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Waste Classification Assessment Proposed Co-Disposal Facility at Kangra Maquasa East Operations

Report

Version - Final 1

17 November 2022

Kangra Coal

GCS Project Number: 22-0161_waste

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DECLARATION OF INDEPENDENCE

GCS (Pty) Ltd was appointed to conduct this waste assessment study and to act as the independent specialist. GCS objectively performed the work, even if this results in views and findings that are not favourable. GCS has the expertise in conducting the specialist investigation and does not have a conflict of interest in the undertaking of this study. This report presents the findings of the investigations which include the activities set out in the scope of work.

EXECUTIVE SUMMARY

GCS Water and Environment (Pty) Ltd (GCS) was appointed by Kangra Coal (Pty) Ltd to undertake a waste classification assessment for the coal discard and coal slurry material that will be deposited at the proposed co-disposal facility at Maquasa East, near Driefontein, Mpumalanga Province. The project falls in quaternary catchment W51B of the Pongola to Mtamvuna Water Management Area (WMA) (DWS, 2016).

In summary, the waste streams could be typified as follows (GNR 635, 2013):

- 'Kdiscard1' (coal discard material)– Type 3 (Low Risk); and
- 'kSlurry1 (coal tailings/coal slurry material)- Type 3 (Low Risk).

Hydrocarbon assessment was excluded from the current investigation at the request of the client (not expected to occur in the samples).

None of the waste streams was flammable. Volatile particle sizes were very low.

Acute toxicity hazard classification, Category 5 was assigned to both streams investigated. Si and Al were also considered for both the oral and inhalation routes due to known toxicity effects.

Acute toxicity risk/hazard category results (please refer to Annexure B) based on the DEEEP protocols, were recorded as follows (Persoone, G, et. al., 2003):

- 'KDiscard1' – Class I (No lethal/sub-lethal hazard) (Wt % 0)
- 'KSlurry1' – Class II (Slight lethal/sub-lethal hazard) (Wt % 33).

It should be noted that it is not expected that the ingredients as recorded in the XRF test will leach in the same form or at the same concentrations. For a summary of SANS 10234 classification findings, please refer to Section 4.

The proposed co-disposal facility will be lined with a Class C Barrier, hence environmental risk will be zero if the barrier is installed correctly.

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1 INTRODUCTION

GCS Water and Environment (Pty) Ltd (GCS) was appointed by Kangra Coal (Pty) Ltd to undertake a waste classification assessment for the coal discard and coal slurry material that will be deposited at the proposed co-disposal facility at Maquasa East, near Driefontein, Mpumalanga Province (refer to Figure 1-3). The project falls in quaternary catchment W51B of the Pongola to Mtamvuna Water Management Area (WMA) (DWS, 2016).

1.1 Project background

Kangra Coal is an existing coal mine located in Driefontein, near Piet Retief, in the Mkhondo Local Municipality within the Gert Sibande District Municipality. The Maquasa East (MQE) operations include the historical opencast and underground operations. Kangra is proposing to construct a water treatment plant as well as a co-disposal facility at their Maquasa East operations. The treatment plant will be used to treat water from the existing decant point as well as any surplus water within the mining operations.

1.1.1 Water Treatment Plant:

Decant is currently observed in the form of clear groundwater discharge emanating from the old underground workings at MQE close to the Heyshope Dam. This decant is observed at an elevation range of approx. 1303 to 1306 mamsl and is contained in an unlined contamination dam. This excess decant is currently pumped from the unlined dam back to the MQE PCDs. Based on available data from previous studies undertaken at the mine decant observed emanating from the old workings occurs at a rate ranging from 1 220 to 2 700 m^3/d (average 1 800 m^3/d), depending on the rainfall season.

Kangra intends to upgrade the current contamination dam with a correctly lined dam as approved by the Department of Water and Sanitation to prevent any seepages onto the Heyshope Dam. The decant will be pumped into the proposed wastewater treatment plant that will be situated close to the Maquasa East PCDs. Construction and operation of the discussed infrastructure will trigger listed activities that will require authorisation.

The master layout plan associated with the proposed water treatment plant and brine storage facilities proposed (and existing PCDs) is shown in Figure 1-1.

It should also be noted that Kangra is investigating the possibility of storing brine on the discard dump/co-disposal that will come from the water treatment plant. This is one of the two options, with the other being dedicated brine evaporation ponds. GCS has not yet received confirmation as to which option Kangra are opting for, thus impacts relating to both are considered in this assessment.

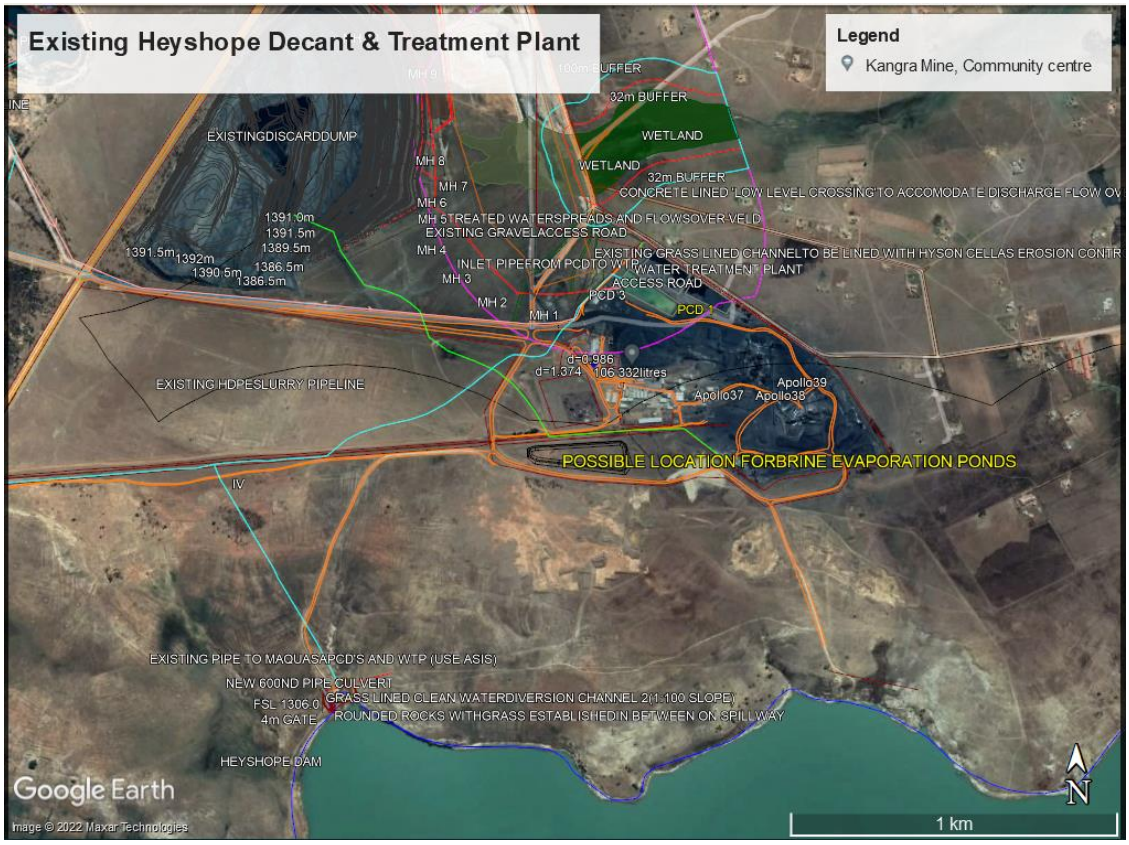

Figure 1-1: Proposed WTP and possible brine evaporation pond

1.1.2 Co-Disposal Facility

The discard dump at MQE has an approved environmental authorisation and a water use license. As a result of changing operational requirements, there is now a need for a co-disposal facility at MQE, this co-disposal facility is not authorised.

- The co-disposal facility will be located within the MQE operation on the remaining (RE) portion of the farm Rooikop 18 HT. The co-disposal facility will accommodate discarded produced from the benefaction plant located at Maquasa East, which currently washes and processes coal from the surrounding Kangra Coal operations and will receive coal from future expansion areas.
- This discard dump was originally designed as a three-compartment side hill-type dump with a footprint of approximately 65ha. The three-compartment layout allows for a modular implementation approach with the benefit of delaying capital expenditure. The implementation of this project will be done in two phases:
- Phase 1 will entail the use of the approved discard dump, and
- Phases 2 and 3 will entail the use of a co-disposal facility that requires authorisations.

In the phases, the plan is to build the full waste dump over 20 years. Phase 1 (7 years capacity), Phase 2 (7 years capacity), and Phase 3 (6 years capacity). GFK are undertaking detailed designs of the dump, as well as stormwater sizing. The facility will be lined with an impermeable barrier. The layout plan for the co-disposal facility is shown in Figure 1-2.

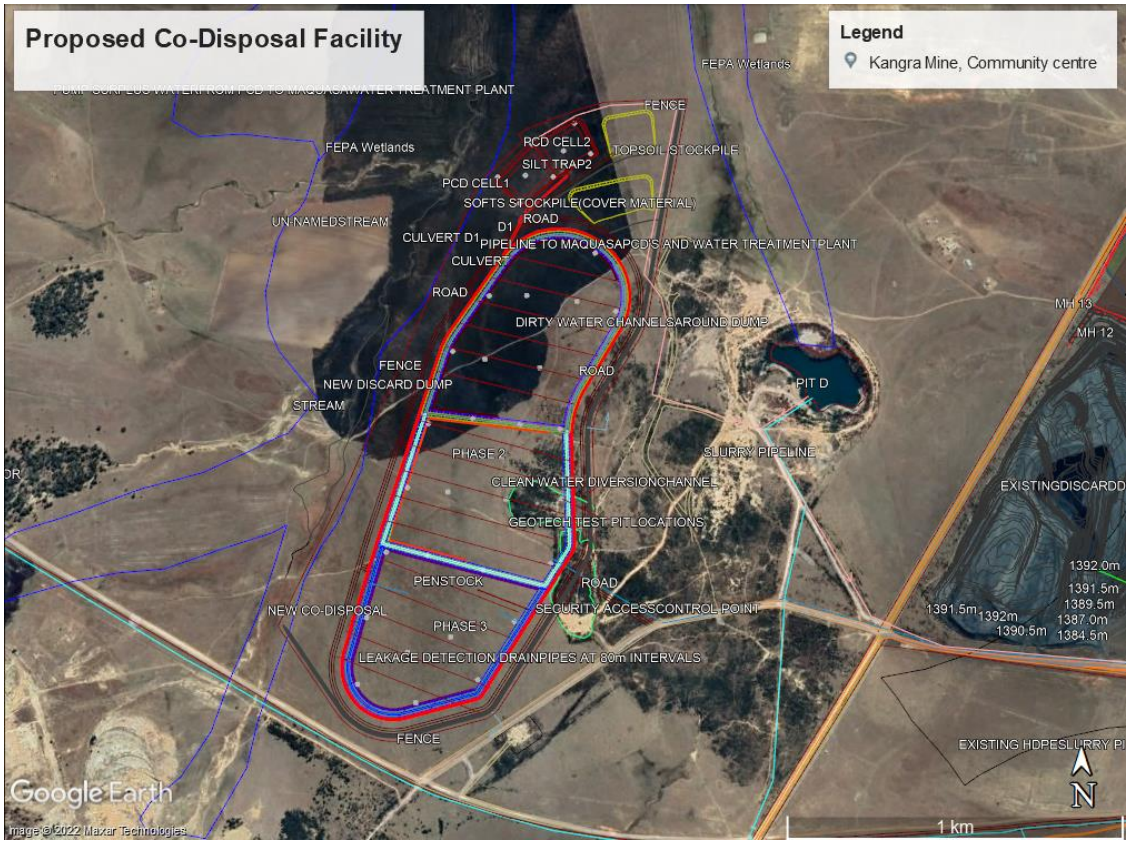

Figure 1-2: Proposed Co-Disposal Facility (Phase 1 already approved, Phase 2 & 3 will be co-disposal)

1.2 Objectives

The objective of this report is to provide the classification data for coal discard and coal slurry waste streams designated for co-disposal. The reason for this classification is for compliance to regulatory stipulations & standards, whereby it will be assessed and determined if the waste stream contains hazardous components of concern and whether there would be an associated risk to the surrounding environment (physical, health and/or environmental) according to the classification standards, SANS 10234 (2008).

1.3 Scope of Work

The classification was conducted per the following regulatory stipulations:

- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), 1 July 2009.
- National Environmental Management: Waste Amendment Act, 2014 (Act No. 26 of 2014). GG37714, 2 June 2014.
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). Waste Classification and Management Regulations, GG36784, GNR 634, 23 August 2013.

- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). National Norms and Standards for the Assessment of Waste for Landfill Disposal, GG36784, GNR 635, 23 August 2013.
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). National
- Norms and Standards for Disposal of Waste to Landfill, GG36784, GNR 636, 23 August 2013.
- GGN39020 GNR 632 of July 2015: NEMWA Regulations regarding the planning and management of residue stockpiles and residue deposits from a prospecting mining, exploration or production operation
- South African National Standard. SABS Standards Division. Globally Harmonized System of Classification and labelling of chemicals (GHS). SANS 10234 (2008). Edition 1.1.

Assessment analyses were performed in alignment with the stipulations found in the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), GG. 36784, GNR 635 National Norms & Standards for Assessment of Waste for Disposal to Landfill (2013) (Australian Standard Leaching Procedures (AS 4439.1 – 3, 1997 - 1999).

Leachable variable concentrations will be determined from a distilled water leach (ratio 1:20) as per regulatory stipulations (GNR 635, 2013), to fit a mono-disposal scenario, as well as a TCLP leach (1:20), together with total concentrations (TC) as specified in these regulations.

1.4 Limitations of this classification

No organic (hydrocarbon) components were tested for in the current investigation, as waste streams were sampled directly from the plants. Hence, no hydrocarbon contamination is anticipated.

Although Aquatico is an accredited facility it is not accredited for the waste analyses method. Certain components of the analysis package have been outsourced to laboratories with experience in executing the specified procedures according to legislative requirements (as far as possible) until a laboratory is established which is accredited for the waste analyses method (stipulated in the Australian Standard Leaching Procedure) (AS 4439.1 – AS 4439.3).

It should be noted that all findings and inferences made in this report are solely based on the limited data available from this investigation and thus it should be consolidated with other specialist investigations on the area (e.g., geohydrology reports, etc.) where applicable, to take a holistic approach with regards to predictions based on the proposed scenario.

In doing so adequate management and/or mitigative measures and procedures can be established and considered for implementation. Disposal requirements will be discussed in light of the GNR 636 (2013).

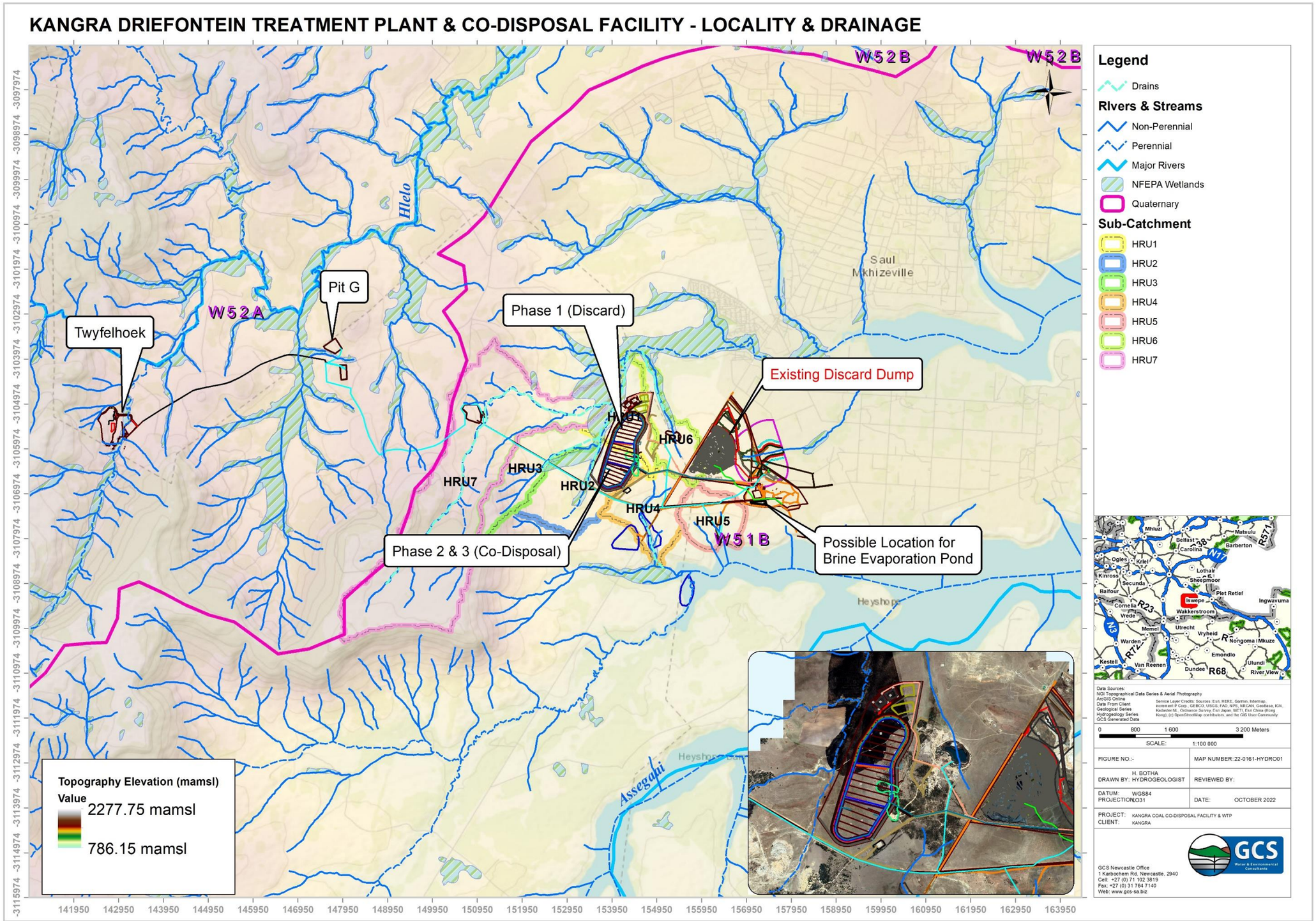

Figure 1-3: Site locality and drainage

2 WASTE CLASSIFICATION

Two (2) samples were collected from Kangra Driefontien/Maquasa Operations, namely a coal slurry sample *Kslurry1" and a coal discard sample "Kdiscard1". The samples will be co-disposed at the proposed co-disposal facility. The samples were submitted to Aquatico Laboratories (SANAS Testing Laboratory T0685) for material analyses and SDS generation.

2.1 Definitions

Definitions were derived from the above-mentioned regulatory documents (see Section 1 of this report), as well as those illustrated in the references. Some are quoted from the SANS 10234 (2008) standards. If any further references are not given here, please refer to the standard.

Residue Stockpiles & Residue Deposits

According to (2)(b) of Annexure 1 (NEM: WAA, 2014) the definition of a "residue stockpile" is as follows: any debris, discard, tailings, slimes, screening, slurry, waste rock, foundry sand, mineral processing plant waste, ash or any other product derived from or incidental to a mining operation and which is stockpiled, stored or accumulated within the mining area for potential re-use, or which is disposed of, by the holder of a mining right, mining permit or, production right or an old order right, including historic mines and dumps created before the implementation of this Act [and]:

Residue Deposits: any residue stockpile remaining at the termination, cancellation or expiry of a prospecting right, mining right, mining permit, exploration right or production right.

Residue deposits and residue stockpiles include:

1. Wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals:
    a. Wastes from mineral excavation
    b. Wastes from physical and chemical processing of metalliferous minerals
    c. Wastes from physical and chemical processing of non-metalliferous minerals
    d. Wastes from drilling muds and other drilling operations [wastes]

Total Concentrations (TC): "…the Total Concentration of a particular element or chemical substance in a waste, expressed as mg/Kg."

Leachable Concentrations (LC): "…the Leachable Concentration of a particular element or chemical substance in a waste, expressed as mg/l."

Based on the above-mentioned definitions, the Total Concentrations (TC) are indicative of the total amount of any element or chemical substance (as listed in the regulations and/or tested for) that is present in the waste stream, whereas the Leachable Concentrations (LC) are indicative of the amount (in mg/l) of those particular elements/chemical substances, identified in the TC, that tends to leach from the solid under the conditions created during the test and the ratio of leaching fluid to solid

Waste Classification: means establishing -

1) Whether a waste is hazardous based on the nature of its physical, health and environmental hazardous properties (hazard classes); and
2) The degree or severity of hazard posed (hazard categories);

- AMD (Acid Mine Drainage) – Occurs when sulphur-containing minerals (e.g. pyrite or iron-sulphide) in geological strata are exposed to oxygen and water to form acidic (pH<5) leaches laden with metals and sulphates.
- Acute Toxicity – "Adverse effects occurring after oral or dermal administration of a single dose of a substance, or multiple doses are given within 24h or an inhalation exposure of 4h."
- AP (Acid Potential) – The potential of a rock/soil sample to generate acid when leaching.
- Carcinogen – "Chemical substance or a mixture of chemical substances which induce cancer or increase its incidence when inhaled, ingested or absorbed through the skin."
- Chronic aquatic toxicity – "Potential or actual properties of a substance to cause adverse effects to aquatic organisms during exposures that are determined about the life-cycle of the organism. "
- Class II Slight Acute/Chronic Environmental Toxicity Hazard – When the percentage effect observed in at least one toxicity test is markedly higher than in the control, but the effect levels are below 50% (TU is <1).
- EC50 – "Concentration of a substance, in milligrams per litre of water, that causes the maximum response to 50% of a population of Daphnia (water flea) and crustacea."
- Hazard Category – "Division of criteria within each hazard class, for example, oral acute toxicity includes five hazard categories and flammable liquids include four hazard categories. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally."
- Hazard class – "Nature of the physical, health or environmental hazard, for example, flammability, carcinogenicity or acute toxicity."

- Hazard statement – "statement assigned to a hazard class and category that describes the nature of the hazards of a hazardous product, including, where appropriate, the degree of hazard."
- LC50 – "Concentration of a substance in the air or in water which causes the death of 50% of a group of test organisms."
- LD50 – "Concentration of a substance, expressed in milligrams per kilogram of body mass, which causes the death of 50% of a group of test animals when ingested, or exposed to the bare skin, all at once."
- NP (Neutralisation Potential) – Describes the ability of rock (based on the amount of alkaline material) to neutralise acid leaches.
- NNP (Nett Neutralisation Potential) – is the difference between the NP and the AP.
- NPR (Neutralising Potential Ratio) – reflects the ratio of AP to NP.
- Precautionary statement – "Phrase or pictogram (or both) that describes recommended measures that should be taken into account to minimise or prevent adverse effects resulting from exposure to a hazardous product, or improper storage or handling of a hazardous product."
- XRF (X-Ray Fluorescence) – Analytical technique used to determine the chemical composition of a sample by measuring the fluorescent x-ray emitted from a sample after being subjected to an x-ray source.

2.2 Waste assessment screening criteria

General Notices (GNR) 634, 635 & 636 were released in the Government Gazette (2013) and describe a classification system for waste. These guidelines stipulate the use of the Australian Standard Leaching Procedure (ASLP), to determine Total Concentrations (TC) and Leachable Concentrations (LC) for specified variables, both inorganic and organic, ultimately establishing suitability for landfill disposal in alignment with the objectives stated above. Test work was carried out by Aquatico Laboratories (Pty) Ltd.

The leaches were performed at a 1:20 liquid/solid ratio as prescribed in the method referred to in the regulations, however, it should be noted that this ratio would not normally be expected to occur naturally in the environment and represents an absolute worst-case scenario, wherein leaching is attempted induced, to determine what concentration of any particular element, has potential for leaching/risk.

It is important to note that the leaching of any element from the solid phase can be influenced by various factors, such as, among others, particle size, surface area, redox potential, pH, biological influences, etc. These conditions are not always relevant in the natural environment and those that do occur in the natural environment from where a sample was collected are not all replicable in situ.

In GNR 635, three categories are specified for leaching, dependent on the aims of disposal. According to Section (5)(2)(a), (b) & (c) these are:

a) Waste to be disposed of with, or waste that contains, putrescible wastes: Use 0.1M acetic acid solution with altered pH 5.0 or pH 2.9 determined as per section 7.5(a-e) of AS 4439.3;

b) Waste to be disposed of with non-putrescible waste: Use a basic 0.1M sodium tetraborate decahydrate solution of pH 9.2 ±0.1, as well as an acetic acid solution (with pH 5.0 or pH 2.9) determined as per section 7.5(a-e) of AS 4439.3; or

c) Non-putrescible waste to be disposed of without any other wastes: Use reagent water.

In the current scenario, the objective involves either mono-disposal (unto a discard dump) or co-disposal (e.g., backfilling into an opencast pit) and therefore distilled water (reagent water) - and TCLP leaches were selected.

Total Concentrations (TC) were determined by the use of microwave-assisted digestion where a dilution ratio of 100:1 is commonly used.

2.2.1 Determining Waste Types

GNR 635, Section 7(2) stipulates (refer to Figure 2-1).

a) Wastes with any element or chemical substance concentration above the LCT3 or TCT2 limits (LC>LCT3 or TC>TCT2) are Type 0 wastes;

b) Wastes with any element or chemical substance concentration above the LCT2 but below or equal to the LCT3 limits, or above the TCT1 but below or equal to the TCT2 limits (LCT2<LC≤LCT3 or TCT1<TC≤TCT2), are Type 1 Wastes;

c) Wastes with any element or chemical substance concentration above the LCT1 but below or equal to the LCT2 limits and all concentrations below or equal to the TCT1 limits (LCT1<LC≤LCT2 and TC≤TCT1) are Type 2 Wastes;

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

e) Wastes with all element and chemical substance concentration levels for metal ions and inorganic anions below or equal to the LCT0 and TCT0 limits (LC≤LCT0 and TC≤TCT0), and with all chemical substance concentration levels also below the following total concentration limits for organics and pesticides, are Type 4 Wastes.

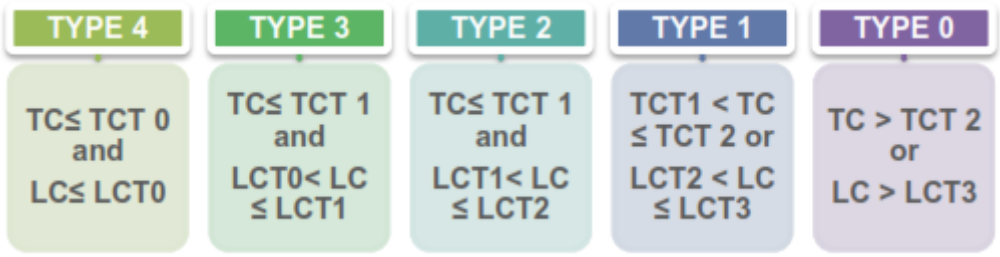

Figure 2-1: Waste classification based on GN R. 634 of 2013 Waste Standards

2.3 Waste assessment laboratory results

The paste pH levels detected in the waste streams were:

- KSlurry1 – Paste pH 7.94 (neutral range pH 6.0 – 8.5); and
- KDiscard1 - Paste pH 7.34 (neutral range pH 6.0 – 8.5).

It is assumed for this report that the paste pH levels recorded would remain stable, with no significant fluctuations.

Results for the TCT, LCT and LCT test for both samples are summarised in Table 2-1 to Table 2-2. Hydrocarbons are not expected to be present in any one of the two waste streams, based on previous assessment results and were therefore excluded.

Laboratory certificates are available in **Appendix A**.

Table 2-1: TCT & LCT (TLCP Leach), 'KSlurry1', October 2022

WASTE ASSESSMENT - DATA TABLE				
PROJECT NAME		GCS - Waste		Guideline for Compliance - GNR 635 (2013) - National Norms & Standards for the Assessment of Waste for Landfill Disposal
Total Concentration-Sample Dry Mass (g)	1	DATE COMPILED	14 November 2022	
Total Concentration-Sample Volume (ml)	50	DATE SAMPLED	10 October 2022	
Leachable Concentrations - Sample Dry Mass (g)	20	COMPILED BY	Theodore Meyer	
Leachable Concentrations - Sample Volume (ml)	400	LOCALITY NAME	KSlurry1	

Total Concentration Solids					
VARIABLE	Guideline Limits (mg/kg)			Variable Concentration (mg/l)	Variable Concentration (mg/kg)
	TCT0	TCT1	TCT2		
Paste pH (1:2)	-	-	-	-	7.94
Iron as Fe	-	-	-	662	33100
Total Cyanide as CN	14	10500	42000	<0.100	<5.00
Redox	-	-	-	-	135
Arsenic as As	5.8	500	2000	0.076	3.8
Boron as B	150	15000	60000	<1.50	<75.0
Barium as Ba	62.5	6250	25000	5.66	283
Cadmium as Cd	7.5	260	1040	<0.075	<3.75
Cobalt as Co	50	5000	20000	<0.500	<25.0
Chromium as Cr	46000	800000	-	6	300
Copper as Cu	16	19500	78000	0.454	22.7
Mercury as Hg	0.93	160	640	<0.009	<0.450
Manganese as Mn	1000	25000	100000	6.19	310
Molybdenum as Mo	40	1000	4000	0.646	32.3
Nickel as Ni	91	10600	42400	0.588	29.4
Lead as Pb	20	1900	7600	0.634	31.7
Antimony as Sb	10	75	300	<0.100	<5.00
Selenium as Se	10	50	200	<0.100	<5.00
Vanadium as V	150	2680	10720	<1.00	<50.0
Zinc as Zn	240	160000	640000	<1.00	<50.0
Aluminium (Al)	-	-	-	202	10100
Total Fluoride (F)	100	10000	40000	-	192
Hexavalent chromium (Cr^{6+})	6.5	500	2000	-	<5
Moisture %	-	-	-	-	8.39

Leachable Concentrations - TCLP					
VARIABLE	Guideline Limits (mg/l)				Variable Concentration (mg/l)
	LCT0	LCT1	LCT2	LCT3	
Aluminium as Al	-	-	-	-	<2.00
Iron as Fe	-	-	-	-	<2.00
Total Cyanide as CN	0.07	3.5	7	28	<0.01
Total oxidised nitrogen as N	-	-	-	-	<10.0
Arsenic as As	0.01	0.5	1	4	<0.010
Boron as B	0.5	25	50	200	<0.500
Barium as Ba	0.7	35	70	280	<0.700
Cadmium as Cd	0.003	0.15	0.3	1.2	<0.003
Cobalt as Co	0.5	25	50	200	<0.400
Chromium as Cr	0.1	5	10	40	<0.100
Hexavalent chromium (Cr^{6+})	0.05	2.5	5	20	<0.020
Copper as Cu	2	100	200	800	<1.00
Mercury as Hg	0.006	0.3	0.6	2.4	<0.006
Manganese as Mn	0.5	25	50	200	4.68
Molybdenum as Mo	0.07	3.5	7	28	0.098
Nickel as Ni	0.07	3.5	7	28	<0.070
Lead as Pb	0.01	0.5	1	4	<0.010
Antimony as Sb	0.02	1	2	8	<0.020
Selenium as Se	0.01	0.5	1	4	<0.010
Vanadium as V	0.2	10	20	80	<0.200
Zinc as Zn	5	250	500	2000	<2.00
Total Dissolved solids @ 180°C	1000	12500	25000	100000	6612
Chloride as Cl	300	15000	30000	120000	<50.0
Sulphate (SO_4)	250	12500	25000	100000	484
Nitrate (NO_3) as N	11	550	1100	4400	<10.0
Fluoride as F	1.5	75	150	600	<1.00

Table 2-2: TCT & LCT (TLCP Leach), 'KDiscard1', October 2022

WASTE ASSESSMENT - DATA TABLE				
PROJECT NAME		GCS - Waste		Guideline for Compliance - GNR 635 (2013) - National Norms & Standards for the Assessment of Waste for Landfill Disposal
Total Concentration-Sample Dry Mass (g)	1	DATE COMPILED	14 November 2022	
Total Concentration-Sample Volume (ml)	50	DATE SAMPLED	10 October 2022	
Leachable Concentrations - Sample Dry Mass (g)	20.2	COMPILED BY	Theodore Meyer	
Leachable Concentrations - Sample Volume (ml)	400	LOCALITY NAME	KDiscard1	

Total Concentration Solids					
VARIABLE	Guideline Limits (mg/kg)			Variable Concentration (mg/l)	Variable Concentration (mg/kg)
	TCT0	TCT1	TCT2		
Paste pH (1:2)	-	-	-	-	7.34
Iron as Fe	-	-	-	726	36300
Total Cyanide as CN	14	10500	42000	<0.100	<5.00
Redox	-	-	-	-	85
Arsenic as As	5.8	500	2000	0.232	11.6
Boron as B	150	15000	60000	<1.50	<75.0
Barium as Ba	62.5	6250	25000	7.92	396
Cadmium as Cd	7.5	260	1040	<0.075	<3.75
Cobalt as Co	50	5000	20000	<0.500	<25.0
Chromium as Cr	46000	800000	-	1.5	75
Copper as Cu	16	19500	78000	0.316	15.8
Mercury as Hg	0.93	160	640	<0.009	<0.450
Manganese as Mn	1000	25000	100000	3.19	160
Molybdenum as Mo	40	1000	4000	0.673	33.7
Nickel as Ni	91	10600	42400	0.621	31.1
Lead as Pb	20	1900	7600	0.471	23.6
Antimony as Sb	10	75	300	<0.100	<5.00
Selenium as Se	10	50	200	<0.100	<5.00
Vanadium as V	150	2680	10720	<1.00	<50.0
Zinc as Zn	240	160000	640000	1.6	80
Aluminium (Al)	-	-	-	350	17500
Total Fluoride (F)	100	10000	40000	-	308
Hexavalent chromium (Cr^{6+})	6.5	500	2000	-	<5
Moisture %	-	-	-	-	4.27

Leachable Concentrations - TCLP					
VARIABLE	Guideline Limits (mg/l)				Variable Concentration (mg/l)
	LCT0	LCT1	LCT2	LCT3	
Aluminium as Al	-	-	-	-	<2.00
Iron as Fe	-	-	-	-	<2.00
Total Cyanide as CN	0.07	3.5	7	28	<0.01
Total oxidised nitrogen as N	-	-	-	-	<10.0
Arsenic as As	0.01	0.5	1	4	<0.010
Boron as B	0.5	25	50	200	<0.500
Barium as Ba	0.7	35	70	280	<0.700
Cadmium as Cd	0.003	0.15	0.3	1.2	<0.003
Cobalt as Co	0.5	25	50	200	<0.400
Chromium as Cr	0.1	5	10	40	<0.100
Hexavalent chromium (Cr^{6+})	0.05	2.5	5	20	<0.020
Copper as Cu	2	100	200	800	<1.00
Mercury as Hg	0.006	0.3	0.6	2.4	<0.006
Manganese as Mn	0.5	25	50	200	2.33
Molybdenum as Mo	0.07	3.5	7	28	0.08
Nickel as Ni	0.07	3.5	7	28	<0.070
Lead as Pb	0.01	0.5	1	4	<0.010
Antimony as Sb	0.02	1	2	8	<0.020
Selenium as Se	0.01	0.5	1	4	<0.010
Vanadium as V	0.2	10	20	80	<0.200
Zinc as Zn	5	250	500	2000	<2.00
Total Dissolved solids @ 180°C	1000	12500	25000	100000	5636
Chloride as Cl	300	15000	30000	120000	<50.0
Sulphate (SO_4)	250	12500	25000	100000	113
Nitrate (NO_3) as N	11	550	1100	4400	<10.0
Fluoride as F	1.5	75	150	600	<1.00

2.4 Geochemical assessment results

2.4.1 XRF Results

XRF results for the waste streams are summarized in Table 2-3 and waste stream composition based on XRF is presented in Table 2-4.

Table 2-3: XRF results for the representative samples collected in October 2022

VARIABLE	UNITS	MONITORING LOCALITIES	
		KDiscard1	KSlurry1
Fe_2O_3	%	4.68	5.56
SiO_2	%	34.41	54.07
Al_2O_3	%	9.53	7.78
K_2O	%	1.42	2.11
P_2O_5	%	0.06	0.04
Mn_3O_4	%	0.03	0.04
CaO	%	3.39	3.23
MgO	%	0.45	0.35
TiO_2	%	0.51	0.44
Na_2O	%	0.37	0.44
V_2O_5	%	0.01	0.01
BaO	%	0.09	0.09
Cr_2O_3	%	0.04	0.09
SrO	%	0.06	0.05
ZrO_2	%	0.04	0.05
MnO	%	0.03	0.04
LOI	%	44.35	22.90
Total XRF (oxides)	%	99.44	97.26

Table 2-4: Waste stream Compositions (XRF)

VARIABLE	UNITS	MONITORING LOCALITIES	
		KDiscard1	KSlurry1
Fe	%	3.270	3.892
Si	%	16.085	25.275
Al	%	5.043	4.117
K	%	1.178	1.755
P	%	0.027	0.018
Mn	%	0.021	0.029
Ca	%	2.425	2.308
Mg	%	0.272	0.212
Ti	%	0.303	0.263
Na	%	0.275	0.326
V	%	0.006	0.006
Ba	%	0.083	0.079
Cr	%	0.027	0.063
Sr	%	0.053	0.041
Zr	%	0.030	0.037
Mn	%	0.021	0.029
LOI	%	44.350	22.897
Total XRF (oxides)	%	99.440	97.257

2.4.2 Waste assessment

From the results obtained in the waste streams tested, the following summary of exceedances was identified:

- In the 'KSlurry1' sample, the Ba, Cu, Pb and total F concentrations exceeded the TCT0 limits and were all recorded below the TCT1 limits. None of these variables exceeded the TCLP leach; however, the Mn, Mo, TDS and SO_4 variables exceeded the LCT0 limit (all of these variables were recorded below the LCT1 limits).
- In the 'KDiscard1' sample, the As, Ba, Pb and total F concentrations exceeded the TCT0 limits and were all recorded below the TCT1 limits. None of these variables exceeded the TCLP leach; however, the Mn, Mo and TDS variables exceeded the LCT0 limit (all of these variables were recorded below the LCT1 limits).

2.5 Waste type determination (GNR 635, 2013)

Section 7 of the GNR 635 (2013) stipulates waste type determination (refer to section 8.2 of this report). A summary of the different categories is illustrated in Table 2-5, below.

Table 2-5: Waste Types for Landfill Disposal

LC > LCT3; TC > TCT2	Type 0
LCT2 < LC ≤ LCT3; TCT1 < TC ≤ TCT2	Type 1
LCT1 < LC ≤ LCT2; TC ≤ TCT1	Type 2
LCT0 < LC ≤ LCT1; TC ≤ TCT1	Type 3
LC ≤ LCT0; TC ≤ TCT0	Type 4

The regulation (GNR 635, 2013) also makes additional comments to classification criteria, such as:

- If a particular substance in a waste stream is not listed with LCT and TCT threshold values and the stream has been classified as hazardous (SANS 10234 health and/or environmental conditions), the waste is considered to be a type 1 waste.
- If the TC for a particular element/substance exceeds the TCT2 limit and its concentration cannot be reduced to below this limit, but the LC is below the LCT3 limit, it is considered a type 1 waste.
- Pre-listed wastes (Annexure 1 f GNR 636, 2013) are considered Type 1 wastes (unless assessed and determined otherwise).
- Waste streams with all element/chemical metal ions and inorganic anion concentrations below or equal to the LCT0 limits are considered Type 3 wastes, irrespective of their total concentrations (if compliant with the listed criteria).

2.6 Pollution Barrier Requirements (GNR 636, 2013)

Pollution barriers required for the waste type identified are listed in Table 2-6.

Table 2-6: Pollution barrier requirements as per GNR 636 (2013)

Waste Type	Landfill Disposal Requirements
Type 0 Waste	The disposal of Type 0 waste in landfills is not allowed. The waste must be treated and re-assessed in terms of the Norms & Standards for the Assessment of Waste for Landfill Disposal
Type 1 Waste	Type 1 waste may only be disposed of at a Class A landfill designed per Section 3(1) and (2) of these Norms and Standards, or, subject to Section 3(4) of these Norms & Standards, may be disposed of at a landfill site designed per the requirements for a Hh/HH landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 2 Waste	Type 2 waste may only be disposed of at a Class B landfill designed per Section 3(1) and (2) of these Norms & Standards, or, subject to section 3(4) of these Norms & Standards, may be disposed of at a landfill site designed per the requirements for a GLB+ landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 3 Waste	Type 3 waste may only be disposed of at a Class C landfill designed per sections 3(1) and (2) of these Norms & Standards, or, subject to section 3(4) of these Norms & Standards, may be disposed of at a landfill site designed per the requirements for a GLB+ landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).
Type 4 Waste	Type 4 waste may only be disposed of at a Class D landfill designed per sections 3(1) and (2) of these Norms & Standards, or, subject to section 3(4) of these Norms & Standards, may be disposed of at a landfill site designed per the requirements for a GLB- landfill as specified in the Minimum Requirements for Waste Disposal by Landfill (2nd Ed., DWAF, 1998).

Both waste streams in the current investigation could be classified as **Type 3 wastes**, posing low risk to the receiving environment. The waste requires a Class C barrier or equivalent for long-term disposal and temporary storage (refer to Figure 2-2).

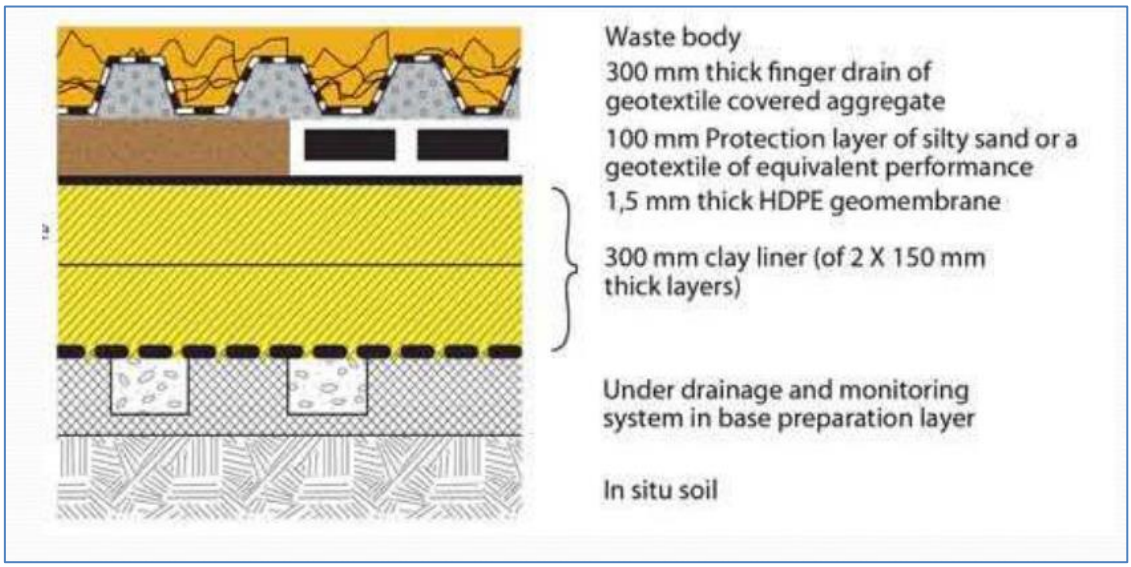

Figure 2-2: Class C Barrier

3 SANS 10234 (2008) CLASSIFICATION – GHS

The SANS 10234 (2008) standard contains the harmonised criteria for the classification of hazardous substances and mixtures (including waste), to ensure safe transport and use concerning potential physical health and environmental hazards. It provides valuable information and contains the harmonised elements of labelling and safety data sheets. Criteria and minimum requirements for the latter are also included. All definitions and abbreviations as per SANS 10234: 2008 apply.

The two waste streams in question in this investigation were classified according to the hazardous characteristics and categories, as well as the severity of those hazardous components where/if relevant. Physical hazards were assessed as far as possible and available data will be presented in section 10.5.1 below, however, classification will be based mainly on chemical characteristics potentially leading to health and environmental risk.

3.1 Physical Hazards

The majority of physical analyses were not tested for or not applicable (N/A). Physical hazards include:

Physical hazards include:

1. 1Explosives (N/A)
2. Flammable Gasses (N/A)
3. Flammable Aerosols (N/A)

4. Oxidizing Gasses (N/A)
5. Gasses under pressure (N/A)
6. Flammable Liquids (N/A)
7. Flammable Solids
    a. 'KDiscard1' – Negative at 30, 60 and 90 degrees Celsius - sample has no flammability).
    b. 'KSlurry1' – Negative at 30, 60 and 90 degrees Celsius - sample has no flammability).
8. Self-reactive Substances & Mixtures (N/A)
9. Pyrophoric Substances (N/A)
10. Self-heating Substances & Mixtures (N/A)
11. Substances & Mixtures that, on contact with water, emit flammable gasses (N/A)
12. Oxidising Substances & Mixtures (N/A)
13. Organic Peroxides (N/A)
14. Corrosive to Metals (N/A) Density:
    a. 'KDiscard1' SG = 2.087 g/cm3
    b. 'KSlurry1' SG = 2.335 g/cm3

3.2 Health Hazards

For classification, the XRF analysis was conducted, to determine sample composition and will be used for Acute Toxicity Estimate (ATE) calculations on the inorganic sample fraction (refer to online references RTECS & ECHA CLP) where applicable. XRF is usually sufficient for mine mineral waste samples.

3.2.1 Toxicity Categories & Exposure Routes

There are five acute toxicity categories into which chemical substances can be allocated based on different exposure routes. The selected route of exposure for these waste streams is the oral route, although inhalation could potentially also be a route of concern. Acute toxicity via oral, dermal or inhalation routes, per the cut-off values provided in the SANS 10234 Standard, was investigated and included where sufficient data was obtained. Gases and vapours were not deemed applicable in this study and toxicological information is also very limited. Known LC50 values for inhalation routes were even more limited. As insufficient pharmacodynamic and pharmacokinetic data were readily available, provisions for 10.1.2.4.2.4 (SANS 10234) were implemented where necessary for unknown ingredients, based on wt%.

According to 10.1.2.4.1.1 (SANS 10234), ingredients falling into any of the GHS categories should be included, however, ingredients can be ignored if the oral test limit does not show acute toxicity at 2000 mg/Kg body weight (BW). The standard indicates that the classification of mixtures for acute toxicity is only needed for a single route of exposure, provided that the same route of exposure is followed for all the ingredients. The rat is the accepted test species for oral and inhalation routes.

A conservative approach was implemented wherein the lowest ATE value for an element (i.e., ensuring the highest toxicity potential) was used, where database information contained more than one value for the same exposure route.

Cut-off values/concentration limits for hazard classes according to the SANS 10234 (for inclusion in SDS – refer to **Appendix B**):

- Elemental composition of ≥ 1.0% that contributes to acute toxicity, skin corrosion, skin irritation, serious damage to eyes, eye irritation, respiratory sensitisation, skin sensitisation, mutagenicity (Category 2), target organ systemic toxicity (with single or repeated exposure), or if it is hazardous to the aquatic environment.
- Elemental composition of ≥ 0.1% that contributes to mutagenicity (Category 1), carcinogenicity or reproductive toxicity.

3.2.2 A – Acute Toxicity

According to the results, Fe, Si, Al, K, Ca and S ("ingredients") recorded above the 1% cut-off value. These "ingredients" are not included as high-risk species in the waste assessment criteria (GNR 635, 2013), however, some toxicity data, albeit limited, are available for these elements. Furthermore, Fe, Si, Al, K, Ca, Mg, Ti, Na, Ba and S concentrations all exceeded the cut-off value of 0.1%.

LOI refers to the fraction of components that escaped (i.e., volatile components) from the mixture when heated to a certain temperature and these are not taken into consideration. The additivity formula (see below) was applied (see SANS 10.1.2.4.1.2) to determine Acute. Toxicity Estimates (ATEs) for the mixture, based on concentrations of the relevant ingredients, as well as unknown fractions (dilution effects):

$$\frac{100}{ATEmix} = \sum_{n=1}^{\infty} \left(\frac{Ci}{ATEi}\right)$$

ATE	=	*Acute Toxicity Estimate (e.eg. LD50 / LC50)*
Ci	=	*Concentration of ingredient i*
I	=	*Individual Relevant ingredient from 1 to n*
N	=	*Number of ingredients*

It should be noted that ATEs for individual elements could exert different effects when in molecular forms, however for this investigation it is expected that when leaching occurs, the elemental form will be of consequence.

The calculated ATE values for the 'Kdiscard1', as well as the 'Kslurry1' streams, lead to classification as Category 5 waste, based on the oral exposure route. Dermal and inhalation routes were also considered (refer to Table 3-1 and Table 3-2).

Table 3-1: Classification for 1.00% cut-off value where stipulated effects may arise

Ingredients equal to or exceeding the 1.00% Cut-off Value		
Oral Toxicity	**KSlurry1**	**KDiscard1**
Calculated ATE	>5000 mg/Kg	>5000 mg/Kg
Acute Toxicity Category	Category 5	Category 5
Symbol	No Symbol	No Symbol
Signal Word	Warning	Warning
Hazard Statement	May be Harmful if Swallowed	May be Harmful if Swallowed
Additional Statements	4.06% of the mixture consists of ingredients of unknown toxicity.	3.6% of the mixture consists of ingredients of unknown toxicity.

Table 3-2: Classification for 0.1% cut-off value where stipulated effects may arise

Ingredients equal to or exceeding the 0.1% Cut-off Value		
Oral Toxicity	**KSlurry1**	**KDiscard1**
Calculated LD50 or LC50	>5000 mg/Kg	>5000 mg/Kg
Acute Toxicity Category	Category 5	Category 5
Symbol	No Symbol	No Symbol
Signal Word	Warning	Warning
Hazard Statement	May be Harmful if Swallowed	May be Harmful if Swallowed
Additional Statements	4.65% of the mixture consists of ingredients of unknown toxicity.	4.18% of the mixture consists of ingredients of unknown toxicity.

Of the above-mentioned elements and available information, only Iron (Fe) contained an LD50 concentration below 2000 mg/Kg for the oral exposure route. The remaining ingredients either exceeded this limit or no data/insufficient data, was available on the RTECS and alternative databases. Other main ingredients of concern (i.e., with known acute toxicity) concerning other exposure routes, were Silica (Si) and Aluminium (Al). Other ingredients deemed relevant to the classification, were also considered. Data was not extrapolated between different test animals or exposure routes.

3.3 Background Information

3.3.1 A: Silica (Si)

Like many other elements, Silica occurs in several minerals that are found naturally in the earth's crust and trace amounts of silica are generally present in all soils. Si is present in various minerals, sedimentary, igneous and metamorphic rocks (e.g., Quartz, Biotite, Vermiculite Hornblende, Anorthoclase, etc.). Si is considered to be chemically unreactive and poorly water-soluble in the environment (EPA, 1991 & IARC, 1997).

Free Silica (SiO2) is generally found in two forms: crystalline and amorphous (the former presents a more serious health risk than its amorphous form). Under certain circumstances, the surface chemistry of Si may vary and amorphous Si may, for instance, contain crystalline Si (Williams, et. al., 2019). Understanding the type of silica that is present is imperative to understanding the associated health concerns. Crystalline Silica that is inhaled, could cause adverse health effects (e.g., Silicosis) with chronic repetitive exposure if these particles are of respirable size (<10 µm) and at high concentrations (i.e., exceeding those found naturally in the environment). Silicosis affects lung function and increases susceptibility to secondary infections such as tuberculosis.

3.3.2 A: Aluminium (Al)

Similarly, aluminium dust has been known to cause effects in the lungs when inhaled, such as granuloma, proteinosis of alveoli, pneumonia, etc. (CCOHS). It should be noted that according to the REACH dossiers and CLP notifications, some notifiers have indicated that impurities or additives present in a substance impacts the notified classification.

3.3.3 B – Skin Corrosion & Skin Irritation

The potential for skin corrosion and/or skin irritation is dependent on several factors even before testing is performed, such as substances that may become corrosive or irritant when coming into contact with water (e.g., when moistened by mucous membranes, etc.).

According to the information database, all ingredients investigated during this study that exceed the 0.1% cut-off value have the potential to cause skin irritation (based on available information), although many of them are unlikely to cause such symptoms. In many instances' irritation is caused by mechanical or frictional action due to particle size. It is furthermore important to note that such health effects are based on pure elemental ATE concentrations, however, they do not occur naturally in the soil in this form and although health effects are important to consider, they are considered relative.

Information on potassium, sodium and calcium, in powder form, indicate the potential to be corrosive and cause burns, inflammation, blistering and damage to skin and eyes (harmonized classification and labelling - CLP00). Several of these elements (e.g., Mg, Na, Ca, etc.) possess physical properties, like spontaneous ignition when in contact with water or air, although as mentioned above, these properties are not expected in molecular form in the natural soil. Literature also stipulates that pH levels of an ingredient below 2 or above 11.5 indicate skin or eye corrosiveness unless proven otherwise by credible data.

Paste pH levels on the solid samples and liquid phase also indicated neutral pH levels and therefore skin or eye irritation, other than that caused by particle size (through mechanical action) is not expected to occur with exposure to this material. Distilled water leach analysis also indicated neutral pH levels in leaches.

None of the waste streams tested was classified as irritative or corrosive to the skin, based on the assumption that pH levels will remain unchanged over time and that these streams will not be mixed with other waste streams, which could cause pH levels to change.

3.3.4 C – Eye Irritation and Damage to Eyes

As mentioned above, certain ingredients are known to potentially be eye irritants (especially at low-level dust with repeated exposure) in their granular form through mechanical action

(e.g., Fe, S, etc.). This can especially be problematic when strong gusts of wind are common in the area.

Each irritant or corrosive component is considered to contribute to the overall properties of the mixture in proportion to its potency and concentration, however, the exact form and concentration that the ingredient will be transferred in are unknown, making accurate classification difficult. Ca, K and Na, are known to have the potential for causing serious damage to the eyes (it is assumed that these effects could be irreversible). These elements are not expected in their pure elemental forms and they will not be classified as hazardous to the eyes.

3.3.5 D – Skin and/or Respiratory Sensitisation

A respiratory sensitizer is a substance that, when inhaled, causes hypersensitivity of the airways. Respiratory hypersensitivity is considered as alveolitis, asthma and rhinitis. A skin sensitizer is a substance that, when coming into contact with the skin, will cause an allergic response (SANS 10234).

A substance shall respectively be considered a respiratory sensitizer or skin sensitizer (classified into Category 1) when there is human evidence or positive results from animal studies to confirm sensitivity (SANS 10234). Of the ingredients exceeding the 0.1% threshold in both waste stream mixtures, there is evidence of respiratory sensitisation with Si (respiratory irritation and stimulation) exposure.

This is however dependent on particle size. The exposure risk of a particular mineral waste stream should also be compared to the content of the natural environment where the waste stream is found. The elements, Ca, Mg and Mn have also been known to cause respiratory irritation, whereas Na in the elemental form at high concentrations could destroy mucous membrane tissues in the upper respiratory tract. Neither of the waste streams tested is classified as skin or respiratory sensitizer.

None of the waste streams tested is classified as skin or respiratory sensitizers.

3.3.6 E – Mutagenicity

Mutagenicity refers to "…chemicals that cause mutations in the germ cells of humans and that can be transmitted to the progeny (SANS 10234)." These encompass heritable genetic alterations expressed at phenotypic levels and DNA modifications when known, for example, certain base pair changes and chromosomal translocations. Mutagens increase the incidence of mutations in populations of cells and/or organisms.

Genotoxic agents are those substances that alter genetic material or segregate damages or interfere with DNA expression and replication and usually serve as indicators for mutagenicity.

Of the ingredients (XRF test) exceeding the 0.1% threshold in either of the waste stream mixtures, there is no evidence of mutagenicity/genotoxicity.

3.3.7 F – Carcinogenicity

A carcinogen is a substance that induces cancer or increases the risk of contracting cancer through inhalation, skin absorption or ingestion. This classification is based on the inherent characteristics of substances and not on the level of risk that the use of the substance may present. Due to the presence of Si in the tested waste stream, it will be mentioned here (please also refer to Section 10.4.2.A.1 above). Crystalline silica has been classified as a human lung carcinogen. The waste streams currently under investigation contain natural, geological material with fine particles that could potentially be inhaled if airborne.

Crystalline Silica that is inhaled, could cause adverse health effects (e.g., Silicosis) with chronic repetitive exposure if these particles are of respirable size (<10 µm) and at high concentrations (i.e., exceeding those found naturally in the environment). Silicosis affects lung function and increases susceptibility to secondary infections such as tuberculosis. Particle size distribution analyses in the current investigation indicated that 4.39 % ('SOM Discard') and 33.5 % ('SOM Slurry') of the particles in each sample were below 10 µm. It should furthermore be noted that the microscopic particle form/structure is not considered during such a test and therefore we must assume conservatively that all particles are homogeneously round and possess an aerodynamic diameter. In addition, XRF results obtained for Si are a reflection of total Si (a combination of crystalline and amorphous) and Si present in the sample is likely naturally occurring, further reducing the associated risk with inhalation.

Dust containing Si, such as quartz dust has been classified as a Category 1A human carcinogen (Si content) by the International Agency for Research on Cancer (IARC).

Category:	Category 1A
Symbol:	
Signal Word:	Danger
Hazard Statement:	H350: May cause cancer due to inhalation

Evidence also exists for Fe as an equivocal tumorigenic agent (RTECS), as well as for Mn, however, there is no confirmation on the latter (IARC, NTP or OSHA).

3.3.8 G – Reproductive Toxicity

Effects of reproductive toxicity include impairment of sexual function and fertility or developmental toxicity. “Adverse effects on sexual function and fertility include, but are not limited to, alterations to the female and male reproductive system, adverse effects on the onset of puberty, gamete production and transport, reproductive cycle normality, sexual behaviour, fertility, ability to give birth, pregnancy outcomes, premature ageing, or modifications in other functions that are dependent on the integrity of the reproductive systems. Adverse effects on, or via, lactation, are also included in reproductive toxicity (SANS 10234).” “Developmental toxicity includes any effect which interferes with normal development of the offspring, either before or after birth and that results from exposure of either parent before conception, or exposure of the developing offspring during prenatal development, or postnatally, to the time of sexual maturation (SANS 10234).” It also refers to adverse effects induced during pregnancy, or as a result of exposure by the parents. Such effects can be shown during any season of the lifespan. Major effects include the death of the developing organism, altered growth and structural abnormalities and functional deficiency.

Human evidence (ECHA) in a single study showed mental retardation in an infant due to exposure to high Al concentrations through the mother during pregnancy, however, results were inconclusive as no direct correlation between the Al and recorded condition was established. The two waste streams in question do not need to be classified in terms of reproductive toxicity.

3.3.9 H – Target Organ Systemic Toxicity – Single Exposure (SE)

Three factors (based on reliable evidence) are important for classification into this category, based on a single exposure:

- Consistent and identifiable toxic effects (in humans and animals);
- Toxicologically significant changes that have affected the function or morphology of tissue or an organ (or both), or
- Serious changes to the biochemistry or haematology of the organism that are relevant for human health.

The primary source of evidence should be based on human data and should include significant changes in single organs or biological systems, as well as those changes involving several organs. Exposure to high elemental Fe, Ca and Mn concentrations has shown to be toxic only with prolonged exposure. Reliability and information based on human trials are uncertain. A human study in RTECS on elemental Fe exposure indicates an LD50 of 200 mg/Kg with toxic effects including hepatitis (hepatocellular necrosis). No Target Organ Systemic Toxicity is expected with a single exposure in either of the two waste streams in question.

3.3.10 I – Target Organ Systemic Toxicity – Repeated Exposure (RE)

The criteria for repeated exposure remain the same as for single exposure, except for effects noticed with repeated exposure and not only with a single exposure. Si and Al were both detected and are often present in the dust (e.g., quartz or AlO dust). Quartz dust is known to cause specific target organ toxicity with repeated exposure (specifically in the lungs), due to high Al and Si levels and therefore samples are conservatively classified into Category 1. Potential dust originating from these waste streams could have been altered in terms of natural characteristics during process activities and therefore a conservative approach should endure ensuring appropriate mitigative/management actions are taken to minimise risk with exposure. In-field stream characteristics could decrease this risk and this inference is based on a worst-case scenario. It should however be noted that the respective LD50 values for both variables exceed 2000 mg/Kg (oral exposure).

Category:	Category 1
Symbol:	
Signal Word:	Danger
Hazard Statement:	H372: Causes damage to lungs through prolonged or repeated exposure via inhalation

3.3.11 J - Hazardous to the Aquatic Environment

that a highly toxic ingredient is present at less than 1%, where such an ingredient will be taken into consideration. Normally, the available XRF data will be used to determine potential acute toxicity based on the ingredients of the sample.

Four basic elements to determine whether a substance or mixture is toxic to the aquatic environment (i.e., ecosystem; ranging from soil microflora to primates) are stipulated in the SANS 10234:

- Acute aquatic toxicity
- Bioaccumulation
- Degradation (abiotic or biotic) for organic chemicals
- Chronic aquatic toxicity

Three trophic levels (indicator species) are identified in the standard for this determination, namely:

- Fish – 96h (LC50)
- Crustacea (e.g., Daphnia Magna) – 48h (EC50)
- Algae – 72h or 96h (ErC50)

Classification of an ingredient in terms of acute toxicity data is based on acute toxicity data only, whereas classification in terms of chronic toxicity uses a combination of acute toxicity data and environmental fate data (e.g., degradability and bioaccumulation data). It should be noted that available data is limited.

3.3.12 J (a) - Acute Aquatic Toxicity

Toxicity values for each species are not available for each ingredient and therefore the highest toxicity (i.e., most sensitive species) where data was found, is normally implemented during classification as per stipulations in the standard.

Table 3-3: Acute toxicity hazard categories - Aquatic Environment

Hazard Category of Acute Toxicity	Classification Criteria	
1	96h LC_{50} (for fish) 48h EC_{50} (for crustacea) 72h or 96h ErC_{50} (for algae or other aquatic plants)	≤1 mg/L ≤1 mg/L ≤1 mg/L
2	96h LC_{50} (for fish) 48h EC_{50} (for crustacea) 72h or 96h ErC_{50} (for algae or other aquatic plants)	> 1 to ≤ 10 mg/L and/or > 1 to ≤ 10 mg/L and/or > 1 to ≤ 10 mg/L
3	96h LC_{50} (for fish) 48h EC_{50} (for crustacea) 72h or 96h ErC_{50} (for algae or other aquatic plants)	> 10 to ≤ 100 mg/L and/or > 10 to ≤ 100 mg/L and/or > 10 to ≤ 100 mg/L

During the current investigation, the distilled water leach of each waste stream was submitted for definitive toxicity testing based on the three trophic levels specified in the standard (refer to Annexure A). Each risk category quantifies acute or chronic risk associated with each waste stream. Rankings (Classes I - V) are based on the highest toxicity unit (TU) found in the battery of tests. A weight % is also assigned to each stream. Higher values indicate a higher rate of toxicity within a specific class. Risk/hazard category results based on the DEEEP protocols, were recorded as follows (Persoone, G, et. al., 2003):

- 'KDiscard1' – Class I (No lethal/sub-lethal hazard) (Wt % 0)
- 'KSlurry1' – Class II (Slight lethal/sub-lethal hazard) (Wt % 33)

The slight lethal/sub-lethal effect recorded from the 'KSlurry1' sample was based on a 30% growth-inhibition effect (sub-lethal) observed on micro-algae (micro-algae are often used as an indicator of potential chronic toxicity), as well as a 16.67% mortality effect on the vertebrate trophic level (lethal) on the 10% dilution level. It should however be noted that no significant toxicity was observed in the 100% sample result.

The pH and dissolved oxygen levels in both tested waste streams were within acceptable ranges for aquatic organisms will survive (these factors can be excluded as potential driving factors for toxicity).

3.3.13 J (b) - Chronic Aquatic Toxicity

"Classification of mixtures as a whole is not possible for chronic categories since both toxicity data and environmental fate data are needed, and there are no degradability and bioaccumulation data available for mixtures as a whole (SANS 10234). Micro-algae are often used as an indicator of chronic toxicity and in the current investing

4 CONCLUSIONS

Neutral pH levels were recorded from both waste streams. In the current scenario, it was assumed that no major changes in pH levels would take place over time. Of the two waste streams tested, both were categorised into the Type 3 (low risk) category (GNR 635, 2013) requiring a Class C liner (pollution barrier).

None of the waste streams was flammable. Volatile particle sizes were very low, reducing potential inhalation risks. Calculated ATE values for both waste streams, lead to acute toxicity hazard classification as Category 5, based on oral exposure routes (based on available data), despite Si and Al concentrations detected in both samples. Si and Al were also considered for both the oral and inhalation routes due to known toxicity effects (see below).

Target Organ Systemic Toxicity – Repeated Exposure (RE):

Category:	Category 1
Symbol:	
Signal Word:	Danger
Hazard Statement:	H372: Causes damage to lungs through prolonged or repeated exposure via inhalation

Carcinogenicity:

Category:	Category 1A
Symbol:	
Signal Word:	Danger
Hazard Statement:	H350: May cause cancer due to inhalation

Acute toxicity risk/hazard category results (please refer to Annexure b) based on the DEEEP protocols, were recorded as follows (Persoone, G, et. al., 2003): - KDiscard1' – Class I (No lethal/sub-lethal hazard) (Wt % 0) - 'KSlurry1' – Class II (Slight lethal/sub-lethal hazard) (Wt % 33) It should be noted that it is not expected that the ingredients as recorded in the XRF test will leach in the same form or at the same concentrations. A summary of the classification for both waste streams is presented in Table 4-1 and Table 4-2, below.

All inferences made in the current investigation are based on the limited data available. Please refer to the National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008) regulations to ensure alignment with all of its requirements. It remains the client's responsibility to ensure implementation and compliance with any related/supplementary regulatory documents.

Table 4-1: GHS classification summary, 'KDiscard1' stream, October 2022

Sample ID	KDiscard1	
Hazard Class	**Category**	**Statement**
1. Physical Hazards		
Explosives	N/A	None
Flammable Gasses	N/A	None
Flammable Aerosols	N/A	None
Oxidising Gasses	N/A	None
Gasses under Pressure	N/A	None
Flammable Liquids	N/A	None
Flammable Solids	Not Flammable; Flash Point = Negative at 30, 60 and 90 degrees Celsius	None
Self-reacting Substances & Mixtures	N/A	None
Pyrophoric Substances	N/A	None
Self-heating Substances & Mixtures	N/A	None
Substances & Mixtures that, on contact with Water Emits Flammable Gasses	N/A	None
Oxidising Substances & Mixtures	N/A	None
Organic Peroxides	N/A	None
Corrosive to Metals	N/A	None
2. Health Hazards		
Acute Toxicity	Category 5	May be harmful if swallowed; 3.6% of the mixture consists of ingredients of unknown toxicity.
Skin Corrosion and Skin Irritation	Not Classified	None
Serious Eye Damage & Eye Irritation	Not Classified	None
Respiratory Sensitization and Skin Sensitization	Not Classified	None
Germ Cell Mutagenicity	Not Classified	None
Carcinogenicity	Category 1A	H350 - May cause cancer, due to inhalation
Reproductive Toxicity	Not Classified	None
Specific Target Organ Toxicity - Single Exposure	Not Classified	None
Specific Target Organ Toxicity - Repeated Exposure	Category 1	H372 - Causes damage to lungs through prolonged or repeated exposure via inhalation

3. Hazards to the Aquatic Environment		
Acute Toxicity	No SANS 10234 Category Assigned	Class I (Non-lethal/Sub-lethal Hazard) (Persoone, G, et. al., 2003)
Chronic Toxicity	N/A	None (limiting data)
*Please refer to ingredient information contained in text		

Table 4-2: GHS classification summary, 'KSlurry1' stream, October 2022

Sample ID	KSlurry1	
Hazard Class	**Category**	**Statement**
1. Physical Hazards		
Explosives	N/A	None
Flammable Gasses	N/A	None
Flammable Aerosols	N/A	None
Oxidising Gasses	N/A	None
Gasses under Pressure	N/A	None
Flammable Liquids	N/A	None
Flammable Solids	Not Flammable; Flash Point = Negative at 30, 60 and 90 degrees Celsius	None
Self-reacting Substances & Mixtures	N/A	None
Pyrophoric Substances	N/A	None
Self-heating Substances & Mixtures	N/A	None
Substances & Mixtures that, on contact with Water Emits Flammable Gasses	N/A	None
Oxidising Substances & Mixtures	N/A	None
Organic Peroxides	N/A	None
Corrosive to Metals	N/A	None
2. Health Hazards		
Acute Toxicity	Category 5	May be harmful if swallowed; 4.06% of the mixture consists of ingredients of unknown toxicity.
Skin Corrosion and Skin Irritation	Not Classified	None
Serious Eye Damage & Eye Irritation	Not Classified	None
Respiratory Sensitization and Skin Sensitization	Not Classified	None

Germ Cell Mutagenicity	Not Classified	None
Carcinogenicity	Category 1A	H350 - May cause cancer, due to inhalation
Reproductive Toxicity	Not Classified	None
Specific Target Organ Toxicity - Single Exposure	Not Classified	None
Specific Target Organ Toxicity - Repeated Exposure	Category 1	H372 - Causes damage to lungs through prolonged or repeated exposure via inhalation
3. Hazards to the Aquatic Environment		
Acute Toxicity	No SANS 10234 Category Assigned	Class II (Slight lethal/Sub-lethal Hazard) (Persoone, G, et. al., 2003)
Chronic Toxicity	N/A	Limiting data, although 'Slight lethal/Sub-lethal Hazard' classification is based on chronic effects species
*Please refer to ingredient information contained in text		

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APPENDIX A: LABORATORY REPORTS

aquatico Laboratories (Pty). Ltd.

Test Report

Client:	Groundwater Consulting Services (GCS)	**Date of certificate:**	14 November 2022
Address:	63 Wessel Road, Woodmead, 2191	**Date accepted:**	11 October 2022
Report no:	137249	**Date completed:**	24 October 2022
Project:	GCS - Waste	**Revision:**	0

Locality name:	**KSlurry1**				
Date sampled:	**10 October 2022**				
Sample dry Mass(g):				**1.00**	
Sample Volume (mL):	**Total Concentrations**			**50.0**	
Guideline Limits:	**TCT 0**	**TCT 1**	**TCT 2**		
Units:	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/L**	**mg/Kg**
Metal Ions					
Arsenic as As	5.80	500	2000	0.076	3.80
Boron as B	150	15000	60000	<1.50	<75.0
Barium as Ba	62.5	6250	25000	5.66	283
Cadmium as Cd	7.50	260	1040	<0.075	<3.75
Cobalt as Co	50.0	5000	20000	<0.500	<25.0
Chromium as Cr	46000	800000	-	6.00	300
Hexavalent chromium (Cr6?)	7	500	2000	NR	NR
Copper as Cu	16.0	19500	78000	0.454	22.7
Mercury as Hg	0.930	160	640	<0.009	<0.450
Manganese as Mn	1000	25000	100000	6.19	310
Molybdenum as Mo	40.0	1000	4000	0.646	32.3
Nickel as Ni	91.0	10600	42400	0.588	29.4
Lead as Pb	20.0	1900	7600	0.634	31.7
Antimony as Sb	10.0	75.0	300	<0.100	<5.00
Selenium as Se	10.0	50.0	200	<0.100	<5.00
Vanadium as V	150	2680	10720	<1.00	<50.0
Zinc as Zn	240	160000	640000	<1.00	<50.0
Inorganic Anions					
Fluoride as F	100	10000	40000	NR	NR
Total Cyanide as CN	14.00	10500.00	42000.00	<0.100	<5.00
Percentage Solids					
Moisture %	-	-	-	8.39	
Solid %	-	-	-	NR	

O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report
N/A = Not Applicable

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Project:	GCS - Waste	**Revision:**	0

Locality name:		**KSlurry1**			
Date sampled:		**10 October 2022**			
Sample dry Mass(g):					**1.00**
Sample Volume (mL):	**Total Concentrations**				**50.0**
Guideline Limits:	**TCT 0**	**TCT 1**	**TCT 2**		
Units:	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/L**	**mg/Kg**
Variables					
Aluminium (Al)	-	-	-	202	10100
Iron as Fe	-	-	-	662	33100

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Locality name:					**KSlurry1**		
Date sampled:					**10 October 2022**		
					Distilled Water	**Borax**	**TCLP**
Sample dry Mass(g):	**Leachable Concentrations**				**20.0**	**NR**	**20.0**
Sample Volume (mL):	**LCT 0**	**LCT 1**	**LCT 2**	**LCT 3**	**400**	**NR**	**400**
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Metal Ions							
Arsenic as As	0.010	0.500	1.00	4.00	NR	NR	<0.010
Boron as B	0.500	25.0	50.0	200	NR	NR	<0.500
Barium as Ba	0.700	35.0	70.0	280	NR	NR	<0.700
Cadmium as Cd	0.003	0.150	0.300	1.20	NR	NR	<0.003
Cobalt as Co	0.500	25.0	50.0	200	NR	NR	<0.400
Chromium as Cr	0.100	5.00	10.0	40.0	NR	NR	<0.100
Hexavalent chromium (Cr6+)	0.050	2.50	5.00	20.0	NR	NR	<0.020
Copper as Cu	2.00	100	200	800	NR	NR	<1.00
Mercury as Hg	0.006	0.300	0.600	2.40	NR	NR	<0.006
Manganese as Mn	0.500	25.0	50.0	200	NR	NR	4.68
Molybdenum as Mo	0.070	3.50	7.00	28.0	NR	NR	0.098
Nickel as Ni	0.070	3.50	7.00	28.0	NR	NR	<0.070
Lead as Pb	0.010	0.500	1.00	4.00	NR	NR	<0.010
Antimony as Sb	0.020	1.00	2.00	8.00	NR	NR	<0.020
Selenium as Se	0.010	0.500	1.00	4.00	NR	NR	<0.010
Vanadium as V	0.200	10.0	20.0	80.0	NR	NR	<0.200
Zinc as Zn	5.00	250	500	2000	NR	NR	<2.00
Inorganic Anions							
Total Dissolved solids @ 180°C	1000	12500	25000	100000	NR	NR	6612
Chloride as Cl	300	15000	30000	120000	NR	NR	<50.0
Sulphate (SO_4)	250	12500	25000	100000	NR	NR	484
Nitrate (NO3) as N	11.0	550	1100	4400	NR	NR	<10.0
Fluoride as F	1.50	75.0	150	600	NR	NR	<1.00
Total Cyanide as CN	0.070	3.50	7.00	28.0	NR	NR	<0.01
Physical characteristics							
Paste pH (1:2)	-	-	-	-		7.94	
Redox	-	-	-	-		135	

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Address:	63 Wessel Road, Woodmead, 2191	**Date accepted:**	11 October 2022
Report no:	137249	**Date completed:**	24 October 2022
Project:	GCS - Waste	**Revision:**	0

Locality name:					**KSlurry1**		
Date sampled:					**10 October 2022**		
					Distilled Water	**Borax**	**TCLP**
Sample dry Mass(g):	**Leachable Concentrations**				**20.0**	**NR**	**20.0**
Sample Volume (mL):	**LCT 0**	**LCT 1**	**LCT 2**	**LCT 3**	**400**	**NR**	**400**
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Variables							
Aluminium (Al)	-	-	-	-	NR	NR	<2.00
Iron (Fe)	-	-	-	-	NR	NR	<2.00
Total oxidised nitrogen as N	-	-	-	-	NR	NR	<10.0

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Project:	GCS - Waste	**Revision:**	0

Locality name:	**KDiscard1**				
Date sampled:	**10 October 2022**				
Sample dry Mass(g):				**1.00**	
Sample Volume (mL):	**Total Concentrations**			**50.0**	
Guideline Limits:	**TCT 0**	**TCT 1**	**TCT 2**		
Units:	**mg/Kg**	**mg/Kg**	**mg/Kg**	**mg/L**	**mg/Kg**
Metal Ions					
Arsenic as As	5.80	500	2000	0.232	11.6
Boron as B	150	15000	60000	<1.50	<75.0
Barium as Ba	62.5	6250	25000	7.92	396
Cadmium as Cd	7.50	260	1040	<0.075	<3.75
Cobalt as Co	50.0	5000	20000	<0.500	<25.0
Chromium as Cr	46000	800000	-	1.50	75.0
Hexavalent chromium (Cr6?)	7	500	2000	NR	NR
Copper as Cu	16.0	19500	78000	0.316	15.8
Mercury as Hg	0.930	160	640	<0.009	<0.450
Manganese as Mn	1000	25000	100000	3.19	160
Molybdenum as Mo	40.0	1000	4000	0.673	33.7
Nickel as Ni	91.0	10600	42400	0.621	31.1
Lead as Pb	20.0	1900	7600	0.471	23.6
Antimony as Sb	10.0	75.0	300	<0.100	<5.00
Selenium as Se	10.0	50.0	200	<0.100	<5.00
Vanadium as V	150	2680	10720	<1.00	<50.0
Zinc as Zn	240	160000	640000	1.60	80.0
Inorganic Anions					
Fluoride as F	100	10000	40000	NR	NR
Total Cyanide as CN	14.00	10500.00	42000.00	<0.100	<5.00
Percentage Solids					
Moisture %	-	-	-	4.27	
Solid %	-	-	-	NR	

O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report
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Project:	GCS - Waste	**Revision:**	0

Locality name:		**KDiscard1**			
Date sampled:		**10 October 2022**			
Sample dry Mass(g):				**1.00**	
Sample Volume (mL):	Total Concentrations			**50.0**	
Guideline Limits:	TCT 0	TCT 1	TCT 2		
Units:	mg/Kg	mg/Kg	mg/Kg	**mg/L**	**mg/Kg**
Variables					
Aluminium (Al)	-	-	-	350	17500
Iron as Fe	-	-	-	726	36300

O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report
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Project:	GCS - Waste	**Revision:**	0

Locality name:					**KDiscard1**		
Date sampled:					**10 October 2022**		
					Distilled Water	**Borax**	**TCLP**
Sample dry Mass(g):	**Leachable Concentrations**				**20.0**	**NR**	**20.2**
Sample Volume (mL):	**LCT 0**	**LCT 1**	**LCT 2**	**LCT 3**	**400**	**NR**	**400**
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Metal Ions							
Arsenic as As	0.010	0.500	1.00	4.00	NR	NR	<0.010
Boron as B	0.500	25.0	50.0	200	NR	NR	<0.500
Barium as Ba	0.700	35.0	70.0	280	NR	NR	<0.700
Cadmium as Cd	0.003	0.150	0.300	1.20	NR	NR	<0.003
Cobalt as Co	0.500	25.0	50.0	200	NR	NR	<0.400
Chromium as Cr	0.100	5.00	10.0	40.0	NR	NR	<0.100
Hexavalent chromium (Cr6+)	0.050	2.50	5.00	20.0	NR	NR	<0.020
Copper as Cu	2.00	100	200	800	NR	NR	<1.00
Mercury as Hg	0.006	0.300	0.600	2.40	NR	NR	<0.006
Manganese as Mn	0.500	25.0	50.0	200	NR	NR	2.33
Molybdenum as Mo	0.070	3.50	7.00	28.0	NR	NR	0.080
Nickel as Ni	0.070	3.50	7.00	28.0	NR	NR	<0.070
Lead as Pb	0.010	0.500	1.00	4.00	NR	NR	<0.010
Antimony as Sb	0.020	1.00	2.00	8.00	NR	NR	<0.020
Selenium as Se	0.010	0.500	1.00	4.00	NR	NR	<0.010
Vanadium as V	0.200	10.0	20.0	80.0	NR	NR	<0.200
Zinc as Zn	5.00	250	500	2000	NR	NR	<2.00
Inorganic Anions							
Total Dissolved solids @ 180°C	1000	12500	25000	100000	NR	NR	5636
Chloride as Cl	300	15000	30000	120000	NR	NR	<50.0
Sulphate (SO_4)	250	12500	25000	100000	NR	NR	113
Nitrate (NO3) as N	11.0	550	1100	4400	NR	NR	<10.0
Fluoride as F	1.50	75.0	150	600	NR	NR	<1.00
Total Cyanide as CN	0.070	3.50	7.00	28.0	NR	NR	<0.01
Physical characteristics							
Paste pH (1:2)	-	-	-	-		7.34	
Redox	-	-	-	-		85.0	

O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report
N/A = Not Applicable

www.aquatico.co.za 89 Regency Drive, R21 Corporate Park, Centurion, South Africa Tel: +27 12 450 3800 Fax: +27 12 450 3851

aquatico Laboratories (Pty). Ltd.

Test Report

Client:	Groundwater Consulting Services (GCS)	**Date of certificate:**	14 November 2022
Address:	63 Wessel Road, Woodmead, 2191	**Date accepted:**	11 October 2022
Report no:	137249	**Date completed:**	24 October 2022
Project:	GCS - Waste	**Revision:**	0

Locality name:					**KDiscard1**		
Date sampled:					**10 October 2022**		
					Distilled Water	**Borax**	**TCLP**
Sample dry Mass(g):	**Leachable Concentrations**				**20.0**	**NR**	**20.2**
Sample Volume (mL):	**LCT 0**	**LCT 1**	**LCT 2**	**LCT 3**	**400**	**NR**	**400**
Units	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
Variables							
Aluminium (Al)	-	-	-	-	NR	NR	<2.00
Iron (Fe)	-	-	-	-	NR	NR	<2.00
Total oxidised nitrogen as N	-	-	-	-	NR	NR	<10.0

O = Outsourced S = Sub-contracted NR = Not requested RTF = Results to follow NATD = Not able to determine ATR = Alternative test report
N/A = Not Applicable

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Report

FINAL CERTIFICATE OF ANALYSIS
REVISON: 0

TO:	Theo Meyer	FROM:	UIS Analytical Services
CLIENT NAME:	Aquatico Laboratories (Pty) Ltd		XRF Laboratory
CLIENT ADDRESS:	89 Regency Drive, R21 Corporate Park Centurion	ADDRESS:	13 Esdoring Nook, Highveld Technopark, Centurion
TEL:		TEL:	+27 12 665 4291
MOBILE:	+27 12 4503800	FAX:	+27 12 665 4294
EMAIL:	outsource@aquatico.co.za	REQUEST DATE:	13-Oct-2022

		ANALYSED GRADE PERCENTAGES																		
		Fe_2O_3	SiO_2	Al_2O_3	K_2O	P_2O_5	Mn_3O_4	CaO	MgO	TiO_2	Na_2O	V_2O_5	BaO	Cr_2O_3	SrO	ZrO_2	MnO	LOI	Total (XRF)	Density
		%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	g/cm³
CLIENT SAMPLE ID	UIS SAMPLE ID																			
1568347/KSlurry1/Batch/no/137250/Lab/no/185801	857566	5.565	54.872	7.778	2.114	0.041	0.041	3.229	0.351	0.439	0.440	0.011	0.089	0.093	0.048	0.050	0.036	22.897	97.257	2.335
1568347/KDiscard1/Batch/no/137250/Lab/no/185802	857567	4.675	34.411	9.528	1.419	0.062	0.029	3.393	0.451	0.506	0.371	0.010	0.092	0.039	0.063	0.041	0.027	44.350	99.440	2.087

NOTES:
*The results relate specifically to the items as tested
*The report shall not be reproduced except in full, without the written approval of the laboratory

Identification of test method:	Major and Minor Elements by XRF	Identification file:	UIS 47957_Report
UIS method identification:	UIS-XF-T007	Authorisation date:	24-Oct-2022
Instrument model:	ARL ADVANTX SERIES	Authorised by:	NAME: E Majola
Asset number:	UIS-AS 0285		DESIGNATION: Technician

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Page 1

ANALYTICAL REPORT: Fluoride & Chromium (VI) Analysis

No unauthorised copies may be made of this report.

To:	**Aquatico Laboratories (Pty) Ltd**	Date of Request: 13-10-2022	UIS Analytical Services
Attention:	**Theo Meyer**		Analytical Chemistry
Project ID	**BATCH 137250 (POAQL 2022 408)**		Laboratories 2, 4
Tel:			Tel: (012) 665 4294
Fax:			

92 53 16 UIS analytical services

Certificate of analysis: 47957

Lims ID	Sample ID	F	Cr^{6+}
		mg/kg	mg/kg
857566	**1568347/KSlurry1/Batch/no/137250/Lab/no/185801**	192	<5
857566 QC	**Duplicate**	187	<5
857567	**1568347/KDiscard1/Batch/no/137250/Lab/no/185802**	308	<5

		Chemical elements:	Cr6+, F
		Instrument:	Fluoride Ion Selective Electrode, Spectrophotometer
		Method:	Hexavalent Chromium in Soil/Ore by alkaline digestion & Spectrophotometry, Total Fluorine in soil/ore by alkaline fusion & ion selective electrode
Date:	26-10-2022	Date:	26-10-2022
Analysed by:	R Kayser/ RGM Rakoma/ V Mammburu	Authorised :	SD Masebe

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Particle size distribution

Malvern Instruments

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Measurement Details	
Sample Name	Average of '185801 KSlurry1 - Screened'
SDS	321
SOP File Name	Default + 60us LV.msop

Measurement Details	
Measurement Date Time	2022/10/13 15:25:29
Analysis Date Time	2022/10/13 15:25:29
Original Record Number	196

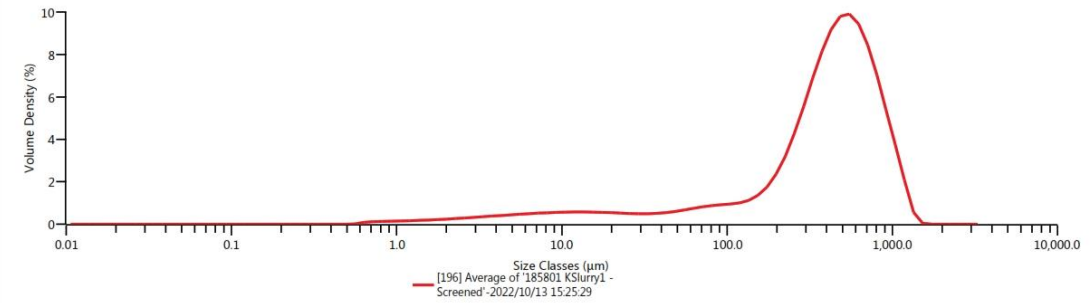
Analysis	
Particle Name	Default 1.0
Dispersant Name	Water
Particle Absorption Index	1.000
Weighted Residual	0.33 %
Analysis Model	General Purpose

Analysis	
Particle Refractive Index	1.520
Dispersant Refractive Index	1.330
Laser Obscuration	7.43 %
Scattering Model	Mie
Analysis Sensitivity	Normal

Result	
Concentration	0.0349 %
Uniformity	0.545
Specific Surface Area	149.9 m^2/kg
D [3,2]	38.1 µm
D [4,3]	453 µm

Result	
Span	1.894
Result Units	Volume
Dv (10)	35.2 µm
Dv (50)	433 µm
Dv (90)	855 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.128	0.00	1.28	0.66	12.7	6.48	111	15.53	1110	97.86
0.0114	0.00	0.146	0.00	1.45	0.81	14.5	6.97	127	16.41	1260	99.61
0.0129	0.00	0.166	0.00	1.65	0.97	16.4	7.43	144	17.32	1430	100.00
0.0147	0.00	0.188	0.00	1.88	1.15	18.7	7.91	163	18.41	1630	100.00
0.0189	0.00	0.214	0.00	2.13	1.35	21.2	8.35	186	19.89	1850	100.00
0.0215	0.00	0.243	0.00	2.50	1.63	24.1	8.79	211	21.81	2100	100.00
0.0278	0.00	0.276	0.00	2.75	1.81	27.4	9.21	240	24.50	2390	100.00
0.0315	0.00	0.314	0.00	3.12	2.07	31.1	9.61	272	27.99	2710	100.00
0.0358	0.00	0.357	0.00	3.55	2.37	35.3	10.01	310	32.73	3080	100.00
0.0407	0.00	0.405	0.00	4.03	2.68	40.1	10.43	352	38.45	3500	100.00
0.0463	0.00	0.460	0.00	4.58	3.02	44.0	10.76	400	45.28		
0.0526	0.00	0.523	0.00	5.21	3.39	45.0	10.84	454	52.90		
0.0597	0.00	0.594	0.00	5.92	3.78	51.8	11.39	516	61.13		
0.0679	0.00	0.675	0.08	6.72	4.19	58.9	11.95	586	69.40		
0.0771	0.00	0.767	0.17	7.64	4.62	66.9	12.58	666	77.33		
0.0876	0.00	0.872	0.28	8.68	5.07	76.0	13.26	756	84.35		
0.0995	0.00	1.00	0.41	10.0	5.59	86.4	14.00	859	90.23		
0.113	0.00	1.13	0.53	11.2	6.01	98.1	14.76	976	94.73		

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Mastersizer - v3.81
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Particle size distribution

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Measurement Details	
Sample Name	Average of '185802 KDiscard - Screened'
SDS	322
SOP File Name	Default + 60us LV.msop

Measurement Details	
Measurement Date Time	2022/10/13 15:32:44
Analysis Date Time	2022/10/13 15:32:44
Original Record Number	200

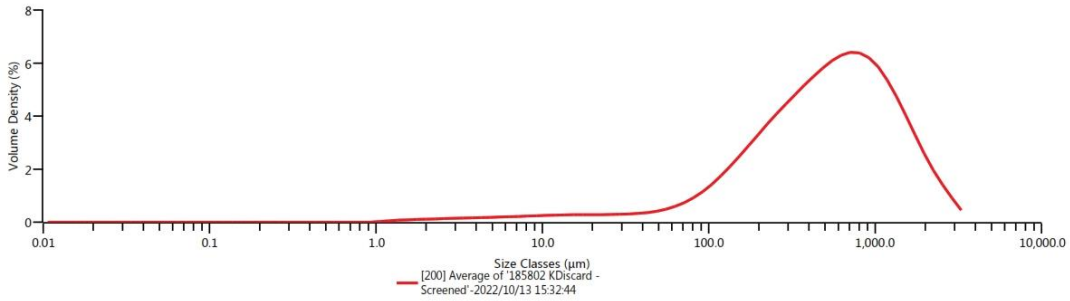
Analysis	
Particle Name	Default 1.0
Dispersant Name	Water
Particle Absorption Index	1.000
Weighted Residual	0.61 %
Analysis Model	General Purpose

Analysis	
Particle Refractive Index	1.520
Dispersant Refractive Index	1.330
Laser Obscuration	6.34 %
Scattering Model	Mie
Analysis Sensitivity	Normal

Result	
Concentration	0.0764 %
Uniformity	0.834
Specific Surface Area	60.11 m^2/kg
D [3,2]	95.1 µm
D [4,3]	708 µm

Result	
Span	2.680
Result Units	Volume
Dv (10)	113 µm
Dv (50)	538 µm
Dv (90)	1560 µm

Frequency (compatible)



Result

Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under	Size (µm)	% Volume Under
0.0100	0.00	0.128	0.00	1.28	0.06	12.7	2.60	111	9.82	1110	79.37
0.0114	0.00	0.146	0.00	1.45	0.13	14.5	2.84	127	11.36	1260	83.85
0.0129	0.00	0.166	0.00	1.65	0.20	16.4	3.06	144	13.09	1430	87.82
0.0147	0.00	0.188	0.00	1.88	0.28	18.7	3.31	163	15.11	1630	91.18
0.0189	0.00	0.214	0.00	2.13	0.37	21.2	3.54	186	17.61	1850	93.92
0.0215	0.00	0.243	0.00	2.50	0.50	24.1	3.78	211	20.33	2100	96.07
0.0278	0.00	0.276	0.00	2.75	0.59	27.4	4.02	240	23.44	2390	97.70
0.0315	0.00	0.314	0.00	3.12	0.71	31.1	4.26	272	26.78	2710	98.87
0.0358	0.00	0.357	0.00	3.55	0.84	35.3	4.52	310	30.59	3080	99.62
0.0407	0.00	0.405	0.00	4.03	0.98	40.1	4.79	352	34.58	3500	100.00
0.0463	0.00	0.460	0.00	4.58	1.12	44.0	5.01	400	38.90		
0.0526	0.00	0.523	0.00	5.21	1.27	45.0	5.06	454	43.44		
0.0597	0.00	0.594	0.00	5.92	1.43	51.8	5.44	516	48.31		
0.0679	0.00	0.675	0.00	6.72	1.60	58.9	5.84	586	53.37		
0.0771	0.00	0.767	0.00	7.64	1.78	66.9	6.33	666	58.65		
0.0876	0.00	0.872	0.00	8.68	1.97	76.0	6.94	756	63.96		
0.0995	0.00	1.00	0.00	10.0	2.20	86.4	7.71	859	69.29		
0.113	0.00	1.13	0.02	11.2	2.38	98.1	8.67	976	74.47		

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Aquatico

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INTERWASTE
2 Brammer St, Industries East
Germiston South
Republic of South Africa
Telephone: +27 11 323 7300
Fax: +27 86 576 8152
Email: sales@interwaste.co.za
www.interwaste.co.za

Sample Identification Number: IW2022-0955

Laboratory Analysis Report for Landfill Assessment			
Requested By:	Cheila Canario	**Waste Name:**	Sample 185801 (KSlurry1)
Generator:	Aquatico	**Received Date:**	17/10/2022
Lab Reference:	IW2022-0955	**Analysis Date:**	18/10/2022
No. of Samples:	1	**Report Date:**	20/10/2022
Sample Description:	Black Powder		

Table 1: Miscellaneous tests for sample: IW2022-0955

Parameter Tested	Unit	IW2022-0955
Sample Moisture Content*	% (w/w)	NT
Conductivity	uS/cm	NT
Initial Sample pH	pH Units	NT
Sample pH after HCl Addition	pH Units	NT
Leach Solution Applied	Solution Type	NT
Final Leach Solution pH	pH Units	NT
Physical State	N/A	Solid
Water Miscibility	N/A	Immiscible
Calorific Value*	MJ/kg	NT
Additional Information	N/A	Low Odour, Not Flammable, Flashpoint:-ve@30,60 & 90°C

UTD = Unable to determine; NT = Not tested; * = Not a SANAS accredited method; Conductivity and pH measured by electronic conductivity and pH meter at ~22C (10% H2O extracts of solids). Moisture by mass loss on heating at ~103C for 30 mins.

Determining the landfill site class for disposal:

The assigned waste type determines the class of landfill site where a particular waste stream may be disposed. A waste type of one (Type 1) is assigned to waste that presents the most risk to the environment when disposed of at a landfill site and therefore requires disposal at a site with stringent engineering controls corresponding to a so called "Class A" site. Type four (Type 4) waste presents a low risk to the environment when disposed of to a landfill site and therefore may be disposed of at a less stringently engineered, "Class D" site. Type zero waste (Type 0) may not be disposed of to any landfill site in South Africa without prior treatment. The *National Waste Classification and Management Regulations* detail specific requirements surrounding the classification and assessment of waste for disposal to landfill (See references). Note that a GHS (SANS10234) compliant classification and safety data sheet is required before a final waste management decision should be taken and should be read in conjunction with this assessment.

Standard Operational Procedure:

Identification of analysis methods:

IW-S-1: Determination of Metals in Liquids and solids using ICP-OES Optima 8300; IW-S-2: Determination of the VOC content of liquid and solids using GC6850, MS5976C; IW-S-3: pH Measurement; IW-S-4: EC Measurement; IW-S-5: Calibration and measurement of samples using Supercal Modular calorimeter; IW-S-6: Toxicity characteristic leaching procedure – TCLP; IW-S-7: Field Protable X-ray Flourecence FTXRF; AS 4439.1-1999: Wastes, sediments and contaminated soils - Preparation of leachates - Preliminary assessment; AS 4439.3-1997: Wastes, sediments and contaminated soils - Preparation of leachates - Bottle leaching procedures.

Scope of Accreditation:

Materials/Products Tested	Types of Tests	Standard Specifications, Equipment/Techniques Used
1- Waste (Solid, sludge and liquid)	Quantification of metals by ICP-OES following ASLP, reagent water (Ag, Al, As, B, Ba, Be, Bi, Cd, Co, Cr, Cu, Fe, Hg, Mn, Mo, Ni, Rb, P, Pb, Sb, Se, Sn, Sr, Ti, Tl, U, V, Zn)	IW-M-01 - Based on method 6010C
2- Solids & Liquids	Determination of VOC; BTEX by GC/MS Headspace	IW-M-02 - Based on method EPA 8260B; EPA 5030B(Liquid) and EPA 5035 (solid)
3- Potable water & leachates	pH at 25 ^{o}C	IW-M-03
4- Potable water & leachates	Electrical Conductivity at 25^{o}C	IW-M-04

Disclaimer:

Analysis results relate only to the samples submitted. The laboratory has no control over the sampling protocol, the representivity of the samples and the manner in which the samples were collected, transported, stored, preserved or otherwise handled outside of the laboratory facility and therefore takes no responsibility whatsoever for these activities. Third parties using INTERWASTE results can verify the results by contacting the laboratory. INTERWASTE are not liable or responsible for the customer use and/or interpretation of test results. This certificate cannot be reproduced without the written consent of INTERWASTE laboratory.

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References

1.) Government Notice R.365, National Environmental Management: Waste Act (59/2008): National norms and standards for the assessment of waste for landfill disposal, Gazette No. 36

Signed by:Dr. Cheila Canario
Signed at:2022-10-20 14:06:02 +02:00
Reason:Chief Chemist

INTERWASTE
2 Brammer St, Industries East
Germiston South
Republic of South Africa
Telephone: +27 11 323 7300
Fax: +27 86 576 8152
Email: sales@interwaste.co.za
www.interwaste.co.za

Sample Identification Number: IW2022-0956

Laboratory Analysis Report for Landfill Assessment			
Requested By:	Cheila Canario	**Waste Name:**	Sample 185802 (KDiscard1)
Generator:	Aquatico	**Received Date:**	17/10/2022
Lab Reference:	IW2022-0956	**Analysis Date:**	18/10/2022
No. of Samples:	1	**Report Date:**	20/10/2022
Sample Description:	Black Powder		

Table 1: Miscellaneous tests for sample: IW2022-0956

Parameter Tested	Unit	IW2022-0956
Sample Moisture Content*	% (w/w)	NT
Conductivity	uS/cm	NT
Initial Sample pH	pH Units	NT
Sample pH after HCl Addition	pH Units	NT
Leach Solution Applied	Solution Type	NT
Final Leach Solution pH	pH Units	NT
Physical State	N/A	Solid
Water Miscibility	N/A	Immiscible
Calorific Value*	MJ/kg	NT
Additional Information	N/A	Low Odour, Not Flammable, Flashpoint: -ve@30,60 & 90°C

UTD = Unable to determine; NT = Not tested; * = Not a SANAS accredited method; Conductivity and pH measured by electronic conductivity and pH meter at ~22C (10% H2O extracts of solids). Moisture by mass loss on heating at ~103C for 30 mins.

Determining the landfill site class for disposal:

The assigned waste type determines the class of landfill site where a particular waste stream may be disposed. A waste type of one (Type 1) is assigned to waste that presents the most risk to the environment when disposed of at a landfill site and therefore requires disposal at a site with stringent engineering controls corresponding to a so called "Class A" site. Type four (Type 4) waste presents a low risk to the environment when disposed of to a landfill site and therefore may be disposed of at a less stringently engineered, "Class D" site. Type zero waste (Type 0) may not be disposed of to any landfill site in South Africa without prior treatment. The *National Waste Classification and Management Regulations* detail specific requirements surrounding the classification and assessment of waste for disposal to landfill (See references). Note that a GHS (SANS10234) compliant classification and safety data sheet is required before a final waste management decision should be taken and should be read in conjunction with this assessment.

Standard Operational Procedure:

Identification of analysis methods:

IW-S-1: Determination of Metals in Liquids and solids using ICP-OES Optima 8300; IW-S-2: Determination of the VOC content of liquid and solids using GC6850, MS5976C; IW-S-3: pH Measurement; IW-S-4: EC Measurement; IW-S-5: Calibration and measurement of samples using Supercal Modular calorimeter; IW-S-6: Toxicity characteristic leaching procedure – TCLP; IW-S-7: Field Protable X-ray Flourecence FTXRF; AS 4439.1-1999: Wastes, sediments and contaminated soils - Preparation of leachates - Preliminary assessment; AS 4439.3-1997: Wastes, sediments and contaminated soils - Preparation of leachates - Bottle leaching procedures.

Scope of Accreditation:

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2- Solids & Liquids	Determination of VOC; BTEX by GC/MS Headspace	IW-M-02 - Based on method EPA 8260B; EPA 5030B(Liquid) and EPA 5035 (solid)
3- Potable water & leachates	pH at 25 ^{o}C	IW-M-03
4- Potable water & leachates	Electrical Conductivity at 25^{o}C	IW-M-04

Disclaimer:

Analysis results relate only to the samples submitted. The laboratory has no control over the sampling protocol, the representivity of the samples and the manner in which the samples were collected, transported, stored, preserved or otherwise handled outside of the laboratory facility and therefore takes no responsibility whatsoever for these activities. Third parties using INTERWASTE results can verify the results by contacting the laboratory. INTERWASTE are not liable or responsible for the customer use and/or interpretation of test results. This certificate cannot be reproduced without the written consent of INTERWASTE laboratory.

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References

1.) Government Notice R.365, National Environmental Management: Waste Act (59/2008): National norms and standards for the assessment of waste for landfill disposal, Gazette No. 36

Signed by:Dr. Cheila Canario
Signed at:2022-10-20 14:06:33 +02:00
Reason:Chief Chemist

BIOTOX LAB
www.biotoxsa.co.za
Company registration number: 2012/106020/07
VAT number: 4740264959

Tests performed at: GAUTENG OFFICE:
P.O. Box 11216, Silver Lakes, Pretoria, 0054
78 Pony Street, Tijgervallei Office Park, Block 5, Unit 2, Silver Lakes
Fax: 086 535 7368
Tel: 012 753 2192
Email: lizet@biotoxsa.co.za or marliseb@biotoxsa.co.za

ilac-MRA sanas Testing Laboratory T0663

Toxicity Specialists

TOXICITY TEST REPORT

For:
Aquatico Laboratories

89 Regency Drive, Route 21 Corporate Park, Irene
PO Box 905008, Garsfontein, 0042
theo@aquatico.co.za/outsource@aquatico.co.za

Survey:
2022-10

Report reference:
AQL-WST-A-22_TOX(sup)

Revision:
0

Project:
GCS-Waste

Samples:
KDiscard1, KSlurry1

Tests performed by: Praise Manyenga (Senior Analyst); Lethabo Mothupi (Junior Analyst)
Inputs and results verified by: Praise Manyenga (Laboratory Manager)
Classification (DEEEP) performed by: Marlise Brown (Quality Assurance Manager)

Report approved by:

Lizet Swart
Quality Manager

Results approved by:

Praise Manyenga
Technical Signatory

Report issue date
16 November 2022

A= Accredited NA =Not accredited O=Outsourced S=Sub-contracted NR=Not requested RTF=Results to follow
The results relate only to the test item(s) tested and for samples as sampled and received from the Client
Results marked "Not SANAS Accredited" in this report are not included in the SANAS Schedule of Accreditation for this laboratory

Table of contents

List of Tables

1. ANALYSES REQUESTED AND SAMPLE INFORMATION

Enclosed please find Test Certificate of analysis number AQL-WST-A-22_TOX(sup). The results relate only to the sample(s) tested. BioToxLab does not accept responsibility for any matters arising from the further use of the results. Tests marked "Not SANAS accredited" (NA or OS) in this Certificate of Analyses are not included in the SANAS Schedule of Accreditation for this Laboratory.

No part of this Certificate of Analyses may be quoted in isolation of the rest of the text without the written permission of BioToxLab. Opinions and Interpretations expressed herein are outside the scope of SANAS accreditation.

Please contact the Laboratory if further information is required.

Table 1: Analyses requested and description for the different samples, including sampling and delivery dates.

Sample name	Sampling date	Sample type (water, sediment, product etc)	Sampled by	Delivery date	Delivered by	Additional comments (sample description or deviations)	Tests requested - Marked with X								
									Water					Sediment	
							Screening	Definitive	*Daphnia magna*	*Poecilia reticulata*	*Alliivibrio fischeri*	*Selenastrum capricornutum*	*Spirodela polyrhiza*	Phyto seeds	Ostracod
KDiscard1	2022.10.10	DI leachate from a coal slurry and coal discard	Aquatico	2022.10.14	Aquatico	Delivered >3 days after sampling		X	X	X		X			
KSlurry1	2022.10.10	DI leachate from a coal slurry and coal discard	Aquatico	2022.10.14	Aquatico	Delivered >3 days after sampling		X	X	X		X			

Key:
Screening = 100% (undiluted) sample tested only
Definitive = Series of sample dilutions tested to enhance classification accuracy and to determine safe dilution

2. METHODOLOGY

Sampling and sample handling

Samples were analysed as received from the Client. The samples received from Aquatico Laboratories were exposed as definitives on 3 trophic levels (*Selenastrum capricornutum*, *Daphnia magna* and *Poecilia reticulata*).

Test Conditions

All toxicity tests were conducted in environmentally controlled rooms using standard techniques.

Quality Assurance

The BioToxLab Aquatic Toxicology Laboratory's Policy and Quality Manual, intended to support and maintain all aspects of the Quality System, is based on the application of ISO/IEC 17025. The following Quality Assurance information can be made available on request (1) inhouse reference toxicant test data and control charts (2) Proficiency Testing Scheme (PTS) test data (3) lot and batch numbers (4) raw toxicity test data.

Assessments

Given the limitations of substance-specific assessments, and the risk of allowing ecological toxicity hazards to go unchecked/undetected, water resource managers and scientists have for some time called for methodologies that will allow more complete assessment s of ecological toxicity hazards to be used in addition to the substance-specific approach. The National Water Act (Act no. 36 of 1998), providing for water in sufficient quantity and in sufficient quality for basic human needs and for maintenance of aquatic ecosystem function, implemented an approach known as the

Direct Estimation of Ecological Effect Potential (DEEEP) protocol as a means of circumventing the shortcomings of direct toxicant monitoring. This protocol consists of a battery of tests to directly assess lethal (acute) and sub-lethal (chronic) toxicity, using test organisms from a range of trophic levels. These toxicity tests can demonstrate whether contaminants are bioavailable, it can evaluate the aggregate toxic effects of all contaminants in the medium and it can evaluate the toxicity of substances whose biological effects may not have been well characterized.

Lethal or sub-lethal toxicity testing (as applied for this assessment) is applied by exposing biota to water sources in order to determine the potential risk of such waters to the biota/biological integrity of the receiving water bodies and the environment. A risk category is determined based on the percentage of mortalities (lethal) or inhibition (sub-lethal) of the exposed biota. It is important to note that the hazard classification is based on the standardised battery of selected test biota and therefore represents the risk/hazard towards similar biota in the receiving aquatic environment. The toxicity hazard is therefore in terms of the aquatic biotic integrity and does in no way represent toxicology towards humans or other mammals.

Physical and chemical properties as required to be performed by the standard toxicity methods are also presented in this report as supplementary data to the toxicity testing data.

Standard, internationally accepted methods and materials were applied in order to conduct lethal and sub-lethal toxicity testing.

***Selenastrum capricornutum* sub-lethal growth inhibition test (A)**

Synonym:	*Raphidocelis subcapitata; Pseudokirchneriella subcapitata*			
BioToxLab method number:	QM7.2/TMH-02			
Standard method:	SANS 8692:2015			
Deviation from the method:	None			
Test endpoint:	EC_{20}/EC_{50}			
Exposure period:	72-hours			
Test chamber type:	10cm path length long cells			
Test sample volume:	25 mL			
Number of replicates per sample:	3			
Test temperature (21-25°C):	22.7°C – 23.7°C			
Test organism species name and source:	*Selenastrum capricornutum*, Printz algae beads (CCAP 278/4 Cambridge, UK)			
Optical density measurement:	Jenway 6300 Spectrophotometer			
Algal beads batch number(s):	SC 260422			
Matrix dissolving batch number(s):	MD 200722			
Nutrient batch number(s):	A: SC030522	B: SC030522	C: SC030522	D: SC030522
Statistical methods used:	Microsoft Excel® spreadsheet formulated by supplier (MicroBioTests Inc., Belgium) – RegTox and Regression analysis			
Date(s) of performance of the test(s):	2022.10.18			
Uncertainty of measurement:	Available on request			
Validity (from Regtox sheet: cell density factor ≥67):	Yes			

Daphnia magna lethality toxicity test (A)

BioToxLab method number:	QM7.2/TMH-03
Standard method:	SANS 6341: 2015
Deviation from the method:	None
Test endpoint:	LC_{10}/LC_{50}
Exposure period:	24- and 48-hours
Test chamber type:	Polycarbonate test plates (6 rinsing wells and 24 testing wells)
Test sample volume:	25 mL
Number of replicates per sample:	4
Number of test organisms per chamber:	5
Test temperature (20-22°C):	21.0°C
Test organism species name, age & source:	*Daphnia magna* – ephippia obtained from MicroBiotests, <24h old
Feeding frequency during testing:	None
Ephippia batch number(s):	DM240322
ISO media batch number(s):	ISO070622
Statistical methods used:	Microsoft Excel®
Date(s) of performance of the test(s):	2022.10.24
Uncertainty of measurement:	Available on request
Validity criteria (control mortality≤10%):	0%

Poecilia reticulata lethality toxicity test (A)

BioToxLab method number:	QM7.2/TMH-04
Standard method:	SANS 7346-1: 2013
Deviation from the method:	None
Test endpoint:	LC_{10}/LC_{50}
Exposure period:	96-hours
Test chamber type:	250 mL disposable polystyrene cups
Test sample volume:	200 mL
Number of replicates per sample:	2
Number of test organisms per chamber:	6
Test temperature (22-24°C):	23.0°C – 23.8°C
Test organism species name, age & source:	*Poecilia reticulata* – 7-21 days old. Obtained from external stock
Feeding frequency during testing:	None
ISO media batch number(s):	ISO070622
Statistical methods used:	Microsoft Excel®
Date(s) of performance of the test(s):	2022.10.24
Uncertainty of measurement:	Available on request
Validity criteria (control mortality≤10%):	8.33%

Physical and chemical properties

Parameter	BioToxLab Method number	Test temperature (25°C±3°C)	Instrument	Batch number(s)	Date(s) of test(s)
pH (A)	QM7.2/TMC-05	26.0°C	HQ440d	pH1.67: N/A pH4: A1354 pH7: A2122A pH10: A1334	2022.10.18
EC (A)	QM7.2/TMC-06	26.0°C	HQ440d	1413µS/m: A1306	2022.10.18
Dissolved oxygen (NA)	QM7.2/TMC-07	26.0°C	HQ440d	N/A	2022.10.18
Uncertainty of measurement for accredited (A) methods available on request					

3. HAZARD CLASSIFICATION METHODOLOGY

The toxicity unit (TU) for each test performed is calculated as 100% (full strength effluent expressed as percentage) divided by the effective concentration or LC_{50} expressed as percentage sample dilution (e.g. *Daphnia magna* and *Poecilia reticulata* lethal toxicity tests) and EC_{50} (e.g. *Aliivibrio fischeri* bioluminescent test and *Selenastrum capricornutum* growth inhibition tests) (Tonkes & Baltus, 1997) (Table 2). If there is insufficient toxicity in a sample to allow for the determination of an EC_{50}/LC_{50} value, then a toxicity unit of <1 will be assigned to the sample.

Table 2: Toxicity Units (Tonkes and Baltus, 1997)

Toxicity Unit	Conclusion/Description
<1	Limited to no toxicity
1 – 2	Negligibly toxic
2 – 10	Mildly toxic
10 – 100	Acutely toxic
> 100	Highly toxic

A risk/hazard category is determined by using a hazard classification system developed by Persoone *et al*. (2003) whereby one can classify sites using the toxicity data of the non-diluted samples. The percentage effect (PE) of toxicity (mortalities, growth inhibition, luminescence inhibition) is used to rank the sample into one of five classes (Table 3 – effluent/waste samples) based on the highest toxic response obtained in at least one of the tests applied.

Table 3: Hazard classification system for effluent/waste samples

Class	Symbol	Hazard rating	PE	Percentage effect
I	☺	No lethal/sub-lethal hazard	≤10/20%	None of the tests show a toxic effect (i.e. an effect value that is significantly higher than that noted in the controls)
II	☹	Slight lethal/sub-lethal hazard	10/20%≤PE<50%	A statistically significant (P<0.05) PE is reached in at least one test, but the effect level is below 50% (TU<1)
III	☠	Lethal/sub-lethal hazard	50%≤PE<100%	The 50% effect level is reached or exceeded in at least one test but the effect level is below 100% (1≤TU<10)
IV	☠☠	High lethal/sub-lethal hazard	PE 100% in at least one test	The 100% effect is reached exceeded in at least one test (10≤TU<100)
V	☠☠☠	Very high lethal/ sub-lethal hazard	PE 100% in all tests	The 100% effect is reached or exceeded in all the tests applied (TU≥100)

Each sample is furthermore weighted (Table 4) according to its relative toxicity level (out of 100%). Higher values indicate that more of the individual tests indicated toxicity within a specific class.

Table 4: Weight score allocation for each test type (Persoone *et al*. (2003))

Score	Category
0	No significant toxicity effect
1	Significant toxicity effect < PE50
2	Toxicity effect >PE50 but <PE100
3	The PE100 is reached

Class weight score calculated as follows:
Class weight score = (∑ all test scores)/n) where n is the number of tests performed
Class weight score % = (class score) / (maximum class weight score) x 100

EP (Percentage effect) = an effect measured either as mortality or inhibition (depending on the type of test). A >10% effect is regarded as slight lethal toxicity for *Daphnia* and *Poecilia* while a >20% effect is regarded as slight sub-lethal toxicity for *Selenastrum*. A 50% effect is regarded as a lethal/sub-lethal toxicity for all the tests (*Daphnia*, *Poecilia* and *Selenastrum*)

The toxicity hazard for each dilution level used to assess the hazard and perform calculations and classifications are presented in Table 5 in order to asses/review data trends and are done according to the following scale:

Table 5: Hazard class per dilution level scale

Scale	Description
0-≤10% (*Daphnia, Poecilia*) 0-≤20% (*Selenastrum*)	Not toxic
10-<50 (*Daphnia, Poecilia*) 20-<50 (*Selenastrum*)	Slightly toxic
50-<100 (*Daphnia, Poecilia, Selenastrum*)	Toxic
≥100 (*Daphnia, Poecilia, Selenastrum*)	Highly toxic

4. RESULTS AND HAZARD CLASSIFICATION DATA

Table 6: Hazard classification of water samples

Site/ sample	Microalgae (A) *Selenastrum capricornutum*			Crustacea (A) *Daphnia magna*			Vertebrates (A) *Poecilia reticulata*			Weight %
	% effect	TU	Test score	% effect	TU	Test score	% effect	TU	Test score	
KDiscard1	-8.80	<1	0	0	<1	0	0	<1	0	0
KSlurry1	-30.05	<1	1	0	<1	0	0	<1	0	33

TUs not applicable to screening testing (N/A)

Table 7: Hazard classification of water sample dilutions (as per Table 5 methodology)

Sample name	Dilution level	Toxicity hazard	Sample name	Toxicity hazard	Sample name	Toxicity hazard
S. capricornutum KDiscard1	100%	Not toxic	*D. magna* KDiscard1	Not toxic	*P. reticulata* KDiscard1	Not toxic
	50%	Not toxic		Not toxic		Not toxic
	25%	Not toxic		Not toxic		Not toxic
	10%	Not toxic		Not toxic		Not toxic
	1%	Not toxic		Not toxic		Not toxic
S. capricornutum KSlurry1	100%	Slightly toxic	*D. magna* KSlurry1	Not toxic	*P. reticulata* KSlurry1	Not toxic
	50%	Slightly toxic		Not toxic		Not toxic
	25%	Slightly toxic		Not toxic		Not toxic
	10%	Not toxic		Not toxic		Slightly toxic
	1%	Slightly toxic		Not toxic		Not toxic

Table 8: Site hazard classification of water samples

	Results	KDiscard1	KSlurry1
Water quality	Test date yy/mm/dd	2022.10.18	2022.10.18
	pH @ 25°C (A)	8.1	8.4
	EC (Electrical conductivity) (mS/m) @ 25°C (A)	29.3	55.6
	Dissolved oxygen (mg/l) (NA)	6.9	7.8
S. capricornutum (micro-algae) (A)	Test started on yy/mm/dd	2022.10.18	2022.10.18
	%72hour inhibition (-) / stimulation (+) (%)	-9(F)	-30(F)
	EC/LC20 (72hours)	n.r.	n.c.
	EC/LC50 (72hours)	n.r.	n.r.
	Toxicity unit (TU) / Description	<1	<1
D. magna (waterflea) (A)	Test started on yy/mm/dd	2022.10.24	2022.10.24
	%48hour mortality rate (-%)	0	0
	EC/LC10 (48hours)	n.r.	n.r.
	EC/LC50 (48hours)	n.r.	n.r.
	Toxicity unit (TU) / Description	<1	<1
P. reticulata (guppy) (A)	Test started on yy/mm/dd	2022.10.24	2022.10.24
	%96hour mortality rate (-%)	0	0
	EC/LC10 (96hours)	n.r.	6
	EC/LC50 (96hours)	n.r.	n.r.
	Toxicity unit (TU) / Description	<1	<1
Estimated safe dilution factor (%) [for definitive testing only]		None required	<1
Overall classification - Hazard class***		Class I - No lethal/sub-lethal hazard	Class II - Slight lethal/sub-lethal hazard
Weight (%)		0	33

Key:

% = for definitive testing, only the 100% concentration (undiluted) sample mortality/inhibition/stimulation is reflected by this summary table. The dilution series results are considered for EC/LC values and Toxicity unit determinations

n.r. = not relevant, i.e. the 100% concentration caused less than 10/20/50% (effective concentration) mortalities or inhibition

n.c. = not calculable, although the 100% concentration led to more than 20% inhibition, the 20% inhition rate was exceeded throughout the test

(F) = Inhibition/Mortality rate with "(F)" indicates that the sample was filtered, this is often essential with turbid or coloured samples to perform the *Selenastrum* test. Filtration could potentially lower the toxicity for the specific test, but *Daphnia* and *Poecilia* test samples are never filtered and hence toxicity will still be detected if affected by filtration

*** = The overall hazard classification takes into account the full battery of tests and is not based on a single test result. Note that the overall hazard classification is expressed as both lethal (*Daphnia* & *Poecilia*) and sub-lethal (*Selenastrum*) levels of toxicity

Weight (%) = relative toxicity levels (out of 100%), higher values indicate that more of the individual tests indicated toxicity within a specific class

site/sample name shaded in orange = definitive test

Site	Hazard classification			Percentage Effect
KDiscard1	I	☺	No lethal/sub-lethal hazard	None of the tests show a toxic effect (i.e. an effect value that is significantly higher than that noted in the controls)
KSlurry1	II	☹	Slight lethal/sub-lethal hazard	A statistically significant (P<0.05) PE is reached in at least one test, but the effect level is below 50% (TU<1)

Sample KDiscard1 showed no lethal or sub-lethal environmental toxicity hazard (Class I). Sample KSlurry1 was classified as having a slight lethal and sub-lethal environmental toxicity hazard (Class II) based on the 30% micro-algae (*S. capricornutum*) growth inhibition effect (sub-lethal) together with the 16.67% vertebrate *(P. reticulata*) mortality effect (lethal) noted on the 10% dilution level (although no significant toxicity was noted on the 100% sample result) (refer to Table 7).

5. COMMENTS

Two liquid samples (DI leachates) were delivered to the BioToxLab office on 2022.10.14. The pH levels of the samples were 8.06 (KDiscard1) and 8.40 (KSlurry1) which are within the acceptable range (pH 6-9) in which pH can be excluded as a driving factor for toxicity (USEPA, 1996). The conductivities (ECs) of the samples were 29.3 mS/m (KDiscard1) and 55.6 mS/m (KSlurry1). A dissolved oxygen (DO) concentration above 4 mg/L is required for aquatic organisms (USEPA, 1996) to survive. The DO levels for the 2 samples were 6.94 mg/L (KDiscard1) and 7.75 mg/L (KSlurry1).

This report (AQL-WST-A-22_TOX(sup)) now supersedes the previous report (AQL-WST-A-22_TOX) sent as a typing error picked up was corrected.

Any queries regarding the results can be lodged with Lizet Swart within 14 days from the date of receiving this report after which the samples will be discarded. It is not advised to use these samples for any retesting other than range confirmation of chemical parameters – re-sampling must be done in the case of any queries relating to the results associated with the samples.

6. REFERENCES

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (USEPA), 1996. Ecological effects test guidelines. Fish acute toxicity test, Freshwater and marine. OPPTS 850.1075.

END OF REPORT

APPENDIX B: SAFETY DATA SHEETS

SAFETY DATA SHEET (SDS)

Sample ID: 'KDiscard1'

Section 1: Identification	
Product or Sample Name:	KDiscard1
Chemical Name:	Mixture
Chemical Formula:	Not Applicable
Sample Type:	Coal Discard
CAS Number:	Not Applicable
EC Number:	Not Applicable
Identified Uses:	Not Applicable
Company (Generator) Name:	Kangra Coal (Pty) Ltd Werk
Emergency Telephone Number:	Not Available

Section 2: Hazards Identification	
Classification According to Regulation (EC) No. 1272/2008	
Description:	Black Powder; immiscible; low odour
Physical:	None
Flammability:	Negative; Flash Point = Negative at 30, 60 and 90 degrees Celsius - sample has no flammability
Health:	Acute Toxicity: Category 5 Carcinogen - Category 1A Specific Target Organ Toxicity - Repeated Exposure - Category 1
Aquatic Toxicity Hazard:	Not Classified; Class I (Non-lethal/Sub-lethal Hazard) (Persoone, G, et. al., 2003)
Pictogram(s):	
Signal Word(s):	Danger Warning

Hazard Statement(s):	May be Harmful if Swallowed (H303) May be Harmful if Inhaled (H333) Causes eye irritation (H320) May cause cancer due to inhalation (H350) Causes damage to lungs through prolonged or repeated exposure via inhalation (H372) Harmful to Aquatic Life (H402)
Precautionary Statement(s):	IF INHALED: (P304) + Call a POISON CENTRE or Doctor/Physician if you feel unwell (P312) Obtain special instructions before use (P201) Do Not Handel until all Safety Precautions have been Read & Understood (P202) Use Personal Protective Equipment as Required (P281) IF EXPOSED OR CONCERNED: Get medical advise/attention (P308 + P313) Store locked up (P405) Collect spillage (P391) Do not breathe dust/fume/gas/mist/vapours/spray (manufacturer/supplier or the competent authority to specify applicable conditions (P260) Wash ...thoroughly after handling (manufacturer/supplier or the competent authority to specify parts of the body to be washed after handling (P264) Do not eat, drink or smoke when using this product (P270) Get medical advise/attention if you feel unwell (P314) Dispose of contents/container to ... (P501) - Class C liner (Type 3) Avoid Release to the Environment - *if this is not the intended use* (P273) If in Eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present, and easy to do. Continue rinsing (P305+P351+P338) If Eye Irritation Persists: (P337) + Get Medical Advice/Attention (P313)

Section 3: Composition/Information on Ingredients

Table 2: XRF results, elemental composition.

VARIABLE	UNITS	MONITORING LOCALITIES	CAS Number
		KDiscard1	
Fe	%	3.270	7439-89-6
Si	%	16.085	7440-21-3
Al	%	5.043	7429-90-5
K	%	1.178	7440-09-7
P	%	0.027	7723-14-0
Mn	%	0.021	7440-66-6
Ca	%	2.425	7440-70-2
Mg	%	0.272	7439-95-4
Ti	%	0.303	7440-32-6
Na	%	0.275	7440-23-5
V	%	0.006	7440-62-2
Ba	%	0.083	7440-39-3
Cr	%	0.027	7440-47-3
Sr	%	0.053	7440-24-6
Zr	%	0.030	7440-67-7
Mn	%	0.021	7439-96-5
LOI	%	44.350	-
Total XRF (oxides)	%	99.440	-

Section 4: First-Aid Measures

Possible Routes of Exposure: Oral & inhalation.
Main route(s) selected: Oral

Ingestion: Rinse mouth thoroughly with plenty of water. Drink plenty of water. Do not induce vomiting. Consult a doctor/physician if patient feels unwell.

Inhalation: If breathing difficulty is observed administer oxygen (qualified person) and if breathing has ceased administer artificial respiration. Call a poison centre or consult a doctor/physician if patient feels unwell.

Eye Contact: Thoroughly rinse opened eyes with water for several minutes. Do not rub eyes. Remove any contact lenses if possible and continue rinsing. Consult a doctor/physician if necessary or if irritation persists.

Skin Contact: Wash the area of contact thoroughly with soap and water. Consult a doctor/physician if patient feels unwell.

Immediate Medical Attention Required: Unknown.
Possible Symptoms and/or Effects: Unknown.
Possible Delayed Effects:

- May potentially cause cancer.
- Can cause damage to lungs through inhalation with prolonged or repeated exposure.

Section 5: Fire-Fighting Measures

Suitable Extinguishing Media:
Not Flammable.

Inappropriate Extinguishers:
None Identified.

Specific Hazards Arising from the Mixture:
None Identified.

Special Protective Equipment and Precautions for Fire Fighters:
No specific precautions identified based on nature of waste stream.
Appropriate protective equipment should be used, e.g., overall, boots, gloves and eye and face protection together with a breathing apparatus.

Section 6: Accidental Release Measures

Personal Precautions: Use appropriate PPE. Wash hands and clothing after handling. Remove and wash clothing after handling.

Environmental Precaution: Prevent entry of spilled product into waterbodies, waterways or confined areas.

Methods for Containment & Clean-up: SHEQ Department procedures for contamination containment and remediation (also refer to Section 13).

Remaining accidental release measures are not applicable.

Section 7: Handling and Storage

Precautions for Safe Handling and Storage:
Make use of appropriate PPE (respiratory masks with appropriate filters, overalls, safety glasses, gloves).

For safe storage refer to waste type determination.
Ensure no unauthorised entry to the storage site. Ensure proper ventilation.

Section 8: Exposure Controls/Personal Protection

Occupational Exposure Limits:

Particulates not otherwise regulated – Total Dust:
OSHA PEL: TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (respirable)
General Industry – TWA 15mg/m^3
Construction – TWA 15mg/m^3
NIOSH REL: TWA 10mg/m^3 (total) TWA 5 mg/m^3 (respirable)
ACGIH: TWA 10 mg/m^3 (inhalation of particles)

ECHA – Information on Chemicals (REACH Dossiers):
The derived no-or minimum effect level (DN(M)EL) – depicts the exposure level(s) above which humans should not be exposed to a substance.

Two main potentially hazardous constituents: Si & Al (see available data below).

1.) Crystalline Silica:
OSHA PEL: 0.05 mg/m$_3$ (8 hrs)
NIOSH REL: 0.05 mg/m$_3$ (quartz dust)

2.) Aluminium

Oral Exposure (general population): Long term systemic effect with repeated exposure – DNEL 3.95mg/Kg/bw/day.
Acute systemic effects – Not Applicable.
Local Effects: No Data Available.
Data on Workers: No Data Available.

Inhalation Exposure (workers): Long term systemic effect with repeated exposure – DNEL 3.72mg/m^3.
Long-term local effects – the same as systemic effects. No acute hazard identified.
General Population: No hazards identified (systemic nor local).

Dermal Exposure: No acute or long-term hazard identified in terms of systemic or local effects in the general population or for workers.

Appropriate Engineering Controls:
Refer to Section 7 of this SDS – no additional specific engineering controls identified.

Individual Protection Measures:

Avoid inhaling dust and contact with eyes. Make use of appropriate PPE (respiratory masks with appropriate filters, overalls, safety glasses, gloves), all compliant with relevant standards (e.g., NOISH, and or European Standards or equivalent (EU or OSHA). All PPE must be certified and approved.

Section 9: Physical & Chemical Properties	
a.) Appearance	Rough, black granular texture; immiscible
b.) Odour	Low Odour
c.) Odour Threshold	Not Determined
d.) pH	Paste pH 7.34
e.) Melting Point/Freezing Point	Not Determined
f.) Initial Boiling Point and Boiling Range	Not Determined
g.) Flash Point	Negative at 30°C, 60°C & 90°C
h.) Evaporation Rate	Not Determined
i.) Flammability (solid or gas)	Not Flammable
j.) Upper/Lower Flammability or Explosive Limits	Not Determined
k.) Vapour Pressure	Not Determined
l.) Vapour Density	Not Determined
m.) Relative Density	2.087 g/cm^3
n.) Solubility	Not Determined
o.) Partition Coefficient: n-octanol/water	Not Determined
p.) Auto-ignition Temperature	Not Determined
q.) Decomposition Temperature	Not Determined
r.) Viscosity	Not Determined

Section 10: Stability & Reactivity	
a.) Reactivity	Redox Potential (85)
b.) Chemical Stability	Substance appears stable under normal ambient conditions; unauthorised entry not permitted
c.) Possibility of Hazardous Reactions	None Known
d.) Conditions to Avoid	None Known
e.) Incompatible Materials	None Known
f.) Hazardous Decomposition Products	None Known

Section 11: Toxicological Information	
Potential Exposure Routes Investigated:	Main route: Oral (inhalation also considered for certain high risk elements)
Likely Exposure Route:	Oral or Inhalation (fine dust)
a.) Acute Toxicity	Category 5
b.) Skin Corrosion/Irritation	Not Classified
c.) Serious Eye Damage & Eye Irritation	Not Classified
d.) Respiratory Sensitization and Skin Sensitization	Not Classified
e.) Germ Cell Mutagenicity	Not Classified
f.) Carcinogenicity	Category 1A
g.) Reproductive Toxicity	Not Classified
h.) Specific Target Organ Toxicity - Single Exposure	Not Classified
i.) Specific Target Organ Toxicity - Repeated Exposure	Category 1
j.) Aspiration Hazards	Not Classified

Supplementary Information:

Crystalline Silica dust (identified as a human carcinogen) if inhaled, could cause adverse health effects (e.g., Silicosis) with chronic repetitive exposure if these particles are of respirable size (<10 µm) and at high concentrations (i.e., exceeding those found naturally in the environment). Silicosis affects lung function and increases susceptibility to secondary infections such as tuberculosis (CCOHS & IARC).
Similarly, aluminium dust has been known to cause effects in the lungs when inhaled, such as granuloma, proteinosis of alveoli, pneumonia, etc. (CCOHS).

Section 12: Ecological Information	
1.) Toxicity	
Acute Aquatic Toxicity	Not Classified; Class I (Non-lethal/Sub-lethal Hazard) (Persoone, G, et. al., 2003)
Chronic Aquatic Toxicity	Not Applicable unless analysed as a whole - Mixture (Environmental Fate Data Required)
2.) Persistance & Degradability	No analysed
3.) Bioaccumulative Potential	No analysed
4.) Mobility in Soil	No analysed
5.) Other Adverse Effects	None Known

Section 13: Disposal Considerations
Based on the assessment a waste Type 3 was identified. The GNR 636 (2013) stipulates a Class C liner requirement for Type 3 waste streams.

Section 14: Transport Information	
UN Number	None (Waste Mixture)
UN Proper Shipping Name	None (Waste Mixture)
Transport Hazard Class(es)	None (Waste Mixture)
Packing Group	Not Applicable
Environmental Hazards	Unknown. Limited information as to individual ingredients. Keep away from water sources.
Specific Precautions	Appropriate PPE should be worn

Section 15: Regulatory Information
Ingredients of the 'KDiscard1' mixture were evaluated in accordance with the SANS 10234 (2008) standard to assess any potential hazard.
Additional: Legal Framework applicable to integrated waste management in South Africa and potentially applicable to the waste stream under investigation: The Stockholm Convention on Persistent Organic Pollutants (POP's), to which SA became a signatory in 2001 and ratified in 2002 (requires that member countries phase out POP's and prevent their import and export).

Section 16: Other Information	
Compilation Date & Date of Issue:	16-Nov-22
SDS Supplier:	Aquatico Scientific (Pty) Ltd

A composite sample of the waste stream was received by Aquatico and accepted based on the conjecture that it is representative of the waste stream.

All data obtained from the sampled waste stream is considered to be accurate and reflective of quality during the time of sampling. No kinetic type analyses were conducted to measure changes over time and it was assumed that no significant changes would occur. Aquatico takes no responsibility for reliability/accuracy/suitability of information based on analyses performed, legislative compliance (e.g., repealed or amended legislation) or intended use (including consequences thereof) for the waste streams tested and shall not be held liable. Classification was performed based on available data.

Abbreviations / Acronyms:

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Literature References:

- EPA. 1991. R.E.D. facts. Silicon dioxide and silica gel. U.S. Environmental Protection Agency. 738F91107. http://www.epa.gov/pesticides/chem_search/reg_actions/reregistration/fs_G-74_1-Sep-91.pdf. October 6, 2015.
- IARC. 1997. Silica. IARC Monographs on the evaluation of carcinogenic risks to humans. Volume 68. Silica, some silicates, coal dust and para-aramid fibrils. Lyon, France: International Agency for Research on Cancer. https://monographs.iarc.fr/wp-content/uploads/2018/06/mono68-6.pdf. December 12, 2018.
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008), 1 July 2009.
- National Environmental Management: Waste Amendment Act, 2014 (Act No. 26 of 2014). GG37714, 2 June 2014.
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). Waste Classification and Management Regulations, GG36784, GNR 634, 23 August 2013.
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). National Norms and Standards for the Assessment of Waste for Landfill Disposal, GG36784, GNR 635, 23 August 2013.
- National Environmental Management: Waste Act, 2008 (Act No. 59 of 2008). National Norms and Standards for Disposal of Waste to Landfill, GG36784, GNR 636, 23 August 2013.

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- SABS: SANS 10234 (2008). Globally Harmonized System of Classification and Labelling of Chemicals (GHS). Edition 1.1.
- Soregaroli, B.A. & Lawrence, R.W. (1998). Update on Waste Characterisation Studies. Proc. Mine Design, Operations & Closure Conference. Polson, Montana.

SAFETY DATA SHEET (SDS)

Sample ID: 'KSlurry1'

Section 1: Identification	
Product or Sample Name:	KSlurry1
Chemical Name:	Mixture
Chemical Formula:	Not Applicable
Sample Type:	Coal Slurry
CAS Number:	Not Applicable
EC Number:	Not Applicable
Identified Uses:	Not Applicable
Company (Generator) Name:	Kangra Coal (Pty) Ltd Werk
Emergency Telephone Number:	Not Available

Section 2: Hazards Identification	
Classification According to Regulation (EC) No. 1272/2008	
Description:	Black Powder; immiscible; low odour
Physical:	None
Flammability:	Negative; Flash Point = Negative at 30, 60 and 90 degrees Celsius - sample has no flammability
Health:	Acute Toxicity: Category 5 Carcinogen - Category 1A Specific Target Organ Toxicity - Repeated Exposure - Category 1
Aquatic Toxicity Hazard:	Not Classified; Class II (Slight lethal/Sub-lethal Hazard) (Persoone, G, et. al., 2003)
Pictogram(s):	
Signal Word(s):	Danger Warning

Hazard Statement(s):	May be Harmful if Swallowed (H303) May be Harmful if Inhaled (H333) Causes eye irritation (H320) May cause cancer due to inhalation (H350) Causes damage to lungs through prolonged or repeated exposure via inhalation (H372) Harmful to Aquatic Life (H402); May cause long lasting harful effects to aquatic life (H413)
Precautionary Statement(s):	IF INHALED: (P304) + Call a POISON CENTRE or Doctor/Physician if you feel unwell (P312) Obtain special instructions before use (P201) Do Not Handel until all Safety Precautions have been Read & Understood (P202) Use Personal Protective Equipment as Required (P281) IF EXPOSED OR CONCERNED: Get medical advise/attention (P308 + P313) Store locked up (P405) Collect spillage (P391) Do not breathe dust/fume/gas/mist/vapours/spray (manufacturer/supplier or the competent authority to specify applicable conditions (P260) Wash ...thoroughly after handling (manufacturer/supplier or the competent authority to specify parts of the body to be washed after handling (P264) Do not eat, drink or smoke when using this product (P270) Get medical advise/attention if you feel unwell (P314) Dispose of contents/container to ... (P501) - Class C liner (Type 3) Avoid Release to the Environment - *if this is not the intended use* (P273) If in Eyes: Rinse cautiously with water for several minutes. Remove contact lenses if present, and easy to do. Continue rinsing (P305+P351+P338) If Eye Irritation Persists: (P337) + Get Medical Advice/Attention (P313)

Section 3: Composition/Information on Ingredients

Table 2: XRF results, elemental composition.

VARIABLE	UNITS	KSlurry1	CAS Number
Fe	%	3.892	7439-89-6
Si	%	25.275	7440-21-3
Al	%	4.117	7429-90-5
K	%	1.755	7440-09-7
P	%	0.018	7723-14-0
Mn	%	0.029	7440-66-6
Ca	%	2.308	7440-70-2
Mg	%	0.212	7439-95-4
Ti	%	0.263	7440-32-6
Na	%	0.326	7440-23-5
V	%	0.006	7440-62-2
Ba	%	0.079	7440-39-3
Cr	%	0.063	7440-47-3
Sr	%	0.041	7440-24-6
Zr	%	0.037	7440-67-7
Mn	%	0.029	7439-96-5
LOI	%	22.897	-
Total XRF (oxides)	%	97.257	-

Section 4: First-Aid Measures

Possible Routes of Exposure: Oral & inhalation.
Main route(s) selected: Oral

Ingestion: Rinse mouth thoroughly with plenty of water. Drink plenty of water. Do not induce vomiting. Consult a doctor/physician if patient feels unwell.

Inhalation: If breathing difficulty is observed administer oxygen (qualified person) and if breathing has ceased administer artificial respiration. Call a poison centre or consult a doctor/physician if patient feels unwell.

Eye Contact: Thoroughly rinse opened eyes with water for several minutes. Do not rub eyes. Remove any contact lenses if possible and continue rinsing. Consult a doctor/physician if necessary or if irritation persists.

Skin Contact: Wash the area of contact thoroughly with soap and water. Consult a doctor/physician if patient feels unwell.

Immediate Medical Attention Required: Unknown.
Possible Symptoms and/or Effects: Unknown.
Possible Delayed Effects:

- May potentially cause cancer.
- Can cause damage to lungs through inhalation with prolonged or repeated exposure.

Section 5: Fire-Fighting Measures

Suitable Extinguishing Media:
Not Flammable.

Inappropriate Extinguishers:
None Identified.

Specific Hazards Arising from the Mixture:
None Identified.

Special Protective Equipment and Precautions for Fire Fighters:
No specific precautions identified based on nature of waste stream.
Appropriate protective equipment should be used, e.g., overall, boots, gloves and eye and face protection together with a breathing apparatus.

Section 6: Accidental Release Measures

Personal Precautions: Use appropriate PPE. Wash hands and clothing after handling. Remove and wash clothing after handling.

Environmental Precaution: Prevent entry of spilled product into waterbodies, waterways or confined areas.

Methods for Containment & Clean-up: SHEQ Department procedures for contamination containment and remediation (also refer to Section 13).

Remaining accidental release measures are not applicable.

Section 7: Handling and Storage

Precautions for Safe Handling and Storage:
Make use of appropriate PPE (respiratory masks with appropriate filters, overalls, safety glasses, gloves).

For safe storage refer to waste type determination.
Ensure no unauthorised entry to the storage site. Ensure proper ventilation.

Section 8: Exposure Controls/Personal Protection

Occupational Exposure Limits:

Particulates not otherwise regulated – Total Dust:
OSHA PEL: TWA 10 mg/m^3 (total) TWA 5 mg/m^3 (respirable)
General Industry – TWA 15mg/m^3
Construction – TWA 15mg/m^3
NIOSH REL: TWA 10mg/m^3 (total) TWA 5 mg/m^3 (respirable)
ACGIH: TWA 10 mg/m^3 (inhalation of particles)

ECHA – Information on Chemicals (REACH Dossiers):
The derived no-or minimum effect level (DN(M)EL) – depicts the exposure level(s) above which humans should not be exposed to a substance.

Two main potentially hazardous constituents: Si & Al (see available data below).

1.) Crystalline Silica:
OSHA PEL: 0.05 mg/m$_3$ (8 hrs)
NIOSH REL: 0.05 mg/m$_3$ (quartz dust)

2.) Aluminium

Oral Exposure (general population): Long term systemic effect with repeated exposure – DNEL 3.95mg/Kg/bw/day.
Acute systemic effects – Not Applicable.
Local Effects: No Data Available.
Data on Workers: No Data Available.

Inhalation Exposure (workers): Long term systemic effect with repeated exposure – DNEL 3.72mg/m^3.
Long-term local effects – the same as systemic effects. No acute hazard identified.
General Population: No hazards identified (systemic nor local).

Dermal Exposure: No acute or long-term hazard identified in terms of systemic or local effects in the general population or for workers.

Appropriate Engineering Controls:
Refer to Section 7 of this SDS – no additional specific engineering controls identified.

Individual Protection Measures:

Avoid inhaling dust and contact with eyes. Make use of appropriate PPE (respiratory masks with appropriate filters, overalls, safety glasses, gloves), all compliant with relevant standards (e.g., NOISH, and or European Standards or equivalent (EU or OSHA). All PPE must be certified and approved.

Section 9: Physical & Chemical Properties	
a.) Appearance	Black granular texture; immiscible
b.) Odour	Low Odour
c.) Odour Threshold	Not Determined
d.) pH	Paste pH 7.94
e.) Melting Point/Freezing Point	Not Determined
f.) Initial Boiling Point and Boiling Range	Not Determined
g.) Flash Point	Negative at 30°C, 60°C & 90°C
h.) Evaporation Rate	Not Determined
i.) Flammability (solid or gas)	Not Flammable
j.) Upper/Lower Flammability or Explosive Limits	Not Determined
k.) Vapour Pressure	Not Determined
l.) Vapour Density	Not Determined
m.) Relative Density	2.335 g/cm^3
n.) Solubility	Not Determined
o.) Partition Coefficient: n-octanol/water	Not Determined
p.) Auto-ignition Temperature	Not Determined
q.) Decomposition Temperature	Not Determined
r.) Viscosity	Not Determined

Section 10: Stability & Reactivity	
a.) Reactivity	Redox Potential (135)
b.) Chemical Stability	Substance appears stable under normal ambient conditions; unauthorised entry not permitted
c.) Possibility of Hazardous Reactions	None Known
d.) Conditions to Avoid	None Known
e.) Incompatible Materials	None Known
f.) Hazardous Decomposition Products	None Known

Section 11: Toxicological Information	
Potential Exposure Routes Investigated:	Main route: Oral (inhalation also considered for certain high risk elements)
Likely Exposure Route:	Oral or Inhalation (fine dust)
a.) Acute Toxicity	Category 5
b.) Skin Corrosion/Irritation	Not Classified
c.) Serious Eye Damage & Eye Irritation	Not Classified
d.) Respiratory Sensitization and Skin Sensitization	Not Classified
e.) Germ Cell Mutagenicity	Not Classified
f.) Carcinogenicity	Category 1A
g.) Reproductive Toxicity	Not Classified
h.) Specific Target Organ Toxicity - Single Exposure	Not Classified
i.) Specific Target Organ Toxicity - Repeated Exposure	Category 1
j.) Aspiration Hazards	Not Classified

Supplementary Information:

Crystalline Silica dust (identified as a human carcinogen) if inhaled, could cause adverse health effects (e.g., Silicosis) with chronic repetitive exposure if these particles are of respirable size (<10 µm) and at high concentrations (i.e., exceeding those found naturally in the environment). Silicosis affects lung function and increases susceptibility to secondary infections such as tuberculosis (CCOHS & IARC).
Similarly, aluminium dust has been known to cause effects in the lungs when inhaled, such as granuloma, proteinosis of alveoli, pneumonia, etc. (CCOHS).

Section 12: Ecological Information	
1.) Toxicity	
Acute Aquatic Toxicity	Not Classified; Class II (Slight lethal/Sub-lethal Hazard) (Persoone, G, et. al., 2003)
Chronic Aquatic Toxicity	Not Applicable unless analysed as a whole - Mixture (Environmental Fate Data Required); above-mentioned toxicity slso based on chronic species
2.) Persistance & Degradability	No analysed
3.) Bioaccumulative Potential	No analysed
4.) Mobility in Soil	No analysed
5.) Other Adverse Effects	None Known

Section 13: Disposal Considerations
Based on the assessment a waste Type 3 was identified. The GNR 636 (2013) stipulates a Class C liner requirement for Type 3 waste streams.

Section 14: Transport Information	
UN Number	None (Waste Mixture)
UN Proper Shipping Name	None (Waste Mixture)
Transport Hazard Class(es)	None (Waste Mixture)
Packing Group	Not Applicable
Environmental Hazards	Unknown. Limited information as to individual ingredients. Keep away from water sources.
Specific Precautions	Appropriate PPE should be worn

Section 15: Regulatory Information
Ingredients of the 'KSlurry1' mixture were evaluated in accordance with the SANS 10234 (2008) standard to assess any potential hazard.
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