. 4. Use sludge generated from the treatment process in manure application if it meets manure requirements; if it does not meet requirements, treat at a waterworks facility via a NEMA certified waste contractor
Boiler Blowdown Water	1. Avoid /Reduce. 2. Reuse/Recycle in the feed water tank. 3. If the water cannot be reused without treatment, treat via Physico-chemical and Biological Effluent Treatment Plant. 4. Dispose of sludge at a landfill via a NEMA certified waste contractor.
Storm Water	1. Avoid /Reduce by using underground storage tanks as a rain water harvesting mechanism. 2. Any water that is not harvested should be directed into drainage outlets that connect to existing drainage networks

5.2.2 Hazardous Waste Management

In terms of waste management for wastes generated from oil fields, often the best practice environmental option (BPEO) internationally is not always the most practically feasibility option at a local level. The table below presents a summary list of the BPEO for handling of hazardous waste from the O&G sector from an international perspective, as well as the currently available facilities for O&G waste management in Uganda.

Table 25: International Industry BPEO and Currently Available BPEO in Uganda for O&G Wastes

Waste category	Waste type	International BPEO	Currently Available BPEO		
			Option 1	Option 2	Option 3
Drill cuttings		Biodegradation	Biodegradation[18]	Cement Kiln[19]	Landfill
Drilling fluids	WBDFs / NADFs	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation[20]	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	-	-
Associated hazardous waste	Batteries (wet and dry)	Recycling (wet only)	Recycling (wet only)	Landfill (dry only)	-
	Chemicals residue	Return to manufacturer	Incineration	Landfill	-
	Completion and well work-over fluids	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	-	-
	Contaminated containers (e.g. oil drums)	Re-use of containers[21]	Incineration	Landfill	-
	Contaminated hydrotest water	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	-	-
	Contaminated personal protective equipment (PPE)	Cement Kiln	Cement Kiln	Incineration	Landfill
	Contaminated scrap metal	Recycling[22]	Recycling	Landfill	-
	Electrical / electronic waste	Refurbishment / recycling	Landfill	-	-
	Foam	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	Ultrafiltration-Reverse Osmosis / Flocculation-Coagulation	-	-
	Medical waste	Cement Kiln	Cement Kiln	Incineration	
	Oil contaminated soil	Biodegradation	Biodegradation	Cement Kiln	Landfill
	Oily rags, filters etc.	Cement Kiln	Cement Kiln	Incineration	Landfill
	Oily sludges (from the bottom of vessels)	Cement Kiln	Cement Kiln	Incineration	Landfill
	Pigging wastes	Cement Kiln	Cement Kiln	Incineration	Landfill

[18] Modification of conventional biodegradation process may be required to extract or immobilize elevated levels of heavy metals in the treated materials. This may include for example, using acids, augmented bacteria, stabilization or Dispersal Chemical Reaction.

[19] Subject to feasibility study and pilot project.

[20] Process changes may be required to adequately treat NADFs.

[21] Requires cleaning to remove chemical and oily residues.

[22] Requires cleaning to remove chemical or oily residues.

Waste category	Waste type	International BPEO	Currently Available BPEO		
			Option 1	Option 2	Option 3
	Paint residue (solid and liquid)	Return to manufacturer	Incineration	Landfill	-
	Pipe dope	Incineration	Incineration	Landfill	-
	Sewage	Sewage Treatment Plant	Sewage Treatment Plant	-	-
	Spent fluorescent tubes and lamps	Recycling	Landfill	-	-
	Spent welding rods, epoxy coatings, grinder wheels, visors, shot blast etc.	Landfill	Landfill	-	-
	Used aerosol cans;	Recycling	Landfill	-	-
	Used fabrication material (e.g. paint, cement, insulation);	Landfill	Landfill	-	-
	Used lubricating / hydraulic oil, grease, solvents and absorbent materials;	Solvent recovery / Central Processing Facility	Cement Kiln	Landfill	-

Table 26 provides the detail to the best waste management options (or BPEO) of the waste types generated at the KDA project phases by taking into account the waste management hierarchy approach as detailed in Section 5.1. In preparing this list of options, the following sources of information were used:

- BPEO for Drilling Wastes (Ref. 34);
- Drilling Waste Management Technology Review (Ref. 29); and
- Waste Management Guidelines (Ref. 33).

It should be noted that some options listed in these documents are not viable in this Ugandan project specific context; therefore, these 'no go' options have been excluded from the options analysis table below.

Table 26: Hazardous Waste Management Options

Waste hierarchy	Option	Locally Available	Waste category	Waste type	Description	Advantages	Disadvantages
Reduce	Source Reduction	Yes	All	All	■ Identify opportunities to eliminate materials, improve inventory control and management, substitute materials, modify processes and improve housekeeping.	■ Offset costly treatment and disposal costs.	■ Potential impact on processes.
Reuse	Reuse of Drilling Fluids	Yes	Drilling fluids	Drilling fluids	■ Reuse of drilling fluids in drilling operations; ■ Water-based drilling fluids are typically only disposed of once drilling is completed; and ■ Non-aqueous drilling fluids are typically reconditioned for reuse in other drilling operations.	■ Standard practice in onshore/offshore drilling operations; ■ Reduce volume of water required for drilling operations; and ■ Reduce volume of waste requiring treatment/ disposal.	■ Can impact on drilling operations.
Reuse	Refurbishment and Reuse of WEEE	No	Associated hazardous wastes	WEEE	■ Refurbishment and reuse of WEEE.	■ Avoid disposal of WEEE which contains toxic heavy metals that poses a risk to the environment and human health; and ■ In compliance with a number of international treaties and Ugandan legislation.	■ Risk to workers refurbishing WEEE.
Reuse	Reuse of Chemical Containers	Yes	Associated hazardous wastes	Contaminated containers	■ Cleaning and reuse of contaminated containers.	■ Offset costly treatment and disposal costs, and purchase of new containers.	■ Generate wastewater from the cleaning of containers.
Recycling	Recycling at Cement Kiln	No	Drill cuttings Associated hazardous wastes	■ Drill cuttings; and ■ Associated hazardous wastes	■ Recycling of drill cuttings and associated hazardous wastes in a cement kiln.	■ Partly replace the fuel that otherwise would have been needed to fire the kiln; ■ Ash from waste can be mixed into the cement matrix, providing desirable source of aluminium, silica, clay, and other minerals; and ■ Kiln may already be fitted with pollution control equipment.	■ Air pollution; and ■ Accumulation of non-organics (e.g. heavy metals) in the ash.
Recycling	Recycling of WEEE	No	Associated hazardous wastes	WEEE	■ Dismantling of WEEE to remove recyclable plastics, cabling and ferrous and non-ferrous metals.	■ Avoid disposal of WEEE which contains toxic heavy metals that poses a risk to the environment and human health; ■ Recovery of precious metals e.g. copper; and ■ In compliance with a number of international treaties and Ugandan legislation.	■ Risk to workers dismantling WEEE; and ■ Risk to receiving environment with fugitive emissions and potentially contamination of water resources.
Recycling	Recycling of Wet-cell Batteries	Yes	Associated hazardous wastes	Wet-cell batteries	■ Dismantling of wet-cell batteries to remove recyclable plastics, and ferrous and non-ferrous metals.	■ Avoid disposal of wet-cell batteries which contain acids and toxic heavy metals that pose a risk to the environment and human health.	■ Risk to workers dismantling wet-cell batteries; and ■ Risk to receiving environment with fugitive emissions and potentially contamination of water resources.

Waste hierarchy	Option	Locally Available	Waste category	Waste type	Description	Advantages	Disadvantages
Recycling	Recycling of Fluorescent Tubes and Lamps	No	Associated hazardous wastes	Fluorescent tubes and lamps	■ Dismantling of fluorescent tubes and lamps to recover glass, ferrous and non-ferrous metals, and mercury.	■ Avoid disposal of fluorescent tube and lamps which contain mercury that poses a risk to the environment and human health.	■ Risk to workers dismantling fluorescent tubes and lamps; and ■ Risk to receiving environment with fugitive mercury vapour emissions and potentially mercury contamination of water resources.
Recycling	Recycling of Treated Cuttings for Construction Material	Yes	Drill cuttings	Drill cuttings	■ Use of treated cuttings for fill or cover materials, aggregate in concrete or brick processing, road pavements, bitumen or asphalt, or cement; and ■ Cuttings typically require some form of pre-treatment to remove hydrocarbons and/or water/liquids.	■ Can be used for hydrocarbon based cuttings; ■ Less costly than incineration (i.e. rotary kiln); ■ Avoid disposal of treated cuttings to land or on in a landfill; ■ Avoid need to quarry/ mine for fill, aggregate, and so on; and ■ Can be used on site, reducing need for transport of construction materials.	■ Dependent on characteristics of the drill cuttings.
Recovery	Solvent extraction	No	Drilling fluids	Drilling fluids	■ Recovery of oils from drilling fluids using solvents, such as carbon dioxide, propane, hexane, trimethylamine or methyl chloride.	■ Properly operated system will also allow for the recovery of oils, as well as the recycling/reuse of the solvents.	■ Air quality and pollution impacts; and ■ Risk to receiving environment with potential contamination of water resources.
Treatment	Incineration	Yes	Drill cuttings Drilling fluids Associated hazardous wastes	■ Drill cuttings; ■ Drilling fluids; ■ Chemicals; ■ Containers; ■ PPE; ■ Medical waste; ■ Oily soil; ■ Oily rags, filters etc.; ■ Oily sludges; ■ Pigging waste; ■ Paint residue; ■ Pipe dope; ■ Spent welding rods etc.; ■ Fabrication materials; and ■ Used oils etc.	■ High temperature combustion process used to reduce the volume of waste and toxicity prior to disposal; ■ Typically used for the destruction or breakdown of organic compounds; and ■ Can also be used liquid wastes, but may require changes to the process.	■ Reduce the volume of waste and toxicity prior to disposal; and ■ Relatively inexpensive in comparison to other treatment technologies. However, if built to international best practice standards to meet air emissions limits it can be relatively expensive for the scrubbers.	■ Air quality and pollution impacts; ■ Can result in accumulation of non-organics e.g. metals and salts in the ash; ■ Ash, which is often classified as hazardous, should be disposed of at a landfill site designed for hazardous waste; and. ■ Certain wastes cannot be incinerated.
Treatment	Thermal Desorption	No	Drill cuttings Associated hazardous wastes	■ Drill cuttings; ■ Oily soils; ■ Oily sludges and ■ Fabrication materials.	■ Non-oxidising process using heat to volatise contaminants (e.g. oils) so that they can be separated from contaminated materials (e.g. soil); ■ Low temperature systems (250 °C – 350 °C) used to treat light oils and high temperature systems (up to 520 °C) used to treat heavier oils; and	■ Effective in separating organics from oily and paint wastes. It can also be used to separate solvents and fuel oils from contaminated soil; and ■ Typically uses less fuel than conventional heat treatment technologies due to the lower temperatures.	■ Not effective for most metals; ■ Does not destroy contaminants, which require additional treatment; and ■ Relatively costly.

Waste hierarchy	Option	Locally Available	Waste category	Waste type	Description	Advantages	Disadvantages
					■ Produces various waste streams, including solids, water condensate, oil condensate, and air stream from the compressor.		
Treatment	Stabilisation	Yes	Drill cuttings	Drill cuttings	■ Conversion of wastes to less soluble, mobile or toxic form in order to reduce the hazards associated with the wastes; and ■ Typically requires the addition of products to the waste, such as cement, fly ash, silicates, and other chemicals.	■ Relatively inexpensive.	
Treatment	Evaporation	Yes	Drilling fluids	Drilling fluids	■ Reduces the volume of liquid wastes by transforming the liquids into vapour; ■ Lagoons are typically used for evaporation, utilising the sun to drive the process. Evaporators can also be used to improve the efficiency of the system; and ■ Lagoons should be lined to reduce the risk to environment and human health and safety.	■ Reduce volume of waste requiring treatment/ disposal.	
Treatment	Gravity Separation	Yes	Drilling fluids	Drilling fluids	■ Typically used to treat liquid waste where the second waste (e.g. oil) has a different specific gravity than water; ■ Tank systems are traditionally used for this process, with the separation occurring over time; and ■ Maximum efficiencies can be achieved using heat, chemicals or pH.	■ Relatively inexpensive.	
Treatment	Centrifugation	Yes	Drilling fluids	Drilling fluids	■ Based on the principles of gravity separation. Centrifugal forces are introduced using an angular velocity, moving the waste in a circular motion, and making the separation process more efficient.	■ Commonly used in de-watering or handling of sludges.	
Treatment	Filtration	Yes	Drilling fluids	Drilling fluids	■ Separation of solids from a liquid by means of a porous medium or screen which retains the solids and allows the liquids to pass; and ■ Includes microfiltration, ultrafiltration, nanofiltration and reverse osmosis.	■ Typically more efficient and adaptable than other liquid treatment technologies; and ■ Can be used to target suspended solids, high molecular weight compounds, sulphates, salts and ions, and organic and inorganic compounds.	■ Relatively costly; ■ Design is dependent on the size of the particles to be removed and the quantity of solid materials present in the liquid; and ■ Membrane fouling without appropriate pre-treatment.

Waste hierarchy	Option	Locally Available	Waste category	Waste type	Description	Advantages	Disadvantages
Treatment	De-Watering (flocculation)	Yes	Drilling fluids	Drilling fluids	■ Removal of water from the waste mixture to produce a more concentrated mixture; ■ Chemicals are typically used to allow suspended materials to floccule and settle out; and ■ The clarified water is recycled and the solid waste collected for treatment/disposal.	■ Can be used to target heavy metals and suspended solids.	■ Consistent sludge production which requires disposal; and ■ Concentration of aluminium in liquid phase if aluminium is used as flocculent.
Treatment	Land Farming	No	Drill cuttings	Drill cuttings	■ Waste is spread to land where the microorganisms present in the soil biodegrade the hydrocarbon constituents; ■ Differs from land spreading in that water and nutrients are added, and the material turned over periodically to increase the effectiveness of the process; and ■ Treated material can potentially be used for construction or crop production, depending on the concentrations of non-biodegradable components.	■ Relatively low capital costs; and ■ Treat multiple loads of waste on same piece of land.	■ Relatively large areas of land required; ■ Relatively high operational costs; ■ Requires frequent monitoring and testing; ■ High levels of pre-treatment required to treat below hazardous waste thresholds; ■ Currently no Ugandan thresholds; ■ Potential accumulation of non-biodegradable components, such as metals, salts and PAHs; and ■ Not suitable for drill cuttings with higher concentrations of oil, metals, and toxic additives.
Treatment	Bio-Treatment Centre	Yes	Drill cuttings	Drill cuttings	■ Based on the same principles as land farming; and ■ However, treatment takes place in a more controlled environment e.g. tanks. The parameters, such as temperature, mixture of waste with air, nutrients, and water, are closely monitored and controlled to achieve maximum level of effectiveness.	■ Requires less area to treat wastes than traditional land farming.	■ Relatively high capital and operational costs;
Disposal	Mix-Bury-Cover	No	Drill cuttings	Drill cuttings (non-hydrocarbon based)	■ Mixing of non-hydrocarbon based drill cuttings with subsoil at a depth of 1 - 1.5 m.	■ Relatively low capital and operational costs; and ■ Option supported by the Ugandan government.	■ Requires pre-treatment to meet thresholds for mixing with subsoil; and ■ Requires frequent monitoring and testing.
Disposal	Land Spray / Pump-off	No	Drilling fluids	Drilling fluids	■ With land spray, drilling fluids are sprayed onto vegetated land or top soil. If the land is exposed, land spraying may involve incorporating the waste into the soil. This option may require separation of the solids from the liquids; and	■ Low capital and operational costs.	■ Not suitable for non-aqueous drilling fluids; ■ Large areas of land required; and ■ Site selection needs to take into account slope, proximity to roadways/properties, proximity to water resources, and application rates and concentrations.

Waste hierarchy	Option	Locally Available	Waste category	Waste type	Description	Advantages	Disadvantages
					■ With pump-off, clear liquids that have separated from the Water-based drilling fluids are sprayed onto adjacent lands, typically using sprinklers, gun spray systems, or vacuum tankers.		
Disposal	Slurry / Annular Injection	No	Drill cuttings Drilling fluids	■ Drill cuttings; and ■ Drilling fluids.	■ In slurry injection, solid materials are ground down to particles of a suitable size, and combined with drilling fluids to create a slurry. The slurry is then injected into a confined formation at a high pressure where it becomes trapped in the formation; and ■ In annular injection, the slurry is injected into the space between the two casing strings (i.e. annulus of the well), down to the desired formation.	■ Potential for waste to come into contact with humans, wildlife, and vegetation is low; and ■ One of the lowest rates of incidents.	■ Can be costly, particularly if new well must be drilled; ■ Dependent on availability of suitable geological formations i.e. target formation must be geologically and mechanically isolated from usable water sources; ■ Annular injection not suitable for continuous disposal i.e. one-time option; ■ Risk of contamination of usable water sources if the surface pipe is breached by corrosion; and ■ May require some pre-treatment before injection e.g. oil removal, coagulation, filtration etc.
Disposal	Landfill	Yes	Drill cuttings General hazardous waste	■ Contaminated material ■ Drill cuttings; ■ Dry cell batteries; and ■ Incinerator ash.	■ Specifically designed and constructed to accommodate the burial of large volumes of non-liquid waste; ■ Landfills generally include an impermeable lining, monitoring boreholes, and leachate collection and treatment system.	■ Relatively low cost; however, if built to Class A equivalent standards and depending on the size it may be more costly; ■ Relatively permanent solution; and ■ Offers greatest local economic development and job creation potential.	

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Figure 17 summarises the BPEO for hazardous wastes generated during the construction and production, and decommissioning phases by the KDA project.

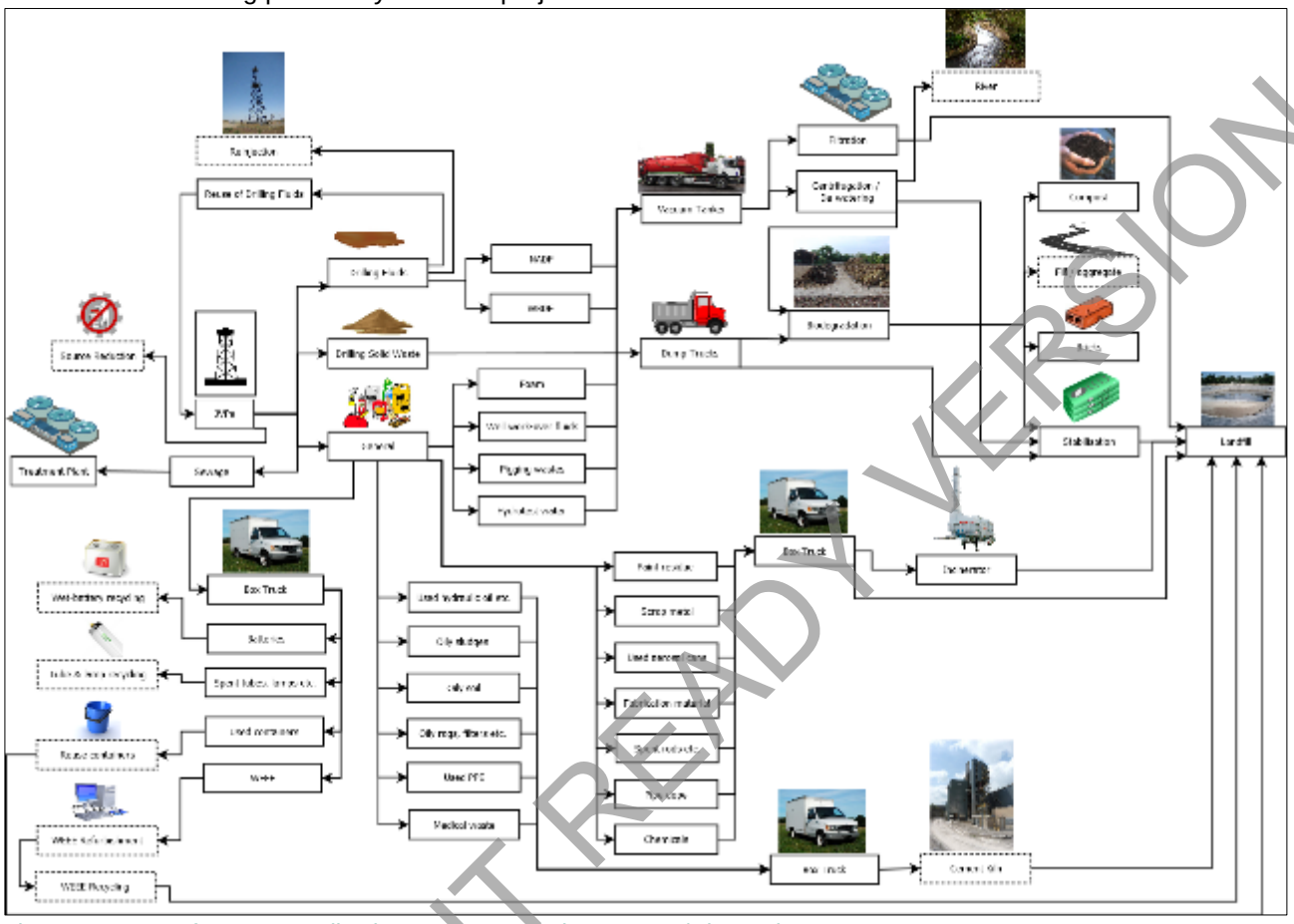

Figure 17: BPEO for Waste Collection, Transport and Treatment/Disposal

With regards to NADFs and cuttings, the BPEO is product substitution of the base fluid with one that is less toxic and has a higher biodegradation rate. This includes for example vegetable esters, low viscosity esters, and internal olefins[23]. While these fluids may be less toxic or persistent than more traditional types of base fluids, their use might not be appropriate in all drilling conditions due to differing formations, water depths and temperatures. The selection of the base fluid should therefore not only be based on toxicity and biodegradation rate, but also on-site conditions. The use of 'clean' barite, with lower concentrations of cadmium and mercury, can also contribute to reduction in the toxicity of the drilling wastes. One component of the non-aqueous drilling fluids and cuttings that is of particular concern is PAH which can typically contain toxic priority pollutants, such fluorene, naphthalene, and phenanthrene. Ideally the base fluid used should be free of PAH or have a PAH content of 0.001% or 10 ppm.

In the United States, the majority of non-aqueous drilling fluids and cuttings are treated via land farming whereby the waste is spread over small areas and allowed to biodegrade, forming clay-like substances which can be stockpiled adjacent the farming areas. The processing of the waste into a reusable construction aggregate is also another common practice. This process consists of dewatering the drilling waste and mixing the solids with binding and solidification agents, such as cement or lime. The oil and metals are stabilized within the solids matrix and cannot leach from the solids. More recently, Dispersion by Chemical Reaction (DCR) is also being used to treat drill cuttings, whereby Calcium Oxide is used to immobilise oils and heavy metals. The treated wastes are then used as daily cover at a Class I municipal

[23] United States Environmental Protection Agency (EPA) (2000), *Development Document for Final Effluent Limitations Guidelines and Standards for Synthetic-Based Drilling Fluids and other Non-Aqueous Drilling Fluids in the Oil and Gas Extraction Point Source Category*, EPA-821-B-00-013

landfill sites and/or base material for road construction and levee maintenance. Sub-surface reinjection at an independent waste disposal facility is another method used to dispose of the drilling wastes.

6.0 IMPACT ASSESSMENT

6.1 Impact Assessment Rating and Methodology

The methodology and approach to be followed for potential impacts for the proposed Project infrastructure including the (i) CPF, drilling wells and well pads, associated infrastructure, as well as (ii) the export pipeline to Kabaale during the construction, operational and closure or decommissioning phases are considered separately in this waste assessment.

6.1.1 Impact Classification

The purpose of the impact assessment process it to compare the intensity of the impact with the sensitivity of the receiving environment. The method relies on a detailed description of both the impact and the environmental or social component that is the receptor. The intensity of an impact depends on its characteristics, which may include such factors as its duration, reversibility, area of extent, and nature in terms of whether positive, negative, direct, indirect or cumulative.

The determination of significance of an impact is largely subjective and primarily based on professional judgment. However, the formal and general principles of the ESIA methodology herein has been detailed to provide meaning to the intensity of the rating with regard to the waste impact assessment of the proposed Project. The purpose of this impact classification for the waste study was to provide a system for ranking the severity of impacts, based on the intensity of the impact and the sensitivity of the receptor that is credible, robust and defendable; and to provide a clear approach for comparison among the categorises the overall impact level for each described receptor during the phases of project development.

6.1.2 Type of Impact

The types of potential Project impacts considered appropriate for the waste assessment are summarised in Table 27.

Table 27: Types of Waste Impact

Direct Impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors.
Indirect impact	Secondary impacts that result from project activity and affect the environment in which the receiving receptor is experienced.
Cumulative impact	Impacts that act together or combine with other impacts (including those from concurrent or planned activities) to affect the same resources and/or receptors of the Project.

6.1.3 Intensity

The first step in the impact severity classification was to determine the intensity, or magnitude, of the effect of the Project within the context of the waste study. The effect was quantified by combining the rankings of the criteria for direction, geographic extent, duration, and reversibility into a single measure of intensity for each key question and valued component.

Intensity describes the severity or magnitude of the effect. To provide a relative illustration of impact significance, it is useful to assign numerical descriptors to the impact **intensity** for each potential impact. Each is assigned a numerical descriptor of 1, 2, 3, or 4, equivalent to negligible, low, medium or high. To classify intensity using this scale in a manner meaningful for the waste study's valued components, the extent of the effect must be placed in the context of the valued component. That is, classifying intensity in a meaningful way depends on the pollution and/or contamination extent. For example, failure of the export pipeline would result in a high magnitude impact effect by polluting the underlying soil and groundwater over

a large area; whereas, the removal and disposal of the waste rock would result in a low magnitude impact effect on vegetation and soil in a small localised area of the escarpment. Fixed quantitative thresholds to define the intensity categories were not applied; however the qualitative descriptions of the potential for an effect of a given size to contribute to a substantial change in the environment were used (see Table 28).

Table 28: Intensity Assessment Rating Scale

Criterion	Criterion	Rating	Rating Scale Description
Intensity (the expected magnitude or size of the impact)	**Negligible**	1	Where the impact affects the environment in such a way that natural, and /or cultural and social functions and processes are negligibly affected and valued, important, sensitive or vulnerable systems or communities are negligibly affected.
	Low	2	Where the impact affects the environment in such a way that natural, and/or cultural and social functions and processes are minimally affected and valued, important, sensitive or vulnerable systems or communities are minimally affected. No obvious changes prevail on the natural, and / or cultural/ social functions/ process as a result of project implementation. Pollution and contamination of the air, soil, groundwater and / or vegetation is likely to small localised area requiring small scale clean-up.
	Medium	3	Where the affected environment is altered but natural, and/or cultural and social functions and processes continue albeit in a modified way, and valued, important, sensitive or vulnerable systems or communities are moderately affected. Pollution and contamination of the air, soil, groundwater and / or vegetation is likely to an area requiring moderate- scale clean-up and/or decontamination.
	High	4	Where natural and/or cultural or social functions and processes are altered to the extent that they will temporarily or permanently cease, and valued, important, sensitive or vulnerable systems or communities are substantially affected. The changes to the natural and/or cultural / social- economic processes and functions are drastic and commonly irreversible. Pollution and contamination of the air, soil, groundwater and / or vegetation is likely to cause severe destruction of the environment and affect a large area requiring extensive excavation / remediation.

6.1.4 Sensitivity

In order to derive an overall level of impact severity, which also reflected the expected extent of contamination or pollution outcome for the particular valued component activity, the predicted effect intensity was combined with a sensitivity value for the valued component.

For the intents of this waste impact assessment, sensitivity represents the vulnerability or resilience of the component activity on the receptor. In other words the sensitivity of the vegetation, soil, groundwater and air to contamination or pollution by the component activity. For example, the soil and groundwater are highly sensitive to contamination by hazardous wastes spills; whereas, the soil and groundwater are less sensitive to contamination by non-hazardous wastes spills.

Sensitivity for each valued component activity ranged from very low / negligible to high (Table 29).

Table 29: Sensitivity Assessment Rating Scale

Criterion	Rating	Rating Scale Description
Negligible	1	None of the below.
Low	2	Where natural recovery of the impacted area to the baseline or pre-project condition is expected in the short-term (1-2 years), or where the potentially impacted area is already disturbed by non-project related activities occurring on a scale similar to or larger than the proposed activity. Pollution and contamination of the air, soil, groundwater and / or vegetation is likely to be limited to a short period requiring small scale clean-up.
Medium	3	Where natural recovery to the baseline condition is expected in the medium term (2-5 years), and where marginal disturbance or modification of the receiving environment by existing activities is present. Pollution and contamination of the air, soil, groundwater and / or vegetation is likely to be limited to a medium-term period until the remediation can be effected.
High	4	Where natural recovery of the receiving environment is expected in the long-term (>5 years) or cannot be readily predicted due to uncertainty over the nature of the potential impact, and where unique or highly valued ecological, social or cultural resources could be adversely affected. Pollution and contamination of the air, soil, groundwater and / or vegetation is likely to persist in the environment with destructive effects over a long term period with limited treatment options available.

6.1.5 Impact Severity

The severity of impact is then indicated by the product of the two numerical descriptors of intensity and sensitivity, as in Table 30. This is a qualitative method designed to provide a broad ranking of the different impacts of a project.

It is important to note that this methodology used is based on the following: (1) the Ugandan authorities have approved this method (2) CNOOC's partners have approved this method.

Table 30: Determination of Impact Severity

			Sensitivity of receptor			
			Negligible	Low	Medium	High
			1	2	3	4
Intensity of Impact	Negligible	1	1 Negligible	2 Minor	3 Minor	4 Minor
	Low	2	2 Minor	4 Minor	6 Moderate	8 Moderate
	Medium	3	3	6	9	12

		Sensitivity of receptor			
		Negligible	Low	Medium	High
		1	2	3	4
		Minor	Moderate	Moderate	Major
High	4	4 Minor	8 Moderate	12 Major	16 Major

6.2 Impact Assessment of the CPF, Wells and Associated Infrastructure

6.2.1 Construction Phase Impacts

The potential waste impacts that are related to the construction of the Project infrastructure phase are provided in the table below. The Groundwater Specialist Study, Soil Specialist Study and Surface Water Specialist Study for the proposed Project should be read in conjunction with this waste impact assessment. The construction phase activities that could potentially impact on the soil and groundwater resources include the materials handling and waste generation.

The potential waste impacts during the construction of project infrastructure are provided in Table 31.

Table 31: Construction Phase Impact Assessment of CPF, Wells and Associated Infrastructure

			Pre-mitigation			Post-mitigation		
Receptor	**Description**	**Type of Impact**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**
Soil, Vegetation and Habitat Loss	**Excavations and removal of topsoil, overburden and vegetation**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	Pollution from **domestic / sanitary waste water discharge**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil, Surface water, Groundwater and Vegetation	Pollution from **accidental chemical spills**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil, and Groundwater	Pollution from **hazardous**	Direct	High	Medium	12 Major	Low	Low	4 Minor

			Pre-mitigation			Post-mitigation		
	waste generation							
Air, Soil and Groundwater	Pollution from **domestic waste generation**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	Pollution from **well drilling**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	Pollution from **well blow-out**	Direct	High	High	16 Major	Low	Low	4 Minor

6.2.1.1 Excavations and Removal of Topsoil, Overburden and Vegetation

The Project areas will be cleared from any vegetation, excavated and levelled before any infrastructure can be constructed. This may lead to soil erosion or soil loss. Some of the soil and overburden will be used for backfilling during construction and the rest strategically stored as berms for future rehabilitation purposes. The impact for this activity on soil and vegetation is rated at **moderate** (9) before mitigation, because of the medium sensitivity and intensity of the impact expected without mitigation. The impact can however be reduced to **minor** (4) if adequate mitigation measures are put in place.

6.2.1.2 Domestic / Sanitary Waste Water Discharge

Domestic waste water from the construction camp kitchen, bathrooms, residential block, and administration areas will be provided at staff ablutions by ventilated chemical toilets and discharged in subsurface drains, until the permanent waste water treatment plant is completed. There is no current detail information on the expected volumes of domestic waste water that will be generated and the design of the systems. The impact description is therefore based on experiences from similar projects.

The presence of the additional workers on site during construction will increase the pressure on the sewage water systems and potential for overloading the existing waste water treatment systems is possible. This could result in spillages and malfunctioning of drain systems, which can lead to shallow soil, surface water and groundwater pollution. Alternatively, an option is to provide portable ablution facilities for areas along the construction routes such that the impacts are moderate rather than major.

The impact from this activity can potentially be **moderate** (9) if local communities are nearby the CPF and associated infrastructure areas; whereby, soil and groundwater resources in the area near the communities could become polluted from the waste disposal which can cause the outbreak of waterborne diseases such as cholera and hepatitis.

The impact can however be reduced to **minor** (4) if adequate mitigation measures are put in place. Mitigation will typically be the provision of clean water or hand washing and provision of portable toilets at the construction sites. These portable toilets need to managed and maintained in a manner that will protect the environment.

6.2.1.3 Accidental Chemical Spills

It is expected that large volumes of potential hazardous materials will be stored and handled at the CPF construction site. The spillage of oils, fuel and chemicals can result in the pollution of water resources if due care is not taken. The risk for a spill has to be considered as a potential impact. The impact is rated with a

medium intensity and medium sensitivity. The magnitude of the impact is considered to be **moderate** (9) before mitigation measures are adopted.

There is the potential for chemical soil contamination arising from spills and mis-management of materials, which can produce local contamination which is detrimental to vegetation and soil organism growth. Metals in soils arise from welding, grinding and poor waste management. Oils and greases arise from equipment operation. Accidental chemical spills have a detrimental effect on vegetation and soil organism growth.

Mitigation of these types of impacts will include the setup of site specific risk assessments and materials handling procedures by construction workers. All workers should be made aware of the risks associated with handling these hazardous materials and spill prevention and clean-up measures. With these applied mitigation measures the impact on the groundwater can be reduced to **minor** (4).

6.2.1.4 Associated Hazardous Waste Generation

Associated Hazardous waste materials will be generated during the construction phase ranging from used solvents, used oil and grease, etc. The magnitude of the soil and groundwater impact of the generation of hazardous waste before mitigation is expected to be **major** (12) (Ref. 32).

After the implementation of mitigation measures, such as the waste management plan, the magnitude can further be reduced to **minor** (4) and the potential impact will be of short term and limited to the directly affected site.

6.2.1.5 Non-Hazardous Waste Generation

The influx of construction workers and permanent staff on the flats will cause the generation of domestic waste from the residential and construction camp. The wastes generated will typically constitute food packaging, food waste, plastic bags, and water bottles, scrap metal and wood etc.

Currently the domestic waste is burned and buried but the volumes will increase to an extent that a formal waste handling/disposal site will have to be developed. If domestic waste is not properly disposed of or managed at a licensed facility it can lead to soil and groundwater pollution at informal dumping areas, or air pollution if burned. As such, domestic waste should rather be disposed at an appropriately licenced off-site facility. A formal waste management plan that takes in account the waste management hierarchy includes re-use and recycling, which will be required to reduce the impact from this activity on the air, soil and groundwater.

The impact is therefore rated as **moderate** (9) before mitigation and after mitigation can reduce to **minor** (4).

6.2.1.6 Well Drilling

There will be two types of drill fluids to be used at the Project area, and WBDFs and NADFs. WBDFs will be used to drill the upper portions of the well and is designed to be environmentally friendly containing water (from Lake Albert) and bentonite (Ref. 32).

The main concern for use of NADFs is safe disposal of the associated drill cuttings. Drilled cuttings removed from the wellbore are typically the largest waste streams generated during oil and gas drilling activities. The impacts on the soil and groundwater from drilling fluids will thus be related to improper handling, treatment and disposal of the drill fluids and cuttings that can cause soil and groundwater pollution. However, due to the use of the selected drill fluids, the impact is rated as moderate (9) before mitigation and reduce to low after considering the mitigation measures in place to safely handle and store drill fluids.

6.2.1.7 Well Blow - Out

A well blow-out is the uncontrolled release of crude oil from a well, resulting in the release of hydrocarbons, water-based mud and/or water. Blow-outs can occur during exploration or development drilling. They can also occur in the production stage, for instance during maintenance work on a well or due to escalation of a collision or a fire or explosion on the platform. The risk of a blow-out is minimal and not all blow-outs have significant environmental impacts. A blow-out will last until the well is under control again. This may take anywhere from a few hours if control can be regained using the safety systems, up to several months if an

additional well needs to be drilled to regain control over the first well. Experience has shown that control over wells can be regained in one or a few days if a blow-out should occur. (Ref. 32)

The crude oil mixture released during a blow-out, will have a detrimental effect on groundwater systems if not brought under control timeously; and is potentially the most severe and long-term environmental impact associated with oil and gas projects. However, blow out incidents are limited by the use of technology advances in drilling techniques and fluid management. The impact is listed here as **major** (16) based on the potential to cause detrimental damage to aquifers and other water sources in the case of a blow-out.

The mitigation measures reduce the impact to **minor** based on the low likelihood of such an incident occurring.

6.2.2 Operational Phase Impacts

The potential waste impacts during operation of the well drilling, production at the CPF and well pads is provided in Table 32.

Table 32: Operational Phase Impact Assessment of CPF, Wells and Associated Infrastructure

			Pre-mitigation			Post-mitigation		
Receptor	**Description**	**Type of Impact**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**
Soil and Groundwater	Pollution from **hazardous waste generation**	Direct	High	Medium	12 Major	Medium	Very Low	3 Minor
Air, Soil and Groundwater	Pollution from **domestic waste generation**	Indirect	Medium	Medium	9 Moderate	Medium	Very Low	3 Minor
Air, Soil and Groundwater	Pollution from **temporary storage of hazardous waste**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Air, Soil and Groundwater	Pollution from **temporary storage of domestic waste**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Air, Soil and Groundwater	**Unauthorised disposal of waste** to the environment	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor

			Pre-mitigation			Post-mitigation		
Receptor	**Description**	**Type of Impact**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**
Soil and Groundwater	Pollution from **domestic waste water discharge**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	Pollution from uncontrolled **waste production water**	Direct	High	High	16 Major	Low	Low	4 Minor
Soil, Surface water, Groundwater and Vegetation	Pollution from **accidental chemical spills**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	Pollution from **associated infrastructure or flowline failure**	Direct	High	High	16 Major	Medium	Medium	9 Moderate
Soil and Groundwater	Pollution from **well drilling wastes**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	Pollution from **well blow-out**	Direct	High	High	16 Major	Low	Low	4 Minor

6.2.2.1 Associated Hazardous Waste Generation

Hazardous waste may be generated during flow line and CPF maintenance activities. Hazardous waste generated during the operation phase ranging from used batteries, solvents, used oil and grease, etc. (see Section 3.1.2.3). The magnitude of the soil and groundwater impact of the generation of hazardous waste before mitigation is expected to be **major** (12). After the implementation of mitigation measures, such as the waste management plan, the magnitude can further be reduced to **minor** (4) and the potential impact will be of short term and limited to the directly affected site

6.2.2.2 Non-Hazardous Waste Generation

Domestic waste generation is common to both the construction and operational phase. As discussed in section 4.3 above, domestic wastes will mainly be generated at the drilling camp and permanent operators' accommodation camp. However, domestic waste is also expected to be generated in smaller amounts at the CPF, material yards (drilling and production) and associated offices, canteen and ablution blocks at the generated at the KDA.

Domestic waste is expected to be predominantly paper and wood waste, as well as food waste, plastics, glass and metals, which will be stored in suitable containers and removed on a regular basis for disposal at a

suitably licensed offs-site disposal facility e.g. landfill site. Currently, domestic waste is burned and buried but volumes will increase during the operational phase to an extent that a formal appropriate off site waste disposal will be undertaken. If domestic waste is not properly disposed of or managed it can lead to soil and groundwater pollution at informal dumping areas, or air pollution if burned.

A formal waste management plan that includes re-use and recycling will be required to reduce the impact from this activity on the air, soil and groundwater source and a formal waste handling/disposal site will have to be developed. The waste management hierarchy approach will be adopted to reduce waste production and reuse or recycle materials wherever possible. Dry waste, such as plastic, cans, paper, cartons and glass will be recycled as far as possible and wet food waste will be sent to the appropriately licensed off site landfill.

The impact is rated as rated as **moderate** (9) before mitigation but is reduced after mitigation to **minor** (4).

6.2.2.3 Temporary Storage of Hazardous Waste

Temporary storage of hazardous materials presents various challenges. Different waste streams such as hazardous oils, solvents and chemicals should not be mixed in any way, but stored in separate containers and bays until removal to prevent any chemical reactions. Hazardous waste will be suitable stored until off site treatment and disposal by a local waste company.

The storage of hazardous waste is overall rated as **moderate** (9) before mitigation but is reduced after mitigation to **minor** (4).

6.2.2.4 Temporary Storage of Non-Hazardous Waste

Volumes of domestic non-hazardous waste expected to be generated will be low. It is expected to consist mainly of paper and wood waste, as well as food waste, plastics, glass and metals, which will be stored in suitable containers. Domestic waste should be removed on a daily basis.

Recyclable waste will be stored in separate containers from food waste. Currently, domestic waste is burned and buried but volumes will increase during the operational phase to an extent that a formal appropriate off site waste disposal by landfill will be undertaken for food waste. Whereas, recyclable materials such as metals, plastic, carton, glass, wood etc. will be sorted and temporarily stored until recycled onsite or sold and removed by contractors. If domestic waste is not properly stored it can lead to soil and groundwater pollution at informal unlined storage areas. Uncontrolled storage of domestic waste can lead to air pollution from rotting organic matter releasing methane and carbon dioxide.

The impact is rated as rated as **moderate** (9) before mitigation but is reduced after mitigation to **minor** (4).

6.2.2.5 Unauthorised Disposal of Waste

Illegal disposal or open burning of waste materials and littering can occur around the KDA. The environmental significance of illegal dumping occurring is rated as **moderate** (9) without any mitigation measures in place. It is expected that CNOOC will implement a waste management plan to manage all waste activities of the operations and this will serve to mitigate the illegal disposal of waste to the surrounding environment, reducing the environmental significance to **minor** (4).

6.2.2.6 Domestic / Sanitary Waste Water Discharge

According to the estimated waste inventory (see Section 4.3), the following amounts of domestic waste water are estimated to be generated from the various camps:

- Drilling camp generating about 15,000 m³ for approximately 250 people;
- EPC contractors camp generating about 20,000 m³ for approximately 250 people;
- Production camp generating about 10,000 m³ for approximately 250 people

Domestic waste water from the camps will be discharged in and treated to a permanent waste water treatment plant (WWTP).

There may be potential for soil and groundwater pollution as a result of spillages and malfunctioning of the WWTP system, which can lead to shallow soil and groundwater pollution. Domestic wastewater from operational sites needs to be collected and transported hence is prone to spillage. The impact for this activity which is the potential for soil and groundwater pollution is rated at **moderate** (9) before mitigation, because of the medium sensitivity and intensity of the impact expected without mitigation.

Mitigation measures include adequate design of the WWTP and management to handle the expected volumes of effluent and treated effluent discharge. Downstream groundwater monitoring of the systems is recommended especially in the case where groundwater may be used for domestic supply. Post mitigation the impact will be **minor**.

6.2.2.7 Waste Production Water

Waste production water will be generated at the CPF and re-injected into the wells; however, some have to be discharged but only once acceptable discharge limits are reached. Discharge of production waste water outside the boundary of the facilities will not be permitted owing to the sensitivity of the receiving environment. Separated produced water from the CPF will be utilised for local water injection requirements in the KDA. The impact for this activity which is the potential for soil and groundwater pollution is rated at **major** (16) before mitigation, because of the high sensitivity and intensity of the impact expected without mitigation.

Mitigation measures include adequate design of the integrity of the pipelines, treatment process and associated infrastructure, as well as to manage and handle the expected volumes of process water. Downstream groundwater monitoring of the systems is recommended especially in the case where groundwater may be used for domestic supply. Post mitigation the impact will be **minor**.

6.2.2.8 Accidental Chemical Spills

It is expected that large volumes of potential hazardous materials will be stored and handled at the drilling wells, CPF and well pads. The spillage of oils, fuel and chemicals can result in the pollution of soil and water resources if due care is not taken. The risk for a spill has to be considered as a potential impact. The impact is rated with a medium intensity and medium sensitivity. The magnitude of the impact is considered to be **moderate** (9) before mitigation measures are adopted.

There is the potential for chemical soil contamination arising from spills and mis-management of materials, which can produce local contamination which is detrimental to vegetation and soil organism growth. Metals in soils arise from welding, grinding and poor waste management in operations and maintenance. Oils and greases arise from equipment operation. Pigging waste arises from pipeline pumping stations and may lead to waste fluid/solid spills. Acid and/or alkaline spills and salinisation contaminating soil from pollution sources along preferential seepage path ways must be managed.

Mitigation of these types of impacts will include the setup of site specific risk assessments and materials handling procedures by construction workers. All workers should be made aware of the risks associated with handling these hazardous materials and spill prevention and clean-up measures. With these applied mitigation measures the impact on the groundwater can be reduced to **minor** (4).

6.2.2.9 Associated Infrastructure or Flowline Failure

The processes utilised at the CPF and the associated infrastructure and pipes are complex and in many instances involve high pressures. Potential failures of materials and equipment could result in the accidental release of hazardous materials and severe soil and groundwater pollution if not brought under control. As such the associated impact is determined as **major** (16) before mitigation. Mitigation will involve hazardous materials management plan including: equipment audits, flow line testing, inspections programs; as well as application of Standard Operating Procedures (SOPs). The probability of such an event taking place over the life time of the CPF and associated infrastructure is high before the mitigation but the impact rating is lowered to **moderate** (9) following mitigation. (Ref. 32)

6.2.2.10 Well Drilling Wastes

As indicated in section 6.2.1.6 above, drilling operations of development wells shall continue after the onset of the first oil production and associated impacts will therefore continue as well. Continued use of selected

drill fluids has the potential to have a **moderate** (9) impact before mitigation measures (i.e. measures in place to safely handle and store drill fluids) reduce it to **minor**. (Ref. 32)

6.2.2.11 Well Blow-Out

The impact of well blow-outs are outlined above in section 6.2.1.7 above and have the same impact rating during the operational phase; being **major** (16) due to its potential to cause detrimental damage to aquifers and other water sources. Again the impact is rated as **minor** following the implementation of mitigation measures. (Ref. 32)

6.2.3 Decommissioning Phase Impacts

The potential waste impacts during decommissioning and closure of the CPF, wells and associated Infrastructure are provided in Table 32.

Table 33: Decommissioning Stage Impact Assessment of CPF, Wells and Associated Infrastructure

			Pre-mitigation			Post-mitigation		
Receptor	**Description**	**Type of Impact**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**
Soil, Groundwater and Vegetation	Removal of **existing industrial structures**	Direct	Medium	Medium	9 Moderate	Medium	Negligible	3 Minor
Soil and Groundwater	Pollution from **hazardous waste generation**	Direct	High	Medium	12 Major	Medium	Negligible	3 Minor
Air, Soil and Groundwater	Pollution from **non-hazardous / domestic waste generation**	Indirect	Medium	Medium	9 Moderate	Medium	Negligible	3 Minor
Air, Soil and Groundwater	**Temporary storage of dismantled used infrastructure materials**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor
Soil and Groundwater	**Closure of any onsite waste storage areas**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor

6.2.3.1 Existing Industrial Structures

Existing industrial structures will be removed and the topography will be returned (as far as possible) to its former state.

The environmental significance of the decommissioning activities in general are rated as **moderate** before mitigation, but with the implementation of a decommissioning plan this is reduced to **minor**. It is uncertain

how extensive this phase would be at this stage, but will at least involve the dismantling of the production / injections wells, wellpads, flowlines, CPF, accommodation camps, offices and associated infrastructure. It is possible that some infrastructure might be used for other purposes and this possibility will only be verified at a later stage. Many of the materials will be recycled as far as possible. Contaminated materials will not be recyclable and those that cannot be removed by waste contractors will need to be disposed of at suitably licenced off site treatment and disposal landfill sites. Stored topsoil and fill material will be used to return the site as close as possible to its pre-development state.

6.2.3.2 Hazardous and Non-Hazardous Waste Generation

Hazardous and non-hazardous / domestic waste streams similar to those generated during the construction and operational phase (see details in Sections 6.2.1.4 and 6.2.1.5) will be generated during closure. The impact severity for hazardous waste generation is expected to be **major** and the impact severity for domestic waste generation is expected to be **moderate**. However, after appropriate mitigation both are expected to have a **low** impact severity.

6.2.3.3 Temporary Storage of Dismantled used Infrastructure Materials

Temporary storage of dismantled used infrastructure materials, steel works, equipment, building rubble and other waste will occur during the closure phase: The environmental significance of the temporary storage of dismantled structure materials, rubble, steel structures, equipment etc. is rated as **moderate** before mitigation. The significance will be reduced to **minor** with the implementation of the decommissioning plan. The impact will be limited to the KDA only and will be for a short-term period lessening the potential impact on the surrounding area.

6.2.3.4 Closure of any Onsite Waste Storage Areas

Closure and rehabilitation of any onsite storage areas will occur during closure. The storage areas will be closed and rehabilitated last once all wastes have been appropriated disposed at offsite licenced facilities. The environmental significance of this activity before mitigation is rated as **moderate**, but with an approved closure and rehabilitation plan in place this would be reduced to a **minor** rating. All activities will have ceased and a monitoring plan will be implemented to ensure the facility does not pose any threats to the surrounding environment. The monitoring period will be determined by the authorities.

6.3 Impact Assessment of Export Pipeline

6.3.1 Construction Phase Impacts

During the construction phase of the export pipeline, the impacts from waste will largely be similar to those as detailed during the construction of the CPF, wells and associated infrastructure in 6.2.1 particularly with regard to the excavation and removal of topsoil, overburden and vegetation; domestic / sanitary waste water discharge; accidental chemical spills; and the generation of hazardous and non-hazardous wastes. Some additional specific impacts during construction of the export pipeline with regard to the waste rock handling and domestic / sanitary wastewater are detailed below.

Table 34: Construction Phase Impact Assessment of the Export Pipeline

			Pre-mitigation			Post-mitigation		
Receptor	**Description**	**Type of Impact**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**	**Sensitivity**	**Intensity of Impact**	**Impact Severity**
Soil, Vegetation and Habitat Loss	**Removal and disposal of the waste rock**	Direct	Low	Low	4 Minor	Low	Low	4 Minor

			Pre-mitigation			Post-mitigation		
Soil and Groundwater	Pollution from **domestic / sanitary waste water discharge**	Direct	Medium	Medium	9 Moderate	Low	Low	4 Minor

6.3.1.1 Waste Rock

With regard to the handling of the waste rock (which although expected to be minimal other than on the escarpment section) the impact from the activity would be **minor** (4) where waste rock is either returned to the trench (where possible), or removed and disposed along the right of way (RoW).

6.3.1.2 Domestic / Sanitary Waste Water Discharge

Provisions for staff ablutions will be provided by ventilated chemical toilets along the export pipeline construction route.

The impact from this activity can potentially be **moderate** (9) if local communities along the pipeline route's soil and groundwater resources are polluted from the waste disposal which can cause the outbreak of waterborne diseases such as cholera and hepatitis.

The impact can however be reduced to **minor** (4) if adequate mitigation measures are put in place. Mitigation will typically be the provision of clean water or hand washing and provision of portable toilets at the construction sites. These portable toilets need to managed and maintained in a manner that will protect the environment.

6.3.2 Operational Phase Impacts

During the operational phase of the export pipeline, the impacts from waste will largely be similar to those as detailed during the operational phase of the CPF, wells and associated infrastructure in 6.2.2 particularly with regard to associated hazardous and non-hazardous waste generation and the temporary storage thereof; and unauthorised disposal of waste; domestic / sanitary waste water discharge (as detailed also in Section 6.3.1.2); and any accidental chemical spills.

The main additional specific impact during operation regards potential failure of the export pipeline or flowline as detailed below.

Table 35: Operational Phase Impact Assessment of the Export Pipeline

			Pre-mitigation			Post-mitigation		
Receptor	**Description**	**Type of Impact**	**Sensitivity**	**Intensity of Impact**	**Receptor**	**Description**	**Type of Impact**	**Sensitivity**
Soil and Groundwater	Pollution from **pipeline/ flowline failure**	Direct	High	High	16 Major	Medium	Medium	9 Moderate

6.3.2.1 Export Pipeline or Flowline Failure

The processes utilised at the CPF and the export pipeline to Kabaale are complex and in many instances involve high pressures. Potential failures of materials and equipment could result in the accidental release of hazardous materials and severe soil and groundwater pollution if not brought under control. The main

pipeline to Kabaale will follow a route through several communities that are dependent on groundwater as the main water supply.

The associated impact is therefore determined as **major** (16) before mitigation. Mitigation will involve hazardous materials management plan including: equipment audits, flow line testing, inspections programs; as well as application of Standard Operating Procedures (SOPs). The probability of such an event taking place over the life time of the plant and pipeline is high before the mitigation but the impact rating is lowered to **moderate** (9) following mitigation.

6.3.3 Decommissioning Phase Impacts

During the closure or decommissioning phase of the export pipeline, the impacts from waste will largely be similar to those as detailed during the decommissioning of the CPF, wells and associated infrastructure in 6.2.3 particularly with regard to existing pipeline structures; hazardous and non-hazardous waste generation; temporary storage of dismantled used infrastructure materials; and closure of any onsite waste storage areas.

7.0 RECOMMENDATIONS FOR MITIGATION/MANAGEMENT AND MONITORING MEASURES

In each of the stages of the Project, waste mitigation measures have been considered, the aim of which was to reduce all predicted impacts to moderate or lower.

The Project will comply with the Ugandan National Environment (Waste Management) Regulations and the National Environment Management Authority (NEMA, Operational Waste Management Guidelines for Oil and Gas Operations (Table 1) with special focus on areas with limited as indicators of best international practice.

7.1 Mitigation of Impacts at the CPF, Wells and Associated Infrastructure

7.1.1 Construction Phase

7.1.1.1 Excavations and Removal of Topsoil, Overburden and Vegetation

Excavations and removal of overburden and topsoil will be minimised as far as possible. It is recommended that excavation and removal of topsoil, overburden and vegetation be done under the supervision of soil specialists and botanists. These specialists will advise on the soil classification and appropriate storage of soil types, and advise on vegetation species to prevent impacts on soil and vegetation respectively

Some of the topsoil and overburden material removed during the construction phase will be used for backfilling and building of roads while the rest will be stored as berms at strategic areas around the KDA. These stockpiles will be sloped and capped to prevent erosion and loss of material. The integrity and aesthetics of the capping layer will further be enhanced by vegetating it with suitable natural plants and grasses indigenous to the area. Storm and run-off water management systems will be implemented to divert storm and run-off water away from these stockpiles.

7.1.1.2 Domestic / Sanitary Waste Water Discharge

Sewage waste from workers camps etc. should be treated and disposed of in accordance with National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, S.I. No 5/1999. Reference also needs to be made to World Bank Group EHS Guidelines, Onshore Oil and Gas Development, 2007. Sanitary sewage must be treated to meet the discharge limits of the Company requirements as stated in Table 36 (Ref.32)

Table 36: Standards for Discharge of Effluent (Ref. 32)

Parameter	Unit	Uganda	IFC	Company requirement
pH	pH	6 – 8	6 – 9	6 – 8

Parameter	Unit	Uganda	IFC	Company requirement
BOD	mg/l	50	30	30
COD	mg/l	100	125	100
Total nitrogen	mg/l	10	10	10
Total phosphorus	mg/l	10	2	2
Oil and grease	mg/l	10	10	10
Total suspended solids	mg/l	100	50	50

Pollution from domestic (i.e. sanitation) wastewater may be prevented by the appropriate location and use of sanitation facilities. Maintenance and integrity inspections of the facilities and associated pipelines are required, as well as, appropriate load removal and treatment through the WWTPs.

Mitigation measures include adequate design and management to handle the expected volumes of wastewater and allow drainage in order not to cause flooding or over saturation of the subsurface.

During the construction phase of the well pads and pipeline (located away from the construction camp), sanitation waste will be generated by workers. There is no permanent ablution facilities associated with these construction sites, and the workers will have to be provided with adequate sanitation solutions on site to prevent the disposal of waste in unsanitary manners. The informal disposal of these wastes can lead to pollution of the soil and groundwater resources at the construction sites. (Ref. 32)

7.1.1.3 Accidental Chemical Spills

Once waste is contained the containers should be stored in a designated area with secondary containment. Ideally a spill kit should be located within the vicinity of the waste storage areas. A PPE storage box and spill kit should be placed within immediate vicinity of waste storage areas. The storage area should be constructed to allow sufficient ventilation and minimize water from collecting in the accumulation area.

7.1.1.4 Hazardous and Non-Hazardous Waste Generation

Waste streams can be subdivided into three broad groups: Recyclable / Recoverable, Non-hazardous, and Hazardous. In order to achieve a successful waste segregation program, waste should be segregated at the source area. Once the waste is contained the containers should be stored in a designated area with secondary containment.

The following measures will be implemented to mitigate the impact of pollution from waste that is generated:

- Development and implementation of a Waste Management Plan for the project;
- Adopt the waste management hierarchy as follows:
  - Prevent and minimise general and hazardous waste generation as far as possible;
  - Re-use waste during construction where possible;
  - Recycle or sell waste to recycling contractors where possible during construction;
- Separate waste at source by separating domestic food and recyclable waste; domestic waste from hazardous waste, and non-compatible hazardous wastes (e.g. acid and toxic).
- Recycle wherever possible;
- Provide suitable labelled containers and temporary storage areas as close to the point of generation as practical possible;

- Off-site waste recovery, recycling, treatment or landfilling at suitably licenced facilities only to ensure unusable waste is disposed of in an environmentally responsible manner (“cradle to grave” responsibility).

The waste management hierarchy is an internationally accepted guide to prioritise waste management options and aims to achieve optimal environmental results. The main priority should be to prevent the generation of waste. If not possible, waste should be minimised or re-used as far as possible. R

7.1.1.5 Well Drilling

Pollution from well drilling stored and/or disposed in pits will be mitigated by the applying the following (Ref. 32):

- Pits should be lined and tested for integrity prior to use;
- Bottom of pits should be higher than 5 m above the seasonal high water table;
- Prevention of natural surface drainage entering the pits during rains;
- Installation of a perimeter fence around the pits or installation of a screen to prevent access by wildlife (including birds), livestock, and people;
- Pit closure should be completed as soon as practical, but no longer than 12 months, after the end of operations; and
- If the drilling waste is to be buried, the Mix-Bury-Cover disposal method should be used.

The pits must be impermeable and possess suitable runoff protection and drainage to prevent impacts to the lake.

7.1.1.6 Well Blow-Out

The drilling fluid is the primary safeguard against blow-out of hydrocarbons from a well and its density can be controlled to balance any anticipated formation pressures. The drilling mud will be tested from time-to-time during the drilling process and its composition adjusted to account for any changing down-hole conditions. The mud density will be adjusted as required by an on-site chemist. The likelihood of a blow-out will be further minimized by using a specially designed blow-out preventer (BOP). When installed on top of the well-bore, a BOP will close the well automatically in case of a blowout. (Ref. 32)

7.1.2 Operational Phase

7.1.2.1 Hazardous Waste Generation

The following measures will be implemented:

- Develop and implement an Waste Management Plan for the project, including objectives for the collection, storage, transport, minimization and disposal of all hazardous and non-hazardous wastes generated;
- Employees and the community will be educated to ensure the objectives of the Waste Management Plan are achieved;
- Demarcated temporary collection/storage areas with suitable waste bins for hazardous waste will be provided at strategic places;
- Hazardous waste streams will be labelled and stored separately and recycled as far as possible to minimise volumes requiring landfilling; and
- Where possible hazardous waste will be returned to the suppliers.
- Waste is to be taken to the closest appropriately licenced waste recycling, treatment and disposal facilitates for the management of hazardous wastes in accordance with a priority to reduce, reuse, and

recycle waste (e.g. oils, greases and oil contaminated absorbents) then treatment and lastly landfill or incinerate wastes generated.

- If no appropriate licenced facilities are available near the KDA, studies should be undertaken to develop a nearby suitably licenced facility.

See further details about mitigation as detailed for the construction phase which will be the same during operation as detailed in Section 7.1.1.4.

7.1.2.2 Non-Hazardous Waste Generation

The following measures will be implemented:

- A Waste Management Plan should be developed and implemented for the project, including objectives for the collection, storage, transport, minimisation and disposal of all wastes generated;
- Employees and the community will be educated to ensure the objectives of the Waste Management Plan are achieved;
- Demarcated areas with suitable waste bins will be provided for non-hazardous domestic recyclable and wet food wastes;
- Waste will be separated and recycled at source as far as possible to minimise volumes requiring landfilling.
- Waste is to be taken to the closest appropriately licenced waste recycling, treatment and disposal facilitates for the management of non-hazardous wastes in accordance with a priority to reduce, reuse, and recycle waste (e.g. ferrous and nonferrous wastes, glass, paper and plastics), then treatment (e.g. compost food wastes) and lastly landfill or incinerate wastes generated.
- If no appropriate licenced facilities are available near the KDA, studies should be undertaken to develop a nearby suitably licenced facility.

See further details about mitigation as detailed for the construction phase which will be the same during operation as detailed in Section 7.1.1.4.

7.1.2.3 Temporary Storage of Hazardous Waste

The following measures to prevent the impact will be implemented:

- Development and implementation of a Waste Management Plan for the project, including objectives for the collection, storage, transport, minimisation and disposal of all hazardous and general domestic wastes generated;
- Employees and community will be educated to ensure the objectives of the Waste Management Plan are achieved;
- All hazardous waste streams will be identified (inventory), sent for testing to be classified to ensure their toxic components are known and to ensure it is managed and disposed of in a safely manner in accordance with local and international best practice standards;
- Hazardous wastes will be stored in sealed containers constructed of a suitable material and will be labelled in terms of best international practices;
- All hazardous waste will be stored, transported, and disposed of in compliance with the relevant legislation for hazardous waste, ideally off site treatment by a local waste company;
- Hazardous waste storage areas will be positioned away from any storm water drains and watercourses and away from moving vehicles and equipment to prevent accidental spills;
- The waste storage/sorting areas will at least comply with the following:

- The migration of any accidental spillage of hazardous liquids or materials into the soil and groundwater regime around the temporary storage area will be prevented;
- The area will be provided with an impervious base to prevent ingress of leach;
- The area will be provided with a spill containment sump to accommodate a volume equal to 1.5 times the volume of all containers stored on it as well as precipitation from a 25 year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater;
- Any contaminated liquid will be treated before re-use or being released;
- Different and incompatible wastes such as chlorine and ammonia will be clearly labelled and stored separately to prevent any chemical reactions such as release of toxic fumes, combustion and fire hazards from occurring;
- Throughout the rainy season, temporary containment will be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs;
- Drums will not be overfilled and different wastes types not be mixed;
- Waste containers will be clearly labelled with the words “Hazardous Waste”.

- The production or generation of hazardous waste will be minimised as far as possible;
- Liquid or semi-liquid hazardous waste in will be kept in appropriate containers (closed drums or similar) and/or under cover;
- All hazardous waste containers will clearly be labelled with the waste being stored and the starting date of accumulation;
- Potentially hazardous waste materials will not be accumulated on the ground;
- The original label of liquids and materials will not be removed as it contains important safety and disposal information;
- Replacement of toxic raw materials with more environ-friendlier resources will continuously be considered; and
- Hazardous waste will be separated and recycled as far as possible to minimise volumes requiring off site treatment or disposal by local contractors.

7.1.2.4 Temporary Storage of Non-Hazardous Waste

The following measures will be implemented:

- A Waste Management Plan will be implemented;
- Employees and the community will be educated to ensure the objectives of the strategy are achieved;
- Sufficient storage and waste bins will be provided as close to the point of generation as possible; and
- Suitably designed central sorting and temporary storage area (salvage yard) for general domestic and industrial wastes will be provided.

7.1.2.5 Unauthorised Disposal of Waste

The following measures should be implemented:

- An integrated Waste Management Plan for the KDA will be implemented which should include the collection, transport, storage, recycling and disposal of all waste materials, but also regular auditing and the on-going monitoring of all waste management activities;

- Corrective actions for non-compliance with the management plan should be implemented;
- Regular environmental audits and inspections of the surrounding area will be undertaken to identify any environmental concerns and take action to rectify them; and
- Workers and the community should be educated and trained to ensure the environment is kept clean and a reporting system be implemented to report transgressors.

7.1.2.6 Domestic / Sanitary Waste Water Discharge

Storm water should be separated from waste production water and domestic waste water (i.e. sanitary) streams wherever possible in order to reduce the volume of wastewater to be treated prior to discharge (See mitigation as detailed in Section 7.1.1.2).

7.1.2.7 Uncontrolled Waste Production Water

Storm water should be separated from waste production water and domestic waste water (i.e. sanitary) streams wherever possible, in order to reduce the volume of wastewater to be treated prior to discharge. Process wastewater must be treated and either recirculated to the plant processes or releases to the environment only once appropriate discharge levels are met and the treated water does not harm the environment it is released into. Treatment processes and associated pipes must be integrity testing and of suitable size with bunding to take into account 1:50 storm water events.

7.1.2.8 Accidental Chemical Spills

The following measures in addition to those detailed in Section 7.1.1.3.will be implemented to prevent the impact:

- Storage areas for liquid and hazardous wastes will be lined;
- Hazardous liquid waste should be placed in suitable sealed containers and labelled to prevent accidental spills to the ground;
- Containment berms or bunds will be provided in fuelling and maintenance areas and where the potential for spills is high;
- Secondary containment and/or drip trays are used for any liquid material stored in drums or tanks;
- Strategically located and adequate supplies of spill kits to control and prevent spills should be provided;
- Only trained persons should handle hazardous wastes;
- Vehicles transporting waste should be purposed built and all display signage and emergency contact details;
- Fuel storage and refuelling procedures should be stringent so that no refuelling or transferring fuel occurs after dark or when light conditions are low;
- Only trained and informed persons should transport hazardous wastes;
- Only adequately licenced waste haulage companies and disposal companies should collect and dispose wastes;
- Strict speed limits should be imposed on hazardous waste vehicles; and
- Access roads should be well maintained to ensure a save trip to the off-site landfill.

7.1.2.9 Associated Infrastructure or Flowline Failure

Failure of infrastructure associated with the CPF can be prevented by choosing the right materials suited to the product transported, equipment and appropriate maintenance. Testing of equipment should be undertaken to check the pressure and subjecting it to above the operating pressure during testing, to prevent

out defects before they reach a critical size in service should also be used to detect corroded infrastructure before it fails in service.

7.1.2.10 Well Drilling Wastes

The impact from drillings muds and cuttings will be prevented by the following:

- Mud recovery systems should be used to minimise amounts of drill fluids to be ultimately discharged;
- Slurry collected in pits should be dewatered and then retained for enough time to allow evaporation to reduce volume of fluid that requires treatment and ultimate treatment or disposal;
- Alternative beneficial disposal options from the drilling cuttings should be explored, e.g. treated cuttings can be used for brick making and/or applied as surfacing aggregate material on local gravel roads, if non-hazardous;
- Biocides used to preserve geo-chemical samples should be avoided; and
- All pits should have contents appropriately treated after drilling and disposed before backfilling.

See mitigation as detailed in Section 7.1.1.6.

7.1.2.11 Well Blow-Out

The risk of well blowout will be mitigated by the following (Ref 13):

- A blow out preventer will be installed and regularly tested for effectiveness to prevent deeper hydrocarbon type blow-outs during drilling; and
- Gas detection systems should be installed to give early indication of any potential for gas blow out.

See mitigation as detailed in Section 7.1.1.6. In order to prevent a catastrophic well blow-out, a management plan should be developed and measures put in place to clean-up soils and groundwater,

7.1.3 Decommissioning Phase

7.1.3.1 Removal of Existing Industrial Structures

The following measures will be implemented to mitigate potential impacts:

- Topsoil stockpiles preserved since the construction phase will be used to level and rehabilitate the area to its original condition;
- Natural vegetation of the area will be re-introduced; and
- All re-usable materials and equipment will be recycled as far as possible;
- The pits from well drilling need to be filled and landscaped to prevent disturbance and mortality of birds and other species feeding in the area. No biocides or other highly toxic chemicals to suppress microflora in the drilling and other circulating fluids should be used. Under no circumstances should cutting be discharged into Lake Albert.

7.1.3.2 Hazardous and Non-Hazardous Waste Generation

See further details about mitigation as detailed in Section 7.1.1.4. Domestic and hazardous wastes that cannot be recycled will be treated or landfilled at appropriately licensed offsite facilities. This will be one of the last activities to take place on site only once all other decommissioning activities and associated plant and infrastructure has been removed from the KDA.

7.1.3.3 Storage of Dismantled used Infrastructure Materials

The following measures will be implemented to mitigate potential impacts:

- Dismantled and used materials will be sorted at source;

- Hazardous and contaminated waste will be disposed of the appropriately offsite facilities;
- Landfilling of any waste will be implemented only as a last resort; and
- Any deviations from set environmental requirements and standards during this phase will be addressed immediately.

7.1.3.4 Closure of any Onsite Waste Storage Areas

The following measures will be implemented to mitigate potential impacts:

- The storage areas will be finally shaped and rehabilitated in compliance of a locally approved closure plan and international industry best practices to limit soil, surface and groundwater impacts;
- An approved environmental monitoring plan (boreholes, air, integrity, vegetation etc.) will be implemented to monitor the areas with the most impacts after closure on an ongoing long-term basis for as long as required by the authorities; and
- Any deviations from set environmental requirements and standards during this period will be addressed immediately.

7.2 Mitigation of Impacts at the Export Pipeline

7.2.1 Construction Phase

7.2.1.1 Waste Rock

The following measures will be implemented to mitigate potential impacts:

- Generation of waste rock will be minimal and limited to the escarpment section of the pipeline
- If removed the waste rock will be returned to the trench
- As a last resort the waste rock will be removed to an identified suitably licensed dissal site along the RoW.

7.2.1.2 Domestic / Sanitary Waste Water Discharge

Measures implemented to mitigate potential impacts of sanitary waste water discharge on the environment around the export pipeline would be the same as those identified at the CPF – see Section 7.1.1.2.

7.2.2 Operational Phase

7.2.2.1 Export Pipeline or Flowline Failure

Failure of the export pipeline to Kibaale can be prevented by choosing the right materials suited to the product transported, equipment and appropriate maintenance and testing of the pipeline. Hydrostatic testing by which the pipeline is subjected to pressure above the operating pressure, to blow out defects before they reach a critical size in service should also be used to detect corroded pipe before it fails in service. A pipeline integrity strategy should be compiled; to guide inspection and preventive maintenance to ensure the integrity of the pipeline (Ref. 32).

In order to prevent a catastrophic pipeline failure, a management plan should be developed and measures put in place to clean-up soils and groundwater.

7.2.3 Decommissioning Phase

Measures implemented to mitigate potential impacts on the environment during decommissioning of the export pipeline would be the same as those identified at the CPF – see Section 7.1.3.

8.0 LIMITATIONS

Limitations to this waste study include the following which requires further investigation:

- Confirmation of the types, quantities and hazardous rating of a detailed waste inventory for waste quantities generated during construction of project infrastructure, operation of drillings wells and production of the CPF and well pads;
- Waste classification of wastes generated at the KDA may only be determined in terms of hazardous properties once they are generated and sent for analytical testing; and
- Development of an integrated Waste Management Plan for the proposed Project at the KDA once the project is underway.

9.0 CONCLUSION

This assessment has considered potential waste impacts associated with the proposed Project at the KDA.

Ugandan legislation and guidelines, and International IFC Performance Standards and EHS Guidelines and international best practice were reviewed in the context of the proposed Project.

The baseline study of is based on the estimated waste inventory received from the three O&G companies, including CNOOC and are also based on Golder's experience on past similar O&G projects with similar processes during construction, operation and closure.

Waste impacts associated with the different phases of the Project were then assessed against the adopted evaluation criteria for receptors, including air, soil, surface water, groundwater and vegetation, in the KDA. The impacts during the construction and decommissioning phases are similar mainly limited to the generation of non-hazardous and hazardous waste, the management of wastes, material and chemical handling, and process and domestic / sanitary waste water. Impact during operation relate to these impacts, as in the construction phase, but also include the well drilling, well blow-out and potential infrastructure and pipe failure, Most of the impacts are rated as major or moderate, and in all cases can be reduced to minor through mitigation and management measures.

Mitigation includes the development of a waste management plan for the proposed Project at the KDA, adopting the principles of the waste hierarchy, ensuring international and best practice methods for chemical, material and waste storage, handling, transporting and disposal at suitably licenced facilities.

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APPENDIX A

Document Limitations

DOCUMENT LIMITATIONS

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vii) 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.

viii) 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.

ix) 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.

x) 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.

xi) 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.

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GOLDER ASSOCIATES AFRICA (PTY) LTD

APPENDIX B

Waste Inventory from CNOOC (August 2017)

As a global, employee-owned organisation with over 50 years of experience, Golder Associates is driven by our purpose to engineer earth's development while preserving earth's integrity. We deliver solutions that help our clients achieve their sustainable development goals by providing a wide range of independent consulting, design and construction services in our specialist areas of earth, environment and energy.

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