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Characterisation and Classification of Wastes at the Proposed Dunbar Coal Mine

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Report	
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1 BACKGROUND AND OBJECTIVES

1.1 Introduction

Vandabyte (Pty) Ltd (hereafter the Applicant), intends to establish a coal mining operation on an area of rural farmland located approximately 14 km West of the town of Hendrina, in the Mpumalanga Province of South Africa. The proposed coal mining operation, which will be known as the Dunbar Coal Mine, is aimed at mining coal reserves over a total mining right of some 1 797 hectares comprising two separate areas located on a Portion of Portion 1, Portion 2 and the remaining extent of the Farm Dunbar 189 IS, Portion 1 of the Farm Middelkraal 50 IS and Portion 6 of the Farm Halfgewonnen 190 IS located in the Mpumalanga Province.. The Applicant holds an approved prospecting right (reference number MP 30/5/1/1/2/10737 PR) for these properties. Figure 1.1 presents a map indicating the location of the two Dunbar mining right areas.

The proposed Dunbar Coal Mine operation will utilise a conventional opencast roll-over mining method for the extraction of coal from two seams that form part of the Witbank Coalfields succession present in the area, with the total coal resource for the Dunbar Coal Mine estimated at some 21 million tons.

According to the Mine Works Program for the Dunbar Coal Mine (Nurizon, 2019) The proposed roll-over mining sequence comprises the following activities:

- Initial topsoil and soft overburden removal which will be stockpiled to ensure it can be replaced back in the initial box cut;
- The physical mining of the coal seam which includes drilling of hard overburden material, charging and blasting;
- The coal is loaded into trucks and hauled to the crushing and screening facility;
- Discard coal will be extracted and replaced in the bottom of the opencast pit, while the product will be taken to the weighbridge via trucks and then removed off site;
- The overburden is replaced back into the pit as mining progresses leaving a minimum area open at any given time;
- The topsoil which was stripped and stockpiled separately before mining commenced is then replaced.

Surface infrastructure associated with the mining operation include, among other, a coal crushing screening and washing plant, Run-of-Mine (RoM) and coal product stockpiles, overburden and top soils stockpiles, pollution control dam, as well as offices workshops, services and worker ablution facilities.

1.2 Study Context and Scope

The intention to undertake mining activities requires an application for a Mining Right in terms of the Minerals and Petroleum Resources Development Act, Act No. 28 of 2002 (MPRDA). In support of this application, an Integrated Environmental Authorisation process is being undertaken for the Dunbar Coal Mine.

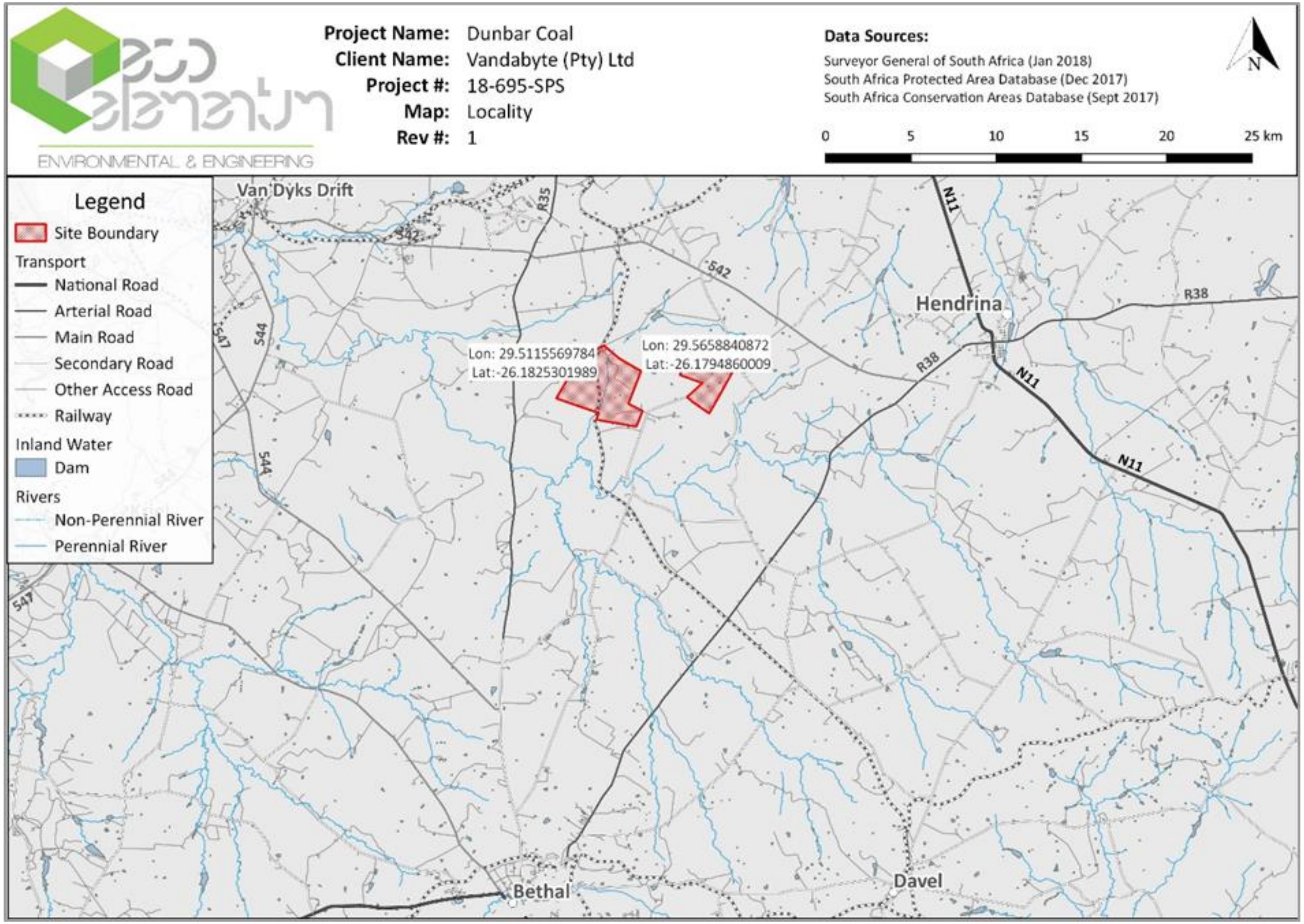

Figure 1.1 **Location of the Dunbar Coal Mine mining right (Enviro Insight, 2019).**

As part of this process, a Scoping and Environmental Impact Assessment (S&EIA) is being prepared on behalf of the Applicant by independent environmental practitioners, Enviro-Insight CC.

Eco Elementum (Pty) Ltd was appointed by Enviro-Insight CC to perform specialist assessments in support of the S&EIA and broader Integrated Environmental Authorisation process, conducted for the proposed Dunbar Coal Mine by. Eco Elementum (Pty) Ltd appointed EnviroSim to perform the characterisation and classification of the mining and mineral processing residues that will be stockpiled at the Dunbar Coal Mine.

The management and stockpiling of mining and mineral processing residues is governed under the National Environmental Management Waste Act (58 of 2008) (NEM:WA). In terms of waste classification, NEM:WA refers to three regulations. These are regulation 634 (GNR634), regulation 635 (GNR635) and regulation 636 (GNR636), promulgated under NEM:WA and published in Government Gazette No 36784 of 23 August 2013.

GNR634 (Waste Classification and Management Regulations) provides generic regulations for the classification and management of waste. GNR635 (National Norms and Standards for the Assessment of Waste for Landfill Disposal) provides regulations governing the waste material assessment methodology, while GNR636 (National Norms and Standards for Disposal of Waste to Landfill) provides regulations for selecting the appropriate barrier system subject to the results of the assessment under GNR635.

The objective of this study is to present information on the characteristics of the mining and mineral processing residue materials that will be stockpiled at the Dunbar Coal Mine, and to determine whether the nature and chemical properties of the residue materials would require implementation of precautionary measures from a waste management perspective.

The study is not an identification or assessment of impacts and is simply a classification in accordance with the principles adopted the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR635).

2 SAMPLES AND ANALYTICAL DATA

2.1 INTRODUCTION

Based on a description of the planned operations at the Dunbar Coal Mine (Nurizon, 2019) it is understood that the mining and mineral processing residues will include discard coal and waste rock (also referred to as overburden) that will be stockpiled for future use in the rehabilitation of the excavations once mining is completed. Although the RoM and coal products that will be temporarily stockpiled on site have the potential to contribute waterborne contaminants to the environment, these will be managed in a manner that prevents environmental pollution, and furthermore, the coal materials do not fall under the definition of waste.

Coal discard is generated from the density separation (so-called washing) of mined coal. RoM brought out from the mine consists of organic and mineral matter components, with different density. The RoM is cleaned or 'washed' by separating the lower-density organic material from the higher-density discard, based on the differential in buoyancy. In the wash plant a process called heavy-media separation is applied. The heavy-media separation process involves the use of a suspension of finely divided magnetite in water to provide a medium with a specific gravity, which is adjusted to the characteristics of the coal chosen to achieve a given degree of separation and achieve the desired product quality, and the acceptable level of coal loss.

The discard generated from the wash process is a low quality coal that contains sulphur and other incombustible minerals (ash) at concentrations too high for its intended use. Although coal discard contains significant amounts of usable carbon, and can be seen as a significant resource, the coal discard generated at the Dunbar Coal Mine is treated as a waste for the purpose of this assessment. According to the Mine Works Program for the Dunbar Coal Mine (Nurizon, 2019), the discard will be placed at the bottom

Waste rock is rock that is incidental to the mining operation and which is brought to the surface in order to access the resource being mined. Figure 2.1 show a schematic representation of the stratigraphy of the Witbank Coalfields succession at the Dunbar Coal Mine. According to the Scoping Report prepared by Enviro Insight (2019), the lower No 4 and No 2 coal seams represent the primary resource that will be extracted at the Dunbar Coal Mine. The layers of rock present in-between the coal seams (indicated as overburden and interburden in Figure 2.1) represent the waste rock that will be extracted to access the coal. The waste rock will be stockpiled on site, to be replaced back into the pit as mining progresses.

2.2 SAMPLES

In accordance with the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR635) the classification of waste is based on the results of laboratory test work and analysis conducted on representative samples of the waste material.

Ave (m)	Profile	Lithology
0 to 27		Overburden
0.46		5 Seam
35		Interburden
< 1.0		4U Seam
2.5		Interburden
3.76		4L Seam
15		Interburden
5.72		2 Seam
		Tillite
		Felsite

Figure 2.1 Dunbar stratagraphic succession.

Since the proposed Dunbar Coal Mine is not yet operational, samples of the discard and indeed the waste rock, is not yet available. As substitute, exploration drill cores, representative of the coal seam as well as overburden and a layer of carbonaceous shale interburden was used. The three samples are identified as follows:

- DC-OVB – Assumed to represent the overburden
- DBR Carb Shl – Assumed to represent a carbonaceous shale layer of the interburden
- NDB08/4L/2 – Assumed to represent the No 4 lower coal seam.

The drill core samples was collected by Eco Elementum and submitted to the WaterLab analytical laboratory in Pretoria for analysis. The following is a list of the analysis conducted on the samples:

- Mineralogical analysis
- Major element compositional analysis
- Determination of the nett acid generating potential
- Acid Base accounting
- Sulphur speciation
- Total elemental analysis
- Leach testing and analysis

The sections that follow present and discuss the results from the testing and analysis performed on the samples of waste rock and coal from the Dunbar Coal Mine.

2.3 Laboratory Test and Analysis Results

2.3.1 Mineralogical Composition

The information received from Eco Elementum include a report by WaterLab, which report the results of an x-ray diffraction analysis performed on the sample of waste rock and coal from the Dunbar Coal Mine.

The report indicates the mineralogical composition o the sample as follows (see Table 2.1). A copy of the report by XRD Analytical Consulting is attached as Annexure A.

Table 2.1 Summary of the reported mineralogical composition of the waste rock and coal samples.

Mineral	Formula	DC-OVB	DBR Carb Shl	INDB08/4L/2
		Amount (weight %)		
Quartz	SiO_2	76.25	29.78	12.81
Kaolinite	$Al_2Si_2O_5(OH)_4$	-	59.49	35.25
Rutile	TiO2	-	0.64	0.43
Muscovite	$K\ Al_2\ ((OH)_2\ Al\ Si_3\ O_{10})$	1.94	3.53	0
Calcite	$CaCO_3$	1.9	0	1.3
Pyrite	FeS	-	0	0.39
Dolomite	Fe_3O_4	-	0.96	4.33
Orthoclase	$K\ Al\ Si_3\ O_8$	3.01	-	-
Plagioclase	$(Na,Ca)(Si,Al)_4O_8$	12.73	-	-
Sepiolite	$Mg_4Si_6O_{15}(OH)_2 \bullet 6(H_2O)$	4.17	-	-
Organic Carbon	C	-	5.59	45.49

The results indicate that the two samples representing waste rock (DC-OVB & DBR Carb Shl) consist predominantly of silicates (quartz and kaolinite). Important to note as that both waste rock samples contain no, or at least very little, pyrite. The coal sample (INDB08/4L/2) consist of less than 50% carbon with a significant quantity of silicates. Given the understanding of what coal discard would constitute, this coal sample is accepted to be indicative of a typical discard coal. The coal sample is shown to contain a trace quantity of pyrite, at 0.39%.

2.3.2 Acid Generating Potential

The analytical data provided by Eco Elementum includes three sets of results which can be used to determine the acid generating potential of a material. In geological materials such as coal and the geological strata associated with coal deposits, the presence of sulphide minerals point to a potential for generating acid

Sulphide minerals are unstable in the presence of atmospheric oxygen and oxidise to form sulphate, ferrous iron and acidity (H^+) as products, as follows:

$$FeS_{2(s)} + \frac{7}{2}O_{2(aq)} + H_2O \rightarrow Fe^{2+} + 2SO_4^{2-} + 2H^+$$

Water in contact with the oxidation products have a low pH induced and the resulting solution has the potential to dissolve major and trace metallic elements from the material.

The first set of analytical data that can be used to indicate the potential for acid production is sulphur speciation results. In this analysis the oxidation state or species of sulphur and carbon present in the sample is determined. Table 2.2 presents a summary of the results from speciation analysis performed on the Dunbar Coal Mine waste rock and coal samples. A copy of the laboratory report is attached as Annexure A.

The results indicate that most of the sulphur present in the samples is present as sulphide, with less of it indicated as the oxidised sulphate species.

Table 2.2 Summary of carbon and sulphur speciation results for the waste rock and coal samples.

Parameter	DC-OVB	DBR Carb Shl	INDB08/4L/2
	Weight %		
Total Sulphur	0.06	0.09	1.25
S (sulphate)	0.01	0.05	0.43
S (sulphide)	0.05	0.03	0.81

The presence of sulphide in the coal sample indicate that the material has a potential to generate acid under oxidative conditions, while the very low concentration of sulphate in the waste rock samples indicate very little chance of these materials generating acid. This is confirmed by results from Nett Acid Generation (NAG) testing performed on the samples. Table 2.3 present a summary of the NAG results. A copy of the laboratory report is attached as Annexure A.

Table 2.3 Summary of NAG results for the waste rock and coal samples.

Sample	NAG pH: (H_2O_2)	NAG at pH 4.5	NAG at pH 7.0
	-	kg $H_2SO_4.t^{-1}$	
DC-OVB	8.3	<0.01	<0.01
DBR Carb Shl	6.5	<0.01	0.2
INDB08/4L/2	7	<0.01	<0.01

NAG is a static test used to give an indication of acid forming potential. It involves the addition of H_2O_2 to a prepared sample of mine rock or process residue to oxidise reactive sulphide minerals, followed by measurement of the pH of the reaction solution and titration of any net acidity produced. Generally, a NAG pH below 4.5 is indicative of a potentially acid generating material

NAG results is best used in conjunction with other static methods, such as Acid-Base Accounting (ABA). Table 2.4 present results of an ABA test conducted on the samples of Dunbar Coal Mine waste rock and coal. ABA investigates the balance between the acid production and acid consumption properties of a material to give an indication of whether the material could produce acidic conditions in water that comes in contact with the materials.

The first aspect to note from the results is a pH above 7 is measured for all samples. The results of the ABA further indicate that the samples of waste rock are non-acid forming while the coal sample is indicated as intermediate.

Table 2.4 Summary of ABA results for the waste rock and coal samples.

Sample	Paste pH	Total Sulphur	Acid Potential (AP)	Neutralization Potential (NP)	Nett Neutralization Potential (NNP)	Neutralising Potential Ratio (NPR) (NP : AP)
		%	kg $CaCO_3.t^{-1}$			NP:AP
DC-OVB	8.4	0.06	1.9	15	13	7.98
DBR Carb Shl	7.4	0.09	2.66	4.8	2.14	1.8
INDB08/4L/2	7.6	1.25	39	46	7.54	1.19

2.3.3 Total Analysis

Table 2.5 presents a summary of the total element composition of the Dunbar Coal Mine waste rock and coal samples submitted for analysis. Elements and ions listed are those detected above the limit of detection, or those of importance with regard to environmental and human health. For a full list of the analytes determined see Annexure A.

The total element composition analysis was performed in accordance with the methods prescribed in GNR 635 as follows:

- Acid digestion (total digestion)of the sample; followed by quantitative analysis by inductively coupled optical emission spectrometry (ICP-OES), and other methods, for the following:
  - ICP analysis for 30 elements;
  - Additional analysis for mercury (Hg), hexavalent chromium (Cr VI) and total fluoride (F).

2.3.4 Leach Testing and Analysis

Table 2.6 presents a summary of the leach test and analysis results of the Dunbar Coal Mine waste rock and coal samples. Elements and ions listed in Table 2.6 are those detected above the limit of detection, or those of importance with regard to environmental and human health. For a full list of the analytes determined see Annexure A.

Table 2.5 Summary of elemental analysis results for the waste rock and coal samples.

Parameter	DC-OVB	DBR Carb Shl	INDB08/4L/2

	mg.kg^{-1}		
As	0.5	2.4	6.1
B	<10	<10	51.2
Ba	757.6	356.4	381.2
Cd	<0.400	0.4	<0.400
Co	<10	12.0	<10
Cr (total)	194.8	225.6	77.6
Cr(VI)	<5	<5	<5
Cu	<4.00	22.0	7.6
F	262.0	410.0	267.0
Hg	<0.400	<0.400	0.4
Mn	166.4	69.2	116.8
Ni	<10	27.2	11.2
Pb	23.1	29.4	26.4
V	<10	74.0	24.4
Zn	29.2	101.2	16.0

The leach test and analysis was performed in accordance with the methods prescribed in GNR 635 as follows:

- An aqueous extraction conducted at a liquid to solid ratio of 20:1, in accordance with the prescribed leach testing procedure AS 4439.3 (1997) standard, which is analysed as follows:
  - ICP analysis for 30 elements;
  - Total dissolved salt (TDS) concentration and specific anions and cations including Cr(VI), Cl, SO_4, NO_3 as N, and F;
  - pH of the leach solution;

Table 2.6 Summary of leach test results for the waste rock and coal samples.

Parameter	DC-OVB	DBR Carb Shl	INDB08/4L/2
	mg.L^{-1}		
As	0.004226	<0.001	<0.001
B	<0.025	<0.025	<0.025
Ba	0.036	0.138	0.056
Cd	<0.001	<0.001	<0.001
Co	<0.025	<0.025	<0.025
Cr (total)	<0.025	<0.025	<0.025
Cr(VI)	<0.01	<0.01	<0.01
Cu	<0.010	<0.010	<0.010
F	<0.2	<0.2	<0.2
Fe	0.108	0.041	<0.025
Hg	<0.001	<0.001	0.029687
Mn	0.102	<0.025	<0.025
Ni	<0.025	<0.025	<0.025
Pb	<0.001	0.00417	<0.001
V	<0.025	<0.025	<0.025
Zn	<0.025	0.323	<0.025

pH	6.6	6.8	6.9

The leach test confirms the ABA and NAG results by reporting a near neutral pH value as for all the materials. Accordingly, almost no metallic elements, aside from iron (Fe), is dissolved in noteworthy concentrations from any of the samples.

3 CHARACTERISATION AND CLASSIFICATION

3.1 Material Characteristics

The waste rock and coal materials from the Dunbar Coal Mine contain very low concentrations of oxidisable sulphides. Even if all the available sulphides are oxidised, it is unlikely that the natural pH of the materials would be significantly altered. The analytical results reported for the Dunbar samples indicate that waste rock, as well as likely also any coal discard which may be generated at the operations, are geochemically stable.

3.2 Classification Approach

The approach used for the classification of waste, as prescribed under the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR 635), involves the determination of a Risk Profile for the waste, by following the prescribed testing and leach testing protocols, described in Section 2.3.

The results must be assessed against the threshold levels for Leachable (LCT) and Total Concentrations (TCT) which, in combination, determine the Risk Profile of the waste as set out below. The threshold values and waste types are documented in GNR 635, *viz*:

- *Type 4 Waste: wastes with all determinant concentrations below the LCT0 and TCT0 values;*
- *Type 3 Waste: wastes with any determinant concentration above the LCT0 but below the LCT1 value and all determinant concentrations below the TCT1 values;*
- *Type 2 Waste; wastes with any determinant concentration above the LCT1 but below the LCT2 values, and all determinant concentrations below the TCT1 values;*
- *Type 1 Waste: wastes with any determinant concentration above the LCT2 but below the LCT3 values, or above the TCT1 but below the TCT2 values; and*
- *Type 0 Waste: wastes with any determinant concentration above the LCT3 or TCT2 values.*

3.3 Disposal Requirements

Following the classification of waste, the derived waste type is used to determine the requirements for the disposal of the waste in terms of containment barrier design and/or landfill classification. The disposal requirements for each waste type prescribed under the National Norms and Standards for Disposal of Waste to Landfill (GNR 636) are as follows:

- *Type 4 Waste: may only be disposed of at a Class D landfill;*
- *Type 3 Waste: may only be disposed of at a Class C landfill;*
- *Type 2 Waste; may only be disposed of at a Class B landfill;*
- *Type 1 Waste: may only be disposed of at a Class A landfill; and*

- *Type 0 Waste: disposal to landfill is not allowed, waste must be treated and reassessed.*

The minimum engineering design requirements for the containment barrier of each landfill class is graphically summarised in GNR 636 as follows (see Figure 3.1 to Figure 3.4):

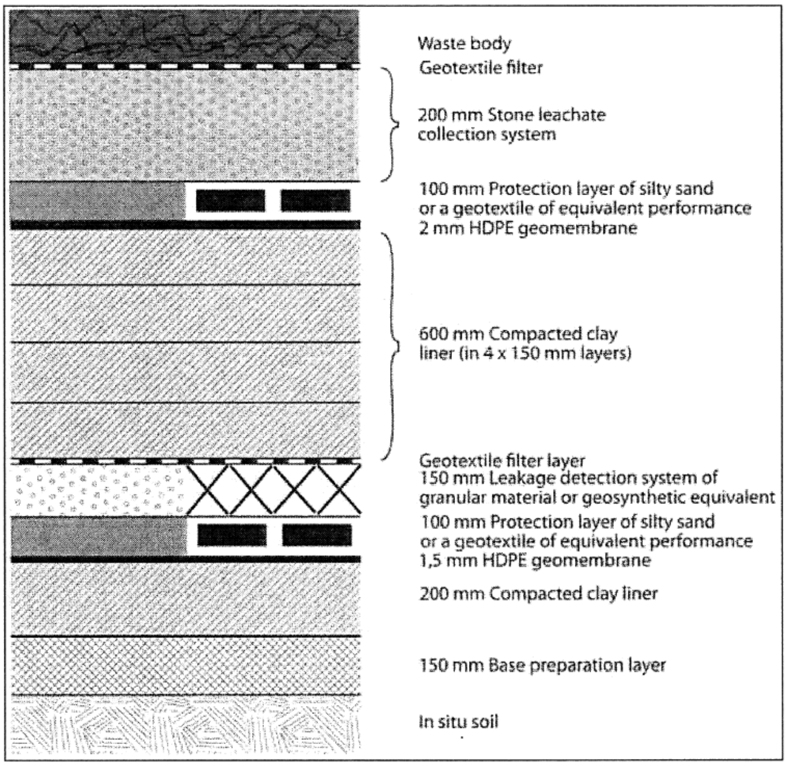

Figure 3.1 Class A containment barrier design

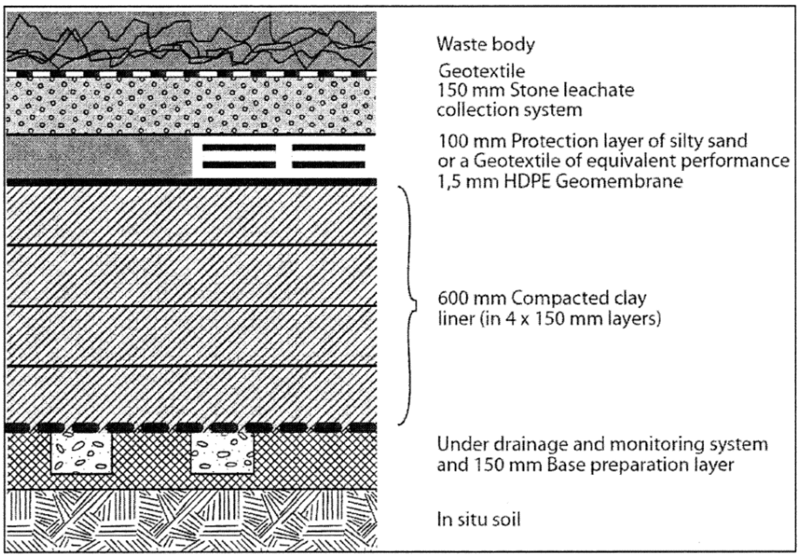

Figure 3.2 Class B containment barrier design

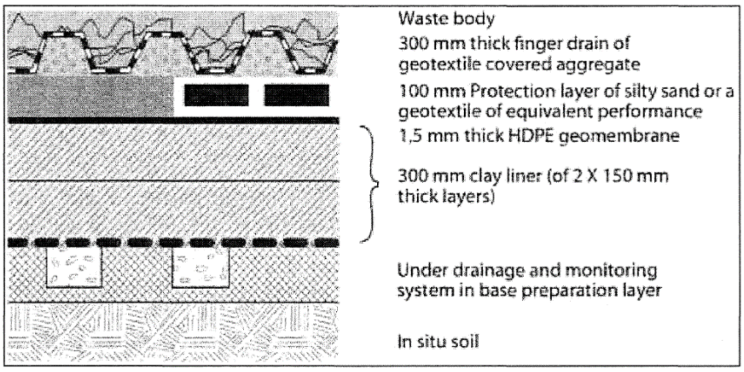

Figure 3.3 Class C containment barrier design

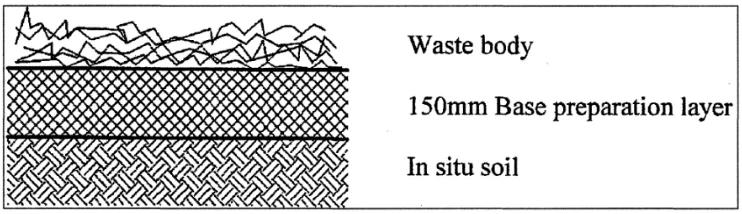

Figure 3.4 Class D containment barrier design

3.4 CLASSIFICATION UNDER GNR 635

Table 3.1 to Table 3.3 lists the total and leachable concentrations of inorganic determinants measured in the samples of waste rock and coal from the Dunbar Coal Mine.

Table 3.1 to Table 3.3 further list the leachate and total concentration threshold values prescribed in GNR 635. The threshold value columns are shaded and where the reported total concentration or leach concentration exceeds the threshold, the values are shaded correspondingly.

Based on the comparison of the measured total and leachable concentrations with the threshold values, the overburden, carbonasios shale and coal materials from the Dunbar Coal Mine all classify as Type 3. The Type 3 classification is due to the total concentration of Arsenic, Barium, Copper, Lead and Fluoride and the leachate concentrations of Mercury from the coal sample (INDB08/4L/2). The concentrations of these elements exceed the TCT0 and LCT0 values only by a small margin and are all well below the TCT1 and LCT1 values.

Table 3.1 Waste Classification Table for Inorganic Determinants in the DC-OVB Sample from the Dunbar Coal Mine.

	Determinant	Measured Concentrations		Threshold Levels (GNR 635)							Waste Type
		Total Concentration (TC)	Leachate Concentration (LC)	TCT0	TCT1	TCT2	LCT0	LCT1	LCT2	LCT3	
		mg.kg^{-1}	mg.L^{-1}	mg.kg^{-1}			mg.L^{-1}				
Metal Ions	As, Arsenic	0.54	0.004	5.8	500	2 000	0.01	0.5	1	4	Type 4
	B, Boron	<10	<0.025	150	15 000	60 000	0.5	25	50	200	Type 4
	Ba, Barium	757.6	0.036	62.5	6 250	25 000	0.7	35	70	280	Type 3
	Cd, Cadmium	<0.400	<0.001	7.5	260	1 040	0.003	0.15	0.3	1.2	Type 4
	Co, Cobalt	<10	<0.025	50	5 000	20 000	0.5	25	50	200	Type 4
	CrTotal, Chromium Total	194.8	<0.025	46 000	800 000	N/A	0.1	5	10	40	Type 4
	Cr(VI), Chromium (VI)	<5	<0.010	6.5	500	2 000	0.05	2.5	5	20	Type 4
	Cu, Copper	<4.00	<0.010	16	19 500	78 000	2	100	200	800	Type 4
	Hg, Mercury	<0.400	<0.001	0.93	160	640	0.006	0.3	0.6	2.4	Type 4
	Mn, Manganese	166.4	0.102	1 000	25 000	100 000	0.5	25	50	200	Type 4
	Mo, Molybdenum	<10	<0.025	40	1 000	4 000	0.07	3.5	7	28	Type 4
	Ni, Nickel	<10	<0.025	91	10 600	42 400	0.07	3.5	7	28	Type 4
	Pb, Lead	23.1	<0.001	20	1 900	7 600	0.01	0.5	1	4	Type 3
	Sb, Antimony	<0.400	<0.001	10	75	300	0.02	1	2	8	Type 4
	Se, Selenium	<0.400	<0.001	10	50	200	0.01	0.5	1	4	Type 4
	V, Vanadium	<10	<0.025	150	2 680	10 720	0.2	10	20	80	Type 4
	Zn, Zinc	29.2	<0.025	240	160 000	640 000	5	250	500	2 000	Type 4
Inorganic Ions	Total Dissolved Solids*	-	56	N/A	N/A	N/A	1 000	12 500	25 000	100 000	Type 4
	Chloride as Cl	-	<2	N/A	N/A	N/A	300	15 000	30 000	120 000	Type 4
	Fluoride as F	262	<0.2	100	10 000	40 000	1.5	75	150	600	Type 3
	Nitrate as N	-	<0.1	N/A	N/A	N/A	11	550	1 100	4 400	Type 4
	Sulphate as SO_4	-	2	N/A	N/A	N/A	250	12 500	25 000	100 000	Type 4

Table 3.2 Waste Classification Table for Inorganic Determinants in the DBR Carb Shl Sample from the Dunbar Coal Mine

Determinant		Measured Concentrations		Threshold Levels (GNR 635)							Waste Type
		Total Concentration (TC)	Leachate Concentration (LC)	TCT0	TCT1	TCT2	LCT0	LCT1	LCT2	LCT3	
		mg.kg^{-1}	mg.L^{-1}	mg.kg^{-1}			mg.L^{-1}				
Metal Ions	As, Arsenic	2.38	<0.001	5.8	500	2 000	0.01	0.5	1	4	Type 4
	B, Boron	<10	<0.025	150	15 000	60 000	0.5	25	50	200	Type 4
	Ba, Barium	356.4	0.138	62.5	6 250	25 000	0.7	35	70	280	Type 3
	Cd, Cadmium	0.4	<0.001	7.5	260	1 040	0.003	0.15	0.3	1.2	Type 4
	Co, Cobalt	12	<0.025	50	5 000	20 000	0.5	25	50	200	Type 4
	CrTotal, Chromium Total	225.6	<0.025	46 000	800 000	N/A	0.1	5	10	40	Type 4
	Cr(VI), Chromium (VI)	<5	<0.010	6.5	500	2 000	0.05	2.5	5	20	Type 4
	Cu, Copper	22	<0.010	16	19 500	78 000	2	100	200	800	Type 3
	Hg, Mercury	<0.400	<0.001	0.93	160	640	0.006	0.3	0.6	2.4	Type 4
	Mn, Manganese	69.2	<0.025	1 000	25 000	100 000	0.5	25	50	200	Type 4
	Mo, Molybdenum	<10	<0.025	40	1 000	4 000	0.07	3.5	7	28	Type 4
	Ni, Nickel	27.2	<0.025	91	10 600	42 400	0.07	3.5	7	28	Type 4
	Pb, Lead	29.4	0.004	20	1 900	7 600	0.01	0.5	1	4	Type 3
	Sb, Antimony	<0.400	<0.001	10	75	300	0.02	1	2	8	Type 4
	Se, Selenium	<0.400	<0.001	10	50	200	0.01	0.5	1	4	Type 4
	V, Vanadium	74	<0.025	150	2 680	10 720	0.2	10	20	80	Type 4
	Zn, Zinc	101.2	0.323	240	160 000	640 000	5	250	500	2 000	Type 4
Inorganic Ions	Total Dissolved Solids*	-	50	N/A	N/A	N/A	1 000	12 500	25 000	100 000	Type 4
	Chloride as Cl	-	<2	N/A	N/A	N/A	300	15 000	30 000	120 000	Type 4
	Fluoride as F	410	<0.2	100	10 000	40 000	1.5	75	150	600	Type 3
	Nitrate as N	-	<0.1	N/A	N/A	N/A	11	550	1 100	4 400	Type 4
	Sulphate as SO_4	-	<2	N/A	N/A	N/A	250	12 500	25 000	100 000	Type 4

Table 3.3 Waste Classification Table for Inorganic Determinants in the INDB08/4L/2 Sample from the Dunbar Coal Mine

Determinant		Measured Concentrations		Threshold Levels (GNR 635)							Waste Type
		Total Concentration (TC)	Leachate Concentration (LC)	TCT0	TCT1	TCT2	LCT0	LCT1	LCT2	LCT3	
		$mg.kg^{-1}$	$mg.L^{-1}$	$mg.kg^{-1}$			$mg.L^{-1}$				
Metal Ions	As, Arsenic	6.08	<0.001	5.8	500	2 000	0.01	0.5	1	4	Type 4
	B, Boron	51.2	<0.025	150	15 000	60 000	0.5	25	50	200	Type 4
	Ba, Barium	381.2	0.056	62.5	6 250	25 000	0.7	35	70	280	Type 4
	Cd, Cadmium	<0.400	<0.001	7.5	260	1 040	0.003	0.15	0.3	1.2	Type 4
	Co, Cobalt	<10	<0.025	50	5 000	20 000	0.5	25	50	200	Type 4
	CrTotal, Chromium Total	77.6	<0.025	46 000	800 000	N/A	0.1	5	10	40	Type 4
	Cr(VI), Chromium (VI)	<5	<0.010	6.5	500	2 000	0.05	2.5	5	20	Type 4
	Cu, Copper	7.6	<0.010	16	19 500	78 000	2	100	200	800	Type 4
	Hg, Mercury	0.4	0.03	0.93	160	640	0.006	0.3	0.6	2.4	Type 4
	Mn, Manganese	116.8	<0.025	1 000	25 000	100 000	0.5	25	50	200	Type 4
	Mo, Molybdenum	<10	<0.025	40	1 000	4 000	0.07	3.5	7	28	Type 4
	Ni, Nickel	11.2	<0.025	91	10 600	42 400	0.07	3.5	7	28	Type 4
	Pb, Lead	26.44	<0.001	20	1 900	7 600	0.01	0.5	1	4	Type 4
	Sb, Antimony	<0.400	<0.001	10	75	300	0.02	1	2	8	Type 4
	Se, Selenium	<0.400	<0.001	10	50	200	0.01	0.5	1	4	Type 4
	V, Vanadium	24.4	<0.025	150	2 680	10 720	0.2	10	20	80	Type 4
	Zn, Zinc	16	<0.025	240	160 000	640 000	5	250	500	2 000	Type 4
Inorganic Ions	Total Dissolved Solids*		54	N/A	N/A	N/A	1 000	12 500	25 000	100 000	Type 4
	Chloride as Cl		<2	N/A	N/A	N/A	300	15 000	30 000	120 000	Type 4
	Fluoride as F	267	<0.2	100	10 000	40 000	1.5	75	150	600	Type 4
	Nitrate as N		<0.1	N/A	N/A	N/A	11	550	1 100	4 400	Type 4
	Sulphate as SO_4		6	N/A	N/A	N/A	250	12 500	25 000	100 000	Type 4

4 CONCLUSIONS AND RECOMMENDATIONS

The evaluation presented above indicates that the waste rock and coal materials from the Dunbar Coal Mine of which samples were analysed classify as a Type 3 waste. As it was assumed that the sample of coal (INDB08/4L/2) is representative of the discard coal that will be generated from the washing process, this classification is therefore accepted to apply also to coal discard materials which may be temporarily stockpiled at the Dunbar Coal Mine. However, the classification was based on the analysis of single samples of drill cores, each collected from only a small band of the overall Dunbar stratagraphic succession. As such the samples can hardly be considered representative of the materials which will eventually be stockpiled on site.

It is therefore recommended that this classification be confirmed once samples of overburden materials become available from the Dunbar Coal Mine operations. Representative, composite samples of overburden and discard coal materials can be submitted at a suitable laboratory for leach testing and compositional analysis, and the results compared to the results used in this classification assessment.

Nevertheless, the presented data provides a good preliminary indication of the geochemical behaviour of the waste rock and coal discard likely at the Dunbar Coal Mine, and findings of this assessment can be applied in the preliminary planning and design of the materials management facilities.

Based on this Type 3 classification, the temporary stored waste rock and coal discard from the Dunbar Coal Mine must be managed at an area that is designed in accordance with requirements of a Class C Landfill (see Section 3.3). The Class C landfill containment barrier requirements include several protective layers of compacted clay and geotextile, as well as an under drainage and monitoring system at the base. This is to contain leachate draining from the temporary stored material. The intention of applying such extensive containment for disposal of a Type 3 waste, is to protect the health of humans and aquatic ecosystems that may be exposed to groundwater and surface water resources impacted by leachate from a permanent landfill.

However, the available laboratory test results indicate that none of the materials tested (i.e. waste rock or coal discard) is potentially acid generating, and does not induce a low pH in water. Furthermore, it was shown that very few elements were actually mobilised from any of the materials during leach testing. The only elements leaching, which also exceeded LCT0 threshold values, is Mercury from the coal discard. The measured concentration of mercury in the leachate, although exceeding the LCT0 threshold value, is far below the LCT1 threshold. The stockpiled waste rock or coal discard will not remain in the environment indefinitely. At the end of life of the mine, both the waste rock and coal discard is planned to be used in the backfill and rehabilitation of the mining excavation. The temporary stored waste rock and coal discard materials from the Dunbar Coal Mine therefore represent a comparatively low risk to water resources.

Another aspect that has to be considered is that during the operational period any contaminated seepage which may occur from the waste rock or coal discard stockpiles will be captured and directed to the PCD via the GN704 compliant water management system, which is designed to separate all clean and dirty water on site. Any contaminated seepage from the waste rock or coal discard stockpiles will therefore most likely not reach any off site groundwater or surface water resources.

Furthermore, any stockpiled waste rock or coal discard will not remain in the environment indefinitely. At the end of life of the mine, both the waste rock and coal discard is planned to be used in the backfill and rehabilitation of the mining excavation.

It is therefore concluded that there is a low likelihood of detrimental effect on water resources from the waste rock or coal discard at the proposed Dunbar Coal Mine. Application of containment suitable for a Class C landfill is therefore considered to be unnecessarily severe and a Class D barrier (see Section 3.3) can be considered adequate for the protection of the environment from the overburden materials stockpile.

5 REFERENCES

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Annexure A
Analytical Results Dunbar Coal Mine waste rock and coal