7.3.1. Construction Phase Activities

- Clearing and grubbing of vegetation;
- Site perimeter fencing and internal fencing of different sections of the mine;
- Removal and stockpiling of topsoil;
- Delivery and storage of vehicles, equipment, machinery and materials;
- Construction of access roads, platforms and drainage structures;
- Construction of process plant infrastructure and installation of required equipment and machinery;
- Construction of the main mine administration complex; and
- Installation of power and water supply infrastructure.

7.3.2. Operational Phase Activities

- Clearing and grubbing of vegetation;
- Dewatering;
- Open-cast mining of two pits through a combination of excavation and blasting;
- Construction and operation of the soil and overburden stockpiles;
- Hauling of raw materials to the process plant;
- Management of clean and dirty water runoff;
- Raw materials processing at the process plant;
- Concurrent rehabilitation of exposed areas (as is practicable); and
- Delivery and storage of vehicles, equipment, machinery and materials.

7.3.3. Closure and Decommissioning Phase Activities

- Dismantling and removal of all identified above-ground infrastructure;
- Rehabilitation of the open-cast pits and overburden stockpiles; and placement of topsoil and re-vegetation of exposed areas.

Table 12: A generalised significance rating both before and after implementation of mitigation measures of the main potential ecological impacts perceived to be associated to the proposed development activities.

Ecologically sensitive habitat (Wetland units)								
Project Activity		Destruction of sensitive habitat	Likelihood		Consequence			Significance Rating
Destruction of wetland units during all construction phase activities due to heavy machinery and indiscriminate habitat destruction.	Phase of Project	Construction Phase	Frequency of Activity	Frequency of Impact	Severity	Spatial Scope	Duration	
	Impact Classification	Direct Impact	Significance Pre-Mitigation					
	Resulting Impact from Activity	Destruction of wetland habitat during construction phase if buffer zones are not taken into consideration	4	4	4	3	5	96 (MH)
			Significance Post-Mitigation					
			1	1	2	2	1	10 (VL)
Project Activity		Destruction of sensitive habitat	Likelihood		Consequence			Significance Rating
Impacts to wetland units during the operations phase from runoff pollution, siltation, habitat smothering and vegetation alteration.	Phase of Project	Operations Phase	Frequency of Activity	Frequency of Impact	Severity	Spatial Scope	Duration	
	Impact Classification	Direct Impact	Significance Pre-Mitigation					
	Resulting Impact from Activity	Everyday operations that will impact on wetland habitat integrity.	4	4	4	4	5	104 (H)
			Significance Post-Mitigation					
			3	3	3	2	4	54 (LM)
Fragmentation of interconnected wetland units (watercourses) that would otherwise offer migratory corridors.	Phase of Project	Construction/Operations phases	Frequency of Activity	Frequency of Impact	Severity	Spatial Scope	Duration	Significance Rating
	Impact Classification	Secondary Impact	Significance Pre-Mitigation					
	Resulting Impact from Activity	Fragmentation of interconnected habitat	5	5	3	3	4	100 (MH)
			Significance Post-Mitigation					
			2	2	2	1	1	16 (VL)
Project Activity		Destruction of sensitive habitat	Likelihood		Consequence			Significance Rating
Wetland vegetation alteration following disturbances that will enhance exotic vegetation encroachment.	Phase of Project	All phases of project	Frequency of Activity	Frequency of Impact	Severity	Spatial Scope	Duration	
	Impact Classification	Secondary & Cumulative Impact	Significance Pre-Mitigation					
	Resulting Impact from Activity	Disturbances that induce invasion of exotic flora	5	5	3	2	5	100 (MH)
			Significance Post-Mitigation					
			1	1	2	1	1	8 (VL)

Soils								
Project Activity		Soil erosion that impacts watercourses and wetland habitat	Likelihood		Consequence			Significance Rating
All construction phase activities	Phase of Project	All phases of project	Frequency of Activity	Frequency of Impact	Severity	Spatial Scope	Duration	
	Impact Classification	Secondary & Cumulative Impact	Significance Pre-Mitigation					
	Resulting Impact from Activity	Soil erosion will impact watercourses both locally as well as downstream within more established habitat.	4	4	4	4	5	104 (H)
			Significance Post-Mitigation					
			2	2	2	1	1	16 (VL)

Water quality								
Project Activity		Water quality	Likelihood		Consequence			
All construction phase and operations phase activities associated with water contamination	Phase of Project	All phases of project	Frequency of Activity	Frequency of Impact	Severity	Spatial Scope	Duration	Significance Rating
	Impact Classification	Direct, Secondary & Cumulative Impact	Significance Pre-Mitigation					
	Resulting Impact from Activity	Contamination of surface water will impact integrity of all surface water resources and will reach further downstream to the greater aquatic system.	4	4	4	4	5	104 (H)
			Significance Post-Mitigation					
			3	3	3	2	4	54 (LM)

7.4. Mitigation measures pertaining to impact features

7.4.1. Destruction of sensitive habitat features

Wetlands and surface water ecosystems are regarded as inherently ecologically sensitive features due to a variety of reasons, the main ones being that they provide a source of water, provide flood management of watercourses and support a wide biodiversity. Therefore, regardless of ecological state, wetland and aquatic units are statutorily protected and subject to their own unique environmental legislature. The survey area falls within a region that is rich in wetland habitat units, which coincides with suitable agricultural areas and rich mining deposits. The main land use within the region is therefore dominated by formal agriculture and mining (with the dominant form of mining being opencast coal mining). These are two high-impact land uses that have had deleterious impacts on the existence as well as functioning of wetland units within the region and also therefore impacts on the aquatic habitat located further downstream within the catchment areas. Historically, cultivation has been confined to higher-lying areas as inundated (wetland / hydromorphic) soils tend to be unpractical to cultivate. The main wetland linear units have therefore often been retained within the landscape. The outer edges (outer temporary zones) have often, however, been included within the cultivated areas and therefore wetland units have lost a degree of functionality. Impoundments along the watercourses for practical agricultural usage as well as aesthetic value within the landscape are also commonplace throughout all of the watercourses within the region. Historically there has been a level of cumulative loss of wetland habitat throughout the region due to agriculture. More recently, mining is gaining ground in displacing agriculture as a more lucrative land use, with the consequence of the wetland units suffering higher ecological degradation and relatively higher cumulative loss of physical presence and/or ecological functionality.

It is regarded as inevitable that wetland habitat units will be lost if the mining development is undertaken. The significance of the impacting features that will affect the wetland units within the survey area is dependent on to what level the unit will lose functionality. This can be anywhere from total loss (both physical and functional) to barely perceptible marginal losses that do not alter functioning within the landscape. The significance of the impact on ecologically sensitive habitat (i.e. wetland units) is therefore largely dependent on the overall loss of habitat through transformation to accommodate the mining infrastructure. It is therefore recommended that the mining infrastructure layout be planned to accommodate as much of the wetland habitat functioning areas as possible.

Vegetation and extent of groundcover plays an important role in preserving wetland functionality. It binds soils to protect from erosion, reduces the scouring potential of runoff water through the reduction of velocity and energy dissipation and also provides the micro-habitat and refuge for supporting a greater array of wetland-dependent biodiversity. Indiscriminate destruction of vegetation layers from wetland areas that fall outside of the ultimate infrastructure footprint should be avoided. A delineation map has been presented (Figure 15), which indicates the extent of the 100 m conservation buffer zones. It is recommended that these buffer zones be fenced off within applicable areas to avoid indiscriminate habitat destruction and treated as "no-go" areas. This includes using these areas for soil stockpiling, equipment storage, fuelling areas, etc.

Erosion is regarded as a major driver of ecological change of wetland habitat. Sediments and silts that are transported to lower-lying valley-bottoms and depressions during rainfall events via stormwater runoff will impact functionality through smothering of habitat, and will displace surface water volume and dependent biodiversity. Silts that enter into the aquatic systems increases turbidity and smothers substrates, also leading to displacement of biodiversity and loss of overall function. Erosion sedimentation must therefore be managed as an ongoing concern throughout all the phases of the development activities. This includes protection of stockpiled soils, rock dumps and other stored materials. Stormwater management must ensure erosion protection at the outfall points into the receiving environment.

Disturbance of soils will often lead to enhancing the encroachment of opportunistic alien vegetation. Wetland areas provide ideal conditions for supporting rapidly-growing exotic and invasive floral species, which quickly out-compete and displace natural vegetation. This will lead to displacement of biodiversity in general, an increase in water consumption and destabilisation of soils. This is an aspect that is readily managed and a management strategy should be in place and in practice throughout all phases of the development.

7.4.2. Soil impacting features

Wetland functionality largely depends on the integrity of the layered characteristics of the underlying soils. It is this layering of the underlying soils that ensures the persistence of inundated soils near the surface and the existence of a wetland feature. Trenching and excavations that alter the characteristics of these layers and/or compaction of the layers through (for example) the movement of heavy vehicles on hydromorphic soils will impact the natural hydrological functioning of the wetland units. Impacting features that intercept soil water and either diverts it away or into areas will all have impacts on the functionality of the soils and the ultimate functionality of the wetland units. Trenching near a wetland unit will often lead to desiccation of the soils and the loss of the wetland unit. Trenching within wetland soils is, however, often necessary from infrastructure developments (especially linear infrastructure such as entrenched pipelines of roads) and therefore some guidelines to mitigate the impacts have been offered. With proper mitigation, the deleterious impacts of trenching within wetlands to accommodate pipelines (etc) can be successfully abated.

As mentioned, wetland functionality is largely governed by a perched water table that occurs due to the stratification characteristics of the underlying soils, including an impermeable base layer that inhibits percolation to deeper groundwater. Retention of wetland functionality through the preservation of lateral water movement through the soils is dependent on correct soil layering and profiling. Therefore any soil that is removed for trenching purposes must be stored in their respective layers and returned to the excavation in reverse order. The soils must be stored outside of the wetland and buffer zones in order not to smother established wetland vegetation. Adequate site reinstatement must be implemented in order to abate the formation of erosion through modification of the surface water hydrology. Silt traps and fencing should be used in areas of steeper topography (if applicable). The movement of heavy machinery within wetland zones should be limited to only single access roadways. Upon completion of the construction phase, this roadway should be ripped and/or disk ploughed to loosen the compacted soils and to allow for the establishment of vegetation within the affected areas, which should be a mixture of veld grasses typical of the surrounding area within similar habitat units. Indiscriminate habitat destruction should be avoided and the construction footprint, including service and support areas should be kept to a minimum.

7.4.3. Water quality

Another impacting feature pertaining to the proposed development is contamination of surface water resources. Water quality degradation will displace dependent biodiversity and will have an impact that will perpetuate throughout the system for a long way downstream as well. Possible sources of contamination include hydrocarbons (from poorly-designed and managed fuelling stations and/or workshop and maintenance areas), and runoff water from processing areas that should be kept separate from clean water runoff with a suitable stormwater management system, and general surface water runoff that should be treated prior to release into the environment. Erosion management also plays an important role in preventing water quality degradation.

7.5. Offset mitigation strategy to compensate for loss of wetland units within the site

In order to retain the viability of the proposed mining operation, the Client has indicated that some areas originally delineated as wetland features are required to be sacrificed. When looking to mitigate for a particular ecological impact there is a stepwise hierarchy of impact mitigation that is considered. These steps include the following (Lukey & Paras, 2017):

- Avoid or prevent: Avoidance or prevention refers to the consideration of options in project location, sitting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services, and people. This is referred to as 'the best option', but it is acknowledged that avoidance or prevention is not always possible.
- Minimize: Minimization refers to the consideration of alternatives in the project location, sitting, scale, layout, technology and phasing that would minimize impacts on biodiversity and ecosystem services.
- Rehabilitate: Rehabilitation refers to the consideration of the rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to a near-natural state or an agreed land use.
- Offset: Offsetting refers to the consideration of measures over and above rehabilitation to compensate for the residual negative effects on biodiversity, after every effort has been made to minimize and then rehabilitate impacts.

The first two points have been exhaustively explored and the initial proposed infrastructure layout was reduced considerably to accommodate the ecologically sensitive features, but some wetland features remained within the prescribed infrastructure and impact footprint areas. The nature of the proposed mining development is such as rehabilitation measures to pre-development status is not practically viable as it requires deep excavations and removal of the unearthed materials. Prescribed rehabilitation measures for large open cast operations at present is to slope the steeper sides, line the pit with topsoil and wither re-vegetate, or allow the pit to naturally fill with water. Considering that the functionality of the present wetland features largely rely on soil layering characteristics at relatively shallow depths, the deep excavations will remove the historical functionality of the wetland unit. This cannot be practically mitigated and therefore an offset mitigation may be the only viable means of mitigating for the loss of wetland features within the survey area. If this is indicated as a requirement by the relevant conservation authorities, then a prescribed method for offset mitigation procedures is followed according to relevant guidelines (MacFarlane et al., 2016), which outlines the best practice guidelines for wetland offsets.

The focus of biodiversity offsets as a mitigation option is to provide a "like for like" area of the same ecosystem type, species composition and ecological function to fully remedy that which is lost (DEA, 2017).

In terms of designing and locating an offset, the following procedural guideline should be followed (DEA, 2017):

1. Obtain a measure of the residual loss of biodiversity (i.e. residual negative impacts) as a consequence of the proposed development. The measure at minimum relates to the area and condition of affected ecosystem/habitat;
2. Determine the best type of offset;
3. Determine the required size of the offset and, where applicable, its optimum location;
4. Investigate candidate offset site(s) in the landscape that could meet the offset requirements. Check whether and any eligible offset receiving area is suitable;
5. Decide on the best way to secure the offset, and ensure that the offset option would be acceptable to the relevant conservation authorities.
6. Prepare an Offsets Report or dedicated section within the EIA report; and
7. Conclude agreements on offsets (between the applicant and an implementing agent) and develop an Offset Management Programme, where applicable.

A guideline document that was drafted as a collaboration between SANBI and DWS entitled Wetland offsets: A best practice guideline for South Africa (MacFarlane et al., 2016) would be utilised to address the offset process. This gives an indication of the extent of the wetland: offset area ratio for the offset mitigation option.

The loss of wetland unit habitat following the presentation of the final proposed infrastructure and mining development layout plan is presented in Table 13. The isolated wetland units that are referred to within Table 13 are presented in section 6.4, where a description of the wetland units that would be included within the proposed infrastructure layout plan, as well as a map, are presented.

Table 13: The wetland unit areas to be lost due to the proposed development, together with the respective PES ratings.

Wetland units category	Total area (within survey site)	Total area to be sacrificed - ha (% of unit)	Total area to be retained – ha (% of unit)	PES of areas to be lost	General notes
1	833.030	133.84 (16.1%)	699.190 (83.9%)	Ranging from C to D/E	Priority wetlands with high functional value. These areas maintain wetland biodiversity as they fall within the main and developed watercourses of the wetland units. These areas also contribute in terms of water source and most include permanent wetland zones.
2	55.902	40.675 (72.8%)	15.227 (27.2%)	Ranging from C to D/E	Secondary wetlands are the temporary wetland areas that act as interlinking corridors between established wetland units and fall within an area with obvious soil water interaction zones. Majority of these areas are, however, cultivated and therefore have suffered a lower PES. Regarded as supportive wetland areas. Loss of these units will constitute a loss of a level of function of the priority wetland areas as it will result in fragmentation of the complex.
3	44.398	0.000 (0.0%)	44.398 (100.0%)	Ranging from C to D/E	Tertiary wetland areas include peripheral zones of established and high priority wetland units. They provide a supportive role in maintaining the function of priority wetland areas. Cultivation is common within these areas, however.
4	168.957	131.673 (77.9%)	37.283 (22.1%)	Ranging from C to D/E	Limited functionality wetland areas. These are temporary wetland areas and most include upland minor tributary that have been actively cultivated. Loss of these areas is considered to have no significant impact to functional and established wetland units.

8. PROPOSED STORMWATER MANAGEMENT PRACTICES & MONITORING MEASURES

8.1. Stormwater management

The purpose of a stormwater management plan is largely to (from *City of Cape Town Management of Urban Stormwater Impacts Policy*):

- Improve on the quality of stormwater runoff.

The development of an area calls for unearthing of underlying geologies that would otherwise not have been exposed to weathering, which may create oxidising agents and/or changes in pH and other pollutants within the runoff water that would otherwise been immobile within the environment. The development of an area also brings in various pollution sources (hydro carbons, chemicals, nutrient and biological contaminants) that would not have been present under natural and undisturbed scenarios. It should be the aim of the stormwater management plan to ensure that the stormwater remains within a target water quality range prior to any release into the environment (DWS target water quality guidelines, 1996).

- Control the quantity and rate of stormwater runoff.

Under natural conditions, varying topography, unconsolidated soils and vegetation features would naturally slow down the runoff by retaining the water within the landscape. This would ensure a slow release into the environment. The development of an area typically strips off the vegetation and topsoil, unearthing a hardened layer of soil. Landscaping also often ensures that surfaces are harder than before the development, which decreases the percolation rate. The rate of discharge is then increased, which often leads to erosion impacts and flooding of the local watercourses.

- Encourage natural groundwater recharge.

As mentioned, by increasing the rate of runoff through the various abovementioned factors, the retention time of the stormwater within the landscape is reduced. This means that the surface water is not given chance to percolate within the soils to recharge the groundwater levels.

Government Notice (GN) 704 from the water Quality Management Series, operational Guideline No. M6.1 (DWAF, 2000) is a comprehensive document outlying the requirements of stormwater management in terms of a mining activity. This document should be consulted when designing a stormwater management system for the *quarry site. The points below highlight points from this document (and other sources) that are thought to be pertinent from an ecological impact and management perspective.*

Section 26(1) of the National Water Act, 1998 (Act 36 of 1998) provides for the development of regulations to, amongst others (from GN 704, DWAF [2000]):

- require that the use of water from a water resource be monitored, measured and recorded;
- regulate or prohibit any activity in order to protect a water resource or in-stream or riparian habitat; and
- prescribe the outcome or effect which must be achieved through management practices for the treatment of waste, or any class of waste, before it is discharged or deposited into or allowed to enter a water resource.

When making regulations, the need for the following must be taken into account (section 26(4) of the National Water Act):

- promoting economic and sustainable use of water;
- conserving and protecting water resources or, in-stream and riparian habitat;
- preventing wasteful water use;
- facilitating the management of water use; and
- facilitating the monitoring of water use and water resources.

8.1.1. Separation of clean and dirty water

One of the ways to achieve these objectives is to isolate clean (unpolluted) water from any dirty (polluted) water and/or area. The distinction between clean and dirty water relies on the specific requirements of a water resource, and should therefore be determined on a catchment specific basis. The quality of water as per definition of “clean water” should be gauged against the DWAF (1996) target water quality guidelines for freshwater aquatic ecosystems (vol 7). Further to this, the water quality of the receiving environment (Orange River in this case) should be monitored over an extended period in order to determine water quality trend data. Many of the parameters defined within the water quality guidelines stipulate a limitation of the range of the parameter that should not be altered. This will be different for every watercourse and therefore background data and trend analysis of the receiving watercourse should be gained.

In order to separate polluted from unpolluted water, any clean water system operating on the quarry site should be designed, constructed and maintained so that it is not likely to spill into any dirty water system more than once in 50 years.

The containment of unpolluted water should only occur if the volumes pose a risk, the water couldn't be diverted to a watercourse by gravitation, or for attenuation purposes. The unpolluted water should as far as possible be released into natural watercourses under controlled conditions. As the storage of water is defined as a water use in section 21 of the National Water Act, the person in control of a mining or related activity need to apply for a water use licence, unless covered under a General Authorisation (DWAF, 2000).

When designing a dam, the emphasis should be placed on *at all time capable of handling the 1:50 year flood-event*. How this is calculated and complied with will be determined by the specific circumstances and processes involved. It is proposed that acceptable engineering principles be used during the design of a water system. Therefore, a suitably qualified person must be responsible for the design of a water system and the construction thereof should take place under the supervision of that person.

8.1.2. Reuse and reticulation of dirty water

Another component is to collect the water arising within any dirty area, including water seeping from mining operations, outcrops or any other activity, into a dirty water system. Any water arising from an area, which causes, has caused or is likely to cause pollution of a water resource, including polluted stormwater, must be contained within a dirty water system. In order to reduce the volume of polluted water, contaminated areas should be minimised. While clean water should be diverted to natural watercourses, polluted water should be re-used wherever possible, thereby reducing the use of clean water.

The ultimate aim of any stormwater management plan is the protection of the water resource. In order to achieve this, it is the responsibility of the quarry management to prevent water containing waste or any substance which causes or is likely to cause pollution of a water resource from entering any water resource, either by natural flow or by seepage, and must retain or collect such substance or water containing waste for use, re-use, evaporation or for purification and disposal in terms of the Act (National Water Act no 36 of 1998). Any water containing waste should be diverted to a dirty water system and prevented from entering and polluting a water resource. This requirement is in line with section 19 of the National Water Act and subscribes to the principle of *pro-active pollution control.*

The intention of this is not to prohibit the discharge or disposal of water containing waste, but only to control such aspects. The person in control of a mining or related activity could apply for a water use licence in terms of section 40 of the National Water Act for the disposal or discharge of any water containing waste. The conditions for the specific disposal or discharge of water containing waste should be based on the site-specific circumstances, and stipulated within the water use licence.

It is also the responsibility of the quarry management to design, modify, locate, construct and maintain all water systems, including residue deposits, in any area so as to prevent the pollution of any water resource through the operation or use thereof and to restrict the possibility of damage to the riparian or in-stream habitat through erosion or sedimentation, or the disturbance of vegetation, or the alteration of flow characteristics.

8.1.3. Prevention of flow through mining areas

Measures should be in place to minimise the flow of any surface water or floodwater into mine workings, opencast workings, other workings or subterranean caverns, through cracked or fissured formations, subsided ground, sinkholes, outcrop excavations, adits, entrances or any other openings. The intention of this regulation is mainly the following:

- to prevent the flooding of mine workings, both underground and opencast, that could cause the loss of life or the sterilisation of the mineral resource;
- to minimise the quantity of clean water contaminated by either the mixing with dirty water or the contamination thereof by the activity. In this way the volume of clean water that can be diverted to the natural resource is maximised; and
- to prevent the pollution of the groundwater resource.

8.1.4. Maintenance and management of operational systems

Another measure to protect the water resource is to design, modify, construct, maintain and use any dam or any residue deposit or stockpile used for the disposal or storage of mineral tailings, slimes, ash or other hydraulic transported substances, so that the water or waste therein, or falling therein, will not result in the failure thereof or impair the stability thereof. The failure of such structures can result in in major pollution of a water resource. This regulation requires that such a structure be designed, constructed and maintained in such a way as to prevent the failure thereof. A suitably qualified person, e.g. civil engineer, who can professionally be held liable in the case of a disaster (loss of human life, extreme water pollution, etc.) or a failure, should design the dam or residue deposit.

8.1.5. Avoidance of leaching from stockpiles and protection of receiving environment

The erosion or leaching of materials from any residue deposit or stockpile from any area and contain material or substances so eroded or leached in such area by providing suitable barrier dams, evaporation dams or any other effective measures to prevent this material or substance from entering and polluting any water resources must also be prevented. Erosion of a residue deposit or stockpile should be prevented through proper management thereof, with inspection and maintenance done on such structures on a regular basis. The dual objectives of this requirement are firstly to prevent the eroded material from entering and polluting a water resource, and secondly to prevent structural failure thereof.

8.1.6. Recycling of dirty water

Another aspect of protection of the water resource is to ensure that water used in any process at a mine or activity is recycled as far as practicable, and any facility, sump, pumping installation, catchment dam or other impoundment used for recycling water, is of adequate design and capacity to prevent the spillage, seepage or release of water containing waste at any time. Dirty water must be re-used as far as possible on the premises of a mining or related activity, thereby minimising the use of clean water and the disposal or discharge of polluted water. Any operations facilities utilised in the management of polluted water must be maintained and operated in a manner that will ensure functionality as infrastructure failure can result in contamination of the receiving environment.

8.1.7. Management of wastewater emanating from domestic use

It is not only dirty water that occurs as a result of mining operations that can create a pollution source to the receiving environment. Water for domestic use (wash water, water-borne sewerage, etc) that cannot be disposed of directly into a municipal sewerage system is to be disposed of in terms of authorisation under the National Water Act. In terms of section 40 of the National Water Act, a person in control of a mining or related activity needs to apply for a water use licence for the disposal of domestic waste and wash-water if not disposed of in a municipal sewage system. The site-specific conditions need to be stipulated within the water use licence.

8.1.8. Further aspects to consider

The opencast areas, for the large part, are subterranean and therefore surface runoff from the pits does not occur, but runoff will occur from surface processing, processing and transport facilities. If large volumes of water do accumulate within the quarry pit, then it is assumed that it would be drained through pumping it to the surface or to an unused/inactive part of the pit where it must be managed as part of the polluted / dirty water system. Inflow of clean runoff stormwater into the pit should be avoided through creating embankments that surround the pits area that will divert clean stormwater toward a clean water management system. It is assumed that stormwater accumulation will be limited in extent and that most of it would be utilised through the routine dust suppression activities that would take place throughout the site (i.e. spraying of roads, sand/rock piles, etc.). It does need to be acknowledged, however, that transformation of the landscape through vegetation removal and surface hardening will increase the surface water runoff and therefore it is recommended that an attenuation pond be established. It is not advised that polluted water be used for dust suppression outside of the quarry pit area as this will merely lead to contamination of clean water areas from runoff.

Points to consider during the planning and construction of such an attenuation pond follow:

- This should be placed at the lowest point of the development area for practical purposes as stormwater runoff is gravity driven (outside of the quarry pit), but not within the riparian zones or associated buffer areas;
- It should be of sufficient volume in order to capture the magnitude of a reasonable flood event. This should be calculated by a suitably qualified engineer;
- It should be protected from other pollution sources (i.e. placed away from any area where fuel and/or oils are stored and completely separate from any dirty water storage or reticulation);
- This pond should be constructed of a material that will allow for practical usage of the water (e.g. pumping into water tanks for road irrigation for the purpose of dust suppression), but should also be designed in a way to allow for slow seepage into soils or for slow release into the receiving environment;
- The overflow outfall of the pond should be designed in a way that will protect the receiving environment from the impacts of erosion. High velocity water being directed onto loose soils will create erosion and impact the aquatic environment that it will eventually enter into. Energy dissipation mechanisms should be in place to slow down the velocity of the flowing water;
- Quarry water that is pumped to the surface should be routinely monitored for quality prior to release into the pond. If it is found that the quality falls outside of guideline values, then further treatment may be required prior to release of usage throughout the site;
- It is not thought that the stormwater release into the environment, however, will create a significant impact to the receiving environment.

Further recommendations to improve stormwater management is to use permeable paving wherever paving is required to stabilise road and/or building surfaces and for dust suppression within the service area (administration areas, etc). This will enhance percolation of water into the soils for groundwater recharge.

8.2. Proposed monitoring plan

The monitoring of ongoing wetland ecological function and overall health and integrity is aimed at monitoring the same points that are utilised in assessing overall wetland health initially, viz vegetation status, hydrology and geomorphology. Water quality should also be monitored for at least every six months (biennially) during normal operations, but will increase in response to accidental spillages or other incidences that warrant more frequent monitoring.

Site photographs from set points at all of the monitoring stations should be taken for all monitoring periods for reference and comparative purposes. These will be useful when undertaking trend analyses of the various monitoring aspects.

The following points should be included in the monitoring:

8.2.1. Vegetation features

- Extent of vegetation cover and the trend of increasing or decreasing extent of cover should be monitored for;
- Species composition and analysis of indigenous versus exotic species communities. Grass species composition should be analysed in terms of status (pioneering, decreaser of increaser species) as an indication of succession;
- Exotic vegetation must be monitored for to enable early detection of exotic invasive species so that this can be timeously managed;
- A change in floral species communities will also indicate the extent of the wetland functioning areas. A decrease or increase in facultative of obligatory wetland species over time will alert to this change.

8.2.2. Hydrological features

- The changes in baseflows will be most noticeable if the water levels within the instream impoundments are monitored. Cumulative data will indicate trending data over time and allow for the trends pertaining to seasonal variation to be accounted for during data interpretation;
- Increases of flow volumes emanating from the stormwater/clean water runoff from the site should be monitored to determine if the increase capacity is creating scouring impacts within the receiving environment;
- Decreases in water volume should also be monitored and areas of wetland desiccation should be flagged for increased monitoring frequency. This is due to the impact that desiccation has on hydromorphic soil structures, which exposes them to structural failure and subsequent erodibility.

8.2.3. Geomorphological features

- Geomorphological features pertain to the sediment load and the sediment transport capacity of the wetland feature. Soil erosion within the wetland unit falls within this category and is perhaps the primary and most pertinent monitoring aspect that warrants active and ongoing management;
- Lowered vegetation cover, increased exotic vegetation invasion, increased water volumes and velocity within a channel and modification of soil features are all interplaying aspects that manifest in modification of geomorphological features of a wetland unit;
- Emerging erosion, in all forms, must be routinely monitored for throughout all areas of the wetland units and management intervention must be undertaken immediately once a problem area has been identified. Erosion is relatively simple to rectify if caught early but increases in scale and complexity with time. Early intervention also allows for the use of natural features (natural vegetation to stabilise soils, etc), whereas a perpetuating erosion impact will eventually require costly civil structure intervention;
- One of the single most important driving factors behind wetland ecological integrity and functionality is erosion control, which is a function of vegetation structure and balanced hydrological features.

8.2.4. Water quality monitoring

- A functioning wetland unit provides a water quality remediation process and therefore adds a protection factor to perhaps more sensitive aquatic habitat located downstream within the system. The capacity for water purification has an obvious limit and is different from one wetland unit to the next. Preserving the overall ecological integrity and functionality of a wetland unit will enhance its capacity for water purification;
- The quality of the water that is being discharged into the wetland units (be it clean stormwater runoff, dirty process water or just the water the flows within the wetland zones) needs to be monitored and the results compared to target water quality guideline values. General water quality parameters, elemental scans and bacteriological counts should be part of routine analysis, undertaken at least every six months;
- If an incident occurs on site, such as an accidental spill, chemical leaks, sewerage contamination and the like, then a water quality monitoring schedule, targeting specifically the offensive pollutant, must be implemented at a frequency recommended by the ECO designated to the site;
- If poor or deteriorating water quality trends are observed, then the source of the pollutants must be identified and remedied appropriately, according to the type of pollution impacts identified;

- Water quality monitoring should be undertaken at the same site each time and the sampled analysed at an accredited laboratory;
- Water samples were taken during the baseline survey and these same sampling points should be considered for the routine monitoring. This can be modified at the discretion of the plant management if necessary;
- Monitoring should be undertaken within watercourses prior to the impact zones as well as within the same watercourses as they leave the impact zones. As it is dependent on the presence of surface waters, the inclusion of all of all of the recommended points may not be practical (see Figure 16);
- Monitoring points must also include as many of the local catchments within the site as possible to gain an overall understanding of the impacts to water quality, how those contaminants are being transported and to where they are being transported to. Managing a local catchment that has a single draining watercourse is then easier to manage, should the need arise.

Figure 16: Recommended points to be utilised for routine water quality monitoring.

9. CONCLUSIONS & RECOMMENDATIONS

A field survey was undertaken during January 2019 in order to evaluate the surface water ecosystems associated with the area pertaining to the proposed development of the Ilima Coal Kranspan Project. Following the field survey of the proposed development area, analyses of the data, and collaboration with the soils and groundwater specialists, the following salient recommendations can be proposed to aid in the conservation of the overall ecological integrity of the wetlands within the region:

- The proposed development area was shown to incorporate a relatively high proportion of wetland habitat units, ranging from valleyhead seeps, hillslope seeps, channelled and unchannelled valley-bottom and depression-type wetland units. These units have been delineated and their outer boundaries, together with conservation buffer zones, are presented in Figure 15;
- The wetland units are interspersed amongst formal cultivation, which is considered to be the main pressure and driver of ecological change at present, and much of the peripheral wetland units have lost functionality and ecological contribution due to cultivation. This was taken into consideration when developing the final buffer zone designation (as indicated in Figure 15);
- The wetland units were shown to all fall within a PES category range of C (moderately modified) to D/E (largely modified), with a high ecological importance and sensitivity;
- Laboratory analysis of water samples showed that the wetlands retain a relatively good water quality, excepting for one depression wetland that is subject to runoff from mining areas located to the north, adjacent to the proposed Kranspan Mining Right Area. Water quality within this wetland unit has been degraded to the point of posing a risk to both human and livestock health;
- The DWS Risk Assessment Matrix indicates that all proposed mining activities that will impact the wetland directly carry a high risk factor. The impact significance ratings also indicate that the potential impacts carry a high significance post mitigation. The significance of the impacts is largely due to the direct involvement of deleterious impacts to wetland habitat units. The significance is, however, largely dependent on the extent of wetland habitat that will be directly affected by mining activities and the severity of those impacts;
- The presented infrastructure layout indicates that some wetland areas are required to be included within the mining area and therefore will be lost. The significance of the ecological loss is dependent on the sensitivity as well as the present functionality of the wetland units. Ultimately, infrastructure layout planning that takes into consideration the wetland delineation mapping, associated conservation buffer zones, as well as the proposed mitigation measures, can greatly reduce the overall significance of the impacts to the wetland systems associated with the site.

It should be noted that, in order to conserve the wetland ecological structures within the area, the wetland needs to be viewed as an interconnected larger system and the individual units should be managed as such. This includes keeping general habitat destruction and construction footprints to an absolute minimum within the terrestrial habitat as well. Conserving the habitat units will ultimately conserve the species communities that depend on it for survival. This can only be achieved by the efforts of the contractor during the construction phase and by strict management during the operations phase.

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WASTE CLASSIFICATION REPORT: KRANSPAN PROJECT

DRAFT REPORT

Ref. iLEH-ABS ILI 10-18

MAY 2019

EXECUTIVE SUMMARY

Ilima proposes to mine the E Coal Seam using both surface and underground mining methods at the proposed Kranspan Project. Mined out opencast pits will be backfilled with overburden material and waste rock. The opencast rehabilitation will be undertaken concurrent with mining during the operational phase of the project.

It is proposed that some of the coal is washed on site. The discard and slurry waste material that will be generated at the wash plant will be disposed of on site. Two options are currently under consideration, namely in-pit disposal and a surface stockpile.

Six discard samples sourced by Ilima from a trial wash at their nearby licensed washing plant and twenty waste rock samples sourced from exploration borehole cores, were analysed and classified according to the National Environmental Management: Waste Act (Act 59 of 2008) and the Waste Classification and Management Regulations (R635) in this report. Both whole rock (Total Concentration Tests) and leach tests (Leachable Concentration Tests) were completed. The results indicate that:

- The Total Concentration Tests on the waste rock and discard samples yielded results that are below the TCT1 threshold values for all elements analysed.
- The Leachable Concentration Tests (both water leachable and TCLP leach tests) yielded results that exceeded the LCT0 threshold values for some samples in both deionised water and TCLP leach tests for some elements. None of the samples yielded concentrations that exceeded the LCT1 threshold values.
- Elements that exceeded the LCT0 threshold values include arsenic (As), barium (Ba), manganese (Mn), nickel (Ni), lead (Pb), Zinc (Zn) and total dissolved solids.
- The discard and waste rock are therefore both classified as Type 3.

No slurry was analysed as part of this assessment, as this material is not yet available. It is however recommended that the slurry material is sampled once it is available for analysis and waste classification.

The necessary management measures must be developed and implemented to manage environmental impacts associated with the discard and slurry on site. The specific design requirements, including barrier containment (liner) specifications, must be determined as part of a risk assessment as required by the Regulations regarding the Planning and Management of Residue Stockpiles and Residue Deposits, 2015 (GN632 (2015) as amended in GN990 (2018)).

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on assessment techniques, which are limited by information available, time and budgetary constraints relevant to the type and level of investigation undertaken and Irene Lea Environmental and Hydrogeology cc reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research, monitoring, further work in this field, or pertaining to the investigation.

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Irene Lea M.Sc. Pr. Sci. Nat
19 May 2019

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LIST OF ACRONYMS AND ABBREVIATIONS USED

DME	Former Department of Minerals and Energy
DMR	Department of Mineral Regulation
DWA	Department of Water Affairs
EAP	Environmental Assessment Practitioner
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
iLEH	Irene Lea Environmental and Hydrogeology cc
LC	Leachable concentration
LCT	Leachable concentration threshold
MPRDA	Minerals and Petroleum Resources Development Act (Act 28 of 2004)
NEMA	National Environmental Management Act (107 of 1998)
NEM:WA	National Environmental Management: Waste Act, 2008 (Act No 59 of 2008)
NWA	National Water Act (Act 36 of 1998)
PCB	Polychlorinated Biphenyls
PE	Percentage effect
PPE	Personal Protection Equipment
TC	Total concentration
TCLP	Toxicity Characteristic Leach Protocol
TCT	Total concentration threshold

1 INTRODUCTION

The Kranspan Project is situated approximately 15 kilometres south of Carolina, on the Mpumalanga Highveld. Ilima intends to mine the E Coal Seam that forms part of the Ermelo Coalfield. Both surface and underground mining is planned at the proposed colliery.

Ilima proposes to backfill mined out opencast pits with overburden material and waste rock. The opencast rehabilitation will be undertaken concurrent with mining during the operational phase of the project.

It is proposed that some of the coal is washed on site. The discard and slurry waste material that will be generated at the wash plant will be disposed of on site. Two options are currently under consideration, namely in-pit disposal and a surface stockpile.

This report discusses the outcome of a waste classification study completed on waste rock and discard material that was provided by Ilima. The discard was sourced from a washing trial undertaken by Ilima for the purpose of establishing the feasibility of the proposed Kranspan Project. This trial was completed at the nearby Ilima washing plant that forms part of an approved mining right and water use license.

No slurry samples were available for the Kranspan Project for inclusion in this report. For this reason, it will be assumed that the discard and slurry will have the same characteristics from a waste classification perspective. It is however proposed that slurry from the project is analysed and interpreted in terms of the Waste Classification Regulations once it is available.

The rock and discard sample analyses and interpretation were undertaken by The Moss Group (Van Hille, 2019) as part of a geochemical assessment undertaken for the EIA Phase of the Kranspan Project. The results of these analyses were made available to iLEH to complete the waste classification report.

iLEH was appointed by ABS Africa to complete a Waste Classification Report for the project, based on the sampling and analysis undertaken by The Moss Group. ABS Africa is the Environmental Assessment Practitioner (EAP) appointed by Ilima to complete the applications for environmental authorisation for the proposed Kranspan Project.

2 LEGAL FRAMEWORK

2.1 Waste classification

The National Environmental Management: Waste Act (Act 59 of 2008) (NEM:WA) and Regulation 4(2) of the Waste Classification and Management Regulations (R634) require that all waste generated is classified in accordance with SANS 10234 within 180 days of generation.

The following general wastes do not have to be classified according to Item 2(a) of Annexure 1 of R634:

Domestic waste;	Business waste not containing hazardous waste or chemicals;	Non-infectious animal carcasses;
Garden waste;	Waste packaging;	Waste tyres;
Building and demolition waste not containing hazardous waste or chemicals;	Excavated earth material not containing hazardous waste or chemicals.	Post consumer packaging

Hazardous waste is, according to Schedule 3, Category A of NEM:WA, waste that contains organic and inorganic elements or compounds that may, owing to the inherent physical, chemical or toxicological characteristics thereof, have a detrimental impact on health and the environment and includes hazardous substances, materials or objects within business waste, residue deposits and residue stockpiles. The latter comprises wastes resulting form exploration, mining, quarrying and physical and chemical treatment of minerals, including:

- Wastes from mineral excavation;
- Wastes from physical and chemical processing of metalliferous minerals;
- Wastes from physical and chemical processing of nonmetalliferous minerals; and
- Wastes from drilling muds and other drilling operations.

The following material is classified as hazardous waste in terms of Item 2(b) Annexure 1 of R634:

Asbestos waste;	PCB waste or PCB containing waste (>50 mg/kg or 50 ppm)	Expired, spoilt or unusable hazardous products;
Expired, spoilt or unusable hazardous products;	General waste, which contains hazardous waste or chemicals;	Mixed, hazardous chemical wastes from analytical laboratories in containers less than 100 litres;
Health care risk waste.		

2.2 Waste assessment

Waste assessment refers to the process to be undertaken to determine whether a waste can be disposed to landfill or whether it requires further treatment prior to disposal.

The assessment of waste must be undertaken in terms of the NEMA National Norms and Standards for the Assessment of Waste for Landfill Disposal (DEAT, 2010). The process includes identifying the chemical substances present in the waste through analysis of the total concentrations (TC) and leachable concentrations (LC) of samples taken. These results are compared to threshold limits specified in R635 and the outcome is used to establish the type of waste and the most suitable disposal method for it. R635 further requires that waste must be re-classified every five years or within 30 days of modification to the process or activity that generated the waste, changes in raw materials or other inputs of any other variations. It is further required that waste that is subject to any form of treatment must be re-classified in terms of R634, including any waste from the treatment process.

If waste is classified as hazardous, a safety data sheet must be prepared for the product the waste originates from, according to the requirements of SANS 10234. The safety datasheets must reflect the specific hazardous waste(s) or chemical(s) in the waste and provide information on the following aspects:

Source and composition of waste;	Hazards identification	Expired, spoilt or unusable Physical and chemical properties;
Toxicological and ecological effects	Transport	Disposal options
First aid/fire-fighting measures	Handling and storage	

2.2.1 Concentration threshold limits

The TC and LC threshold limits, according to Section 6 of R635, are presented in Tables 1 and 2. These concentrations limits are used to classify the waste as explained below. The concentrations were derived from a combination of South African soil screening, land remediation and human health effect values as well as from Australian standards.

Table 1 Total Concentration Threshold (TCT) limits

Elements and Chemical Substances in Waste	TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
Metal Ions			
As, Arsenic	5,8	500	2000
B, Boron	150	15000	60000
Ba, Barium	62,5	6250	25000
Cd, Cadmium	7,5	260	1040
Co, Cobalt	50	5000	20000
Cr_{total}, Total Chromium	46000	800000	NA
Cr(VI), Chromium (VI)	6,5	500	2000
Cu, Copper	16	19500	78000
Hg, Mercury	0,93	160	640
Mn, Manganese	1000	25000	100000
Mo, Molybdenum	40	1000	4000
Ni, Nickel	91	10600	42400
Pb, Lead	20	1900	7600
Sb, Antimony	10	75	300
Se, Selenium	10	50	200
V, Vanadium	150	2680	10720
Zn, Zinc	240	160000	640000
Inorganic Anions			
TDS, Total Dissolved Solids	NA	NA	NA
Cl, Chloride	NA	NA	NA
SO_4, Sulphate	NA	NA	NA
NO_3, Nitrate	NA	NA	NA
F, Fluoride	100	10000	40000
CN (total), Total Cyanide	14	10500	42000
Organics			
Benzene	NA	10	40
Benzo(a)pyrene	NA	1,7	6,8
Carbon tetrachloride	NA	4	16
Chlorobenzene	NA	8800	35200
Chloroform	NA	700	2800
2-Chlorophenol	NA	2100	8400
Di (2 ethylhexyl) phthalate	NA	40	160
1,2-Dichlorobenzene	NA	31900	127600
1,4-Dichlorobenzene	NA	18400	73600
1,2-Dichloroethane	NA	3,7	14,8
1,1-Dichloroethylene	NA	150	600
1-2-Dichloroethylene	NA	3750	15000
Dichloromethane	NA	16	64
2,4-Dichlorophenol	NA	800	3200
2,4-Dinitrotoluene	NA	5,2	20,8
Ethylbenzene	NA	540	2160
Formaldehyde	NA	2000	8000
Hexachlorobutadiene	NA	2,8	5,4
Methyl ethyl ketone	NA	8000	32000
MTBE (Methyl t-butyl ether)	NA	1435	5740
Nitrobenzene	NA	45	180
PAHs (total)	NA	50	200
Petroleum H/Cs, C6 to C9	NA	650	2600
Petroleum H/Cs, C10 to C36	NA	10000	40000

Elements and Chemical Substances in Waste	TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
Phenols (total, non-halogenated	NA	560	2240
Polychlorinated biphenyls	NA	12	48
Styrene	NA	120	480
1,1,1,2-Tetrachloroethane	NA	400	1600
1,1,2,2-Tetrachloroethane	NA	5,0	20
Tetrachloroethylene	NA	200	800
Toluene	NA	1150	4600
Trichlorobenzenes (total)	NA	3300	13200
1,1,1-Trichloroethane	NA	1200	4800
1,1,2-Trichloroethane	NA	48	192
Trichloroethylene	NA	11600	46400
2,4,6-Trichlorophenol	NA	1770	7080
Vinyl chloride	NA	1,5	6,0
Xylenes (total)	NA	890	3560
Pesticides			
Aldrin + Dieldrin	0,05	1,2	4,8
DDT + DDD + DDE	0,05	50	200
2,4-D	0,05	120	480
Chlordane	0,05	4	16
Heptachlor	0,05	1,2	4,8

Table 2 Leachable Concentration Threshold (LCT) Limits

Elements and Chemical Substances in Waste	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/l)	LCT3 (mg/l)
Metal Ions				
As, Arsenic	0,01	0,5	1	4
B, Boron	0,5	25	50	200
Ba, Barium	0,70	25	70	280
Cd, Cadmium	0,003	0,15	0,3	1,2
Co, Cobalt	0,5	25	50	200
Cr_{total}, Total Chromium	0,1	5	10	40
Cr(VI), Chromium (VI)	0,05	2,5	5	20
Cu, Copper	2,0	100	200	800
Hg, Mercury	0,006	0,3	0,6	2,4
Mn, Manganese	0,5	25	50	200
Mo, Molybdenum	0,07	3,5	7	28
Ni, Nickel	0,07	3,5	7	28
Pb, Lead	0,01	0,5	1	4
Sb, Antimony	0,02	1,0	2	8
Se, Selenium	0,01	0,5	1	4
V, Vanadium	0,2	10	20	80
Zn, Zinc	5,0	250	500	2000
Inorganic Anions				
TDS, Total Dissolved Solids	1000	12500	25000	100000
Cl, Chloride	300	15000	30000	120000
SO_4, Sulphate	250	12500	25000	100000
NO_3, Nitrate	11	550	1100	4400
F, Fluoride	1,5	75	150	600
CN (total), Total Cyanide	0,07	3,5	7	28
Organics				
Benzene	NA	0,01	0,02	0,08
Benzo(a)pyrene	NA	0,035	0,07	0,28
Carbon tetrachloride	NA	0,20	0,40	1,6
Chlorobenzene	NA	5,0	10	40
Chloroform	NA	15	30	120
2-Chlorophenol	NA	15	30	120
Di (2 ethylhexyl) phthalate	NA	0,50	1	4
1,2-Dichlorobenzene	NA	5	10	40
1,4-Dichlorobenzene	NA	15	30	120
1,2-Dichloroethane	NA	1,5	3	12
1,1-Dichloroethylene	NA	0,35	0,7	2,8
1-2-Dichloroethylene	NA	2,5	5	20
Dichloromethane	NA	0,025	0,5	2
2,4-Dichlorophenol	NA	10	20	80
2,4-Dinitrotoluene	NA	0,065	0,13	0,52
Ethylbenzene	NA	3,5	7	28
Formaldehyde	NA	25	50	200
Hexachlorobutadiene	NA	0,03	0,06	0,24
Methyl ethyl ketone	NA	100	200	800
MTBE (Methyl t-butyl ether)	NA	2,5	5,0	20,0

Elements and Chemical Substances in Waste	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/l)	LCT3 (mg/l)
Nitrobenzene	NA	1	2	8
PAHs (total)	NA			
Petroleum H/Cs, C6 to C9	NA			
Petroleum H/Cs, C10 to C36	NA			
Phenols (total, non-halogenated	NA	7	14	56
Polychlorinated biphenyls	NA	0,025	0,05	0,2
Styrene	NA	1,0	2	8
1,1,1,2-Tetrachloroethane	NA	5	10	40
1,1,2,2-Tetrachloroethane	NA	0,65	1,3	5,3
Tetrachloroethylene	NA	0,25	0,5	2
Toluene	NA	35	70	280
Trichlorobenzenes (total)	NA	3,5	7	28
1,1,1-Trichloroethane	NA	15	30	120
1,1,2-Trichloroethane	NA	0,6	1	4
Trichloroethylene	NA	0,25	2	8
2,4,6-Trichlorophenol	NA	10,0	20	80
Vinyl chloride	NA	0,015	0,03	0,12
Xylenes (total)	NA	25	50	200
Pesticides				
Aldrin + Dieldrin	NA	0,015	0,03	0,03
DDT + DDD + DDE	NA	1	2	2
2,4-D	NA	1,5	3	3
Chlordane	NA	0,05	0,1	0,1
Heptachlor	NA	0,015	0,03	0,03

2.2.2 Definition of the waste types

Waste types are determined through comparison of the TC and LC concentrations with threshold limits presented in Tables 1 and 2. Five waste type categories were developed, as detailed in Table 3.

Table 3 Definition of type of waste

Criteria	Waste Type
LC > LC3; or TC > TC2	Type 0
LCT2 < LC ≤ LCT3; or TCT1 < TC ≤ TCT2	Type 1
LCT1 < LC ≤ LCT2; and TC ≤ TCT1	Type 2
LCT0 < LC ≤ LCT1; and TC ≤ TCT1	Type 3
LC ≤ LCT0; and TC ≤ TCT0	Type 4*

* All chemical substance concentration levels must also be below the following values to be characterised as a Type 4 waste:

TOC	< 30 000 mg/kg (=3%)
BTEX	< 6 mg/kg
PCBs	< 500 mg/kg
Aldrin + Dieldrin	< 0,05 mg/kg
DDT + DDD + DDE	< 0,05 mg/kg
2,4-D	< 0,05 mg/kg
Chlordane	< 0,05 mg/kg
Hetachlor	< 0,05 mg/kg

In addition to the above, a waste will be classified as Type 1 if a particular substance in the waste is not listed in Tables 1 and 2 and the waste has been classified as hazardous in terms of Section 4(2) of NEM:WA, based on health or environmental hazard characteristics of the specific element or chemical substance.

If the TC of an element is above TCT2 and the concentration cannot be reduced to below the TCT2 limit, but the LC is below the LCT3 limit, the waste will also be considered a Type 1 waste.

Wastes with metal ions and inorganic anions below or equal to LCT0 limits are considered Type 3 waste, irrespective of the TC of the waste, provided that the inherent physical and chemical character of the waste is stable and will not change over time, the waste is disposed of to a landfill without any other waste and the concentrations for organics and pesticides, as listed beneath Table 3, are complied with.

2.3 Inert waste

Inert waste is waste that does not undergo any significant physical, chemical or biological transformation after disposal. It is further classified as waste that does not burn, react physically or chemically biodegrade or otherwise adversely affect any other matter or the environment with which it may come into contact. Inert waste does not impact negatively on the environment, because of its pollutant content and because the toxicity of its leachate is insignificant.

Examples of inert waste include:

- Discarded concrete, bricks, tiles and ceramics
- Discarded glass
- Discarded soil, stones and dredging spoil

2.4 Safety Data Sheets

Should the outcome of the tests completed on the waste indicate that it is hazardous, a safety data sheet must be prepared according to the requirements of SANS 10234 for the waste material as well as for the product the waste originates from.

2.5 Waste disposal

As part of an amendment to the Regulations regarding the Planning and Management of Residue Stockpiles and Residue Deposits (2015) in September 2018, the prescribed pollution control barrier system (for example liners), as defined by the National Norms and Standards for the Assessment of Waste for Landfill Disposal and the National Norms and Standards for Disposal of Waste to Landfill (NEM:WA, 2013) were deleted from Regulation 3. Regulation 3(2) and 3(4) were replaced with the following:

Regulation 3(5) - A competent person must recommend the pollution control measures suitable for a specific residue stockpile or residue deposit on the basis of a risk analysis as contemplated in Regulations 4 and 5 of these Regulations. The following amendments were consequently made to Regulation 5:

Regulation 5(2) - A risk analysis must be conducted and documented on all residue stockpiles and residue deposits to be established.

> Regulation 5(2A) - The risk analysis must be undertaken by a competent person.
>
> Regulation 5(3) - The classification of residue stockpile and residue deposit must be undertaken on the basis of the –
>
> > (e) pollution control measures determined as a result of the risk analysis as contemplated in Regulations 4 and 5 of these Regulations.

The amended regulations therefore no longer prescribe the liner requirements for residue deposits and stockpiles. The liner requirements are to be determine through a risk analysis, which is based among other factors on the classification of the waste. It is further noted that the amended regulations are applicable to new stockpiles and deposits only.

3 PROJECT METHODOLOGY

Rock sampling was conducted by Ilima in two phases. The first phase involved the sampling and analysis of discard samples generated during small-scale washing experiments. The material selected for the wash tests was based on the analysis of information for 24 reject samples provided by the Ilima project geologist. Six samples were selected that covered the range of total sulphur, ash content and calorific value. The discard samples are the ANT-series samples discussed further in this report.

The second phase of sampling involved the sampling and analysis of 20 samples, selected from drill core material from four newly drilled exploration boreholes. These are representative of waste rock material and overburden that will be backfilled into the opencast pits as part of concurrent rehabilitation during the operational phase of mining.

Sample descriptions for the assessment are presented in Table 4.

Table 4 Sample description

Discard samples			
Designation	**Calorific value (MJ/kg)**	**Ash content (%)**	**Total sulphur (%)**
Ant 3 (2)	11.93	58.54	4.27
Ant 100 (4)	17.73	39.03	2.06
Ant 105 (1)	8.65	61.55	3.45
Ant 105 (3)	13.21	39.77	2.48
Ant 110 (1)	13.59	49.23	2.68
Ant 185 (1)	15.11	45.01	5.83
Waste rock samples			
Sample designation	**Description**		
GC01-2	Unweathered Sandstone (fair amount of silica)		
GC01-4	Carbonaceous Shale & Sandstone		
GC01-5	Sandstone (roof of coal seam)		
GC01-6	Carbonaceous Sandstone		
GC02-2	Carbonaceous Clay (roof of B seam)		
GC02-3	Sandstone (floor of B-lower)		
GC02-5	Mix of sandstone/siltstone and clay (floor of C seam)		
GC02-6	Carbonaceous Shale		
GC02-7	Sandstone		
GC02-9	Sandstone (roof and floor of E seam)		
GC03-2	Siltstone/sandstone		
GC03-3	Carbonaceous Shale and sandstone mix		
GC03-4	Carbonaceous Sandstone		
GC03-6	Sandstone & Shale mix		
GC03-8	Carbonaceous Shale		
GC03-10	Carbonaceous sand stone and Shale mix		
GC04-2	Carbonaceous Shale		
GC04-3	Shale and Sandstone mix		
GC04-4	Sandstone		
GC04-6	Sandstone		

The leach tests were performed at a solids loading of 5% (m/v), equivalent to a solid to liquid ratio of 1:20. Samples were removed and filtered through a 0.45 µm membrane filter ahead of cation and anion analysis by ICP and IC.

Samples were subjected to two leach tests, namely with distilled water and a standard Toxicity Characteristic Leach Protocol (TCLP). During the TCLP leach test a solids loading of 5%, equivalent to a solid to liquid ratio of 1:20, was used. The results of the analyses received are attached in Appendix 1 and are discussed below.

4 RESULTS OF ANALYSES

4.1 Total and leachable concentration tests

ABS Africa submitted the discard and waste rock samples to Waterlab for total and leachable concentration tests, which is a SANAS accredited laboratory. The analyses include metal ions and inorganic anions, which are reasonably expected to occur in the rock samples. Organic elements, inorganic ions and pesticides were not included in the total concentration analyses; and organics and pesticides were not included in the leachable concentrations. These elements are not expected to occur in the mine waste material sampled.

Leaching in the context of the project refers to the process of transferring chemical constituents from a solid particle to an aqueous solution. It is noted that the total concentration of a chemical element in a solid form will only have a limited influence on the extent to which the element can be leached and thus affect the receiving environment. It is therefore important not to make assumptions about the magnitude of a leaching risk posed from the total concentration tests alone. The quantity of any element that could leach from a solid rock will depend on several factors, including *inter alia* particle size, permeability, surface area, temperature, pH, redox potential, presence of non-reactive soluble salts, biological activity, etc.

For the purpose of completing the waste classification for the material sampled, both deionised water and TCLP leach tests were completed. Net Acid Generating (NAG) leach tests were also completed as part of the geochemical study completed by The Moss Group. The NAG tests were not considered during the waste classification process.

The results of the total concentration test are compared to Total Concentration Threshold (TCT) values in Table 6 and 7 for the waste rock and discard samples respectively. The following is concluded from the whole rock analysis:

- TCT concentrations in the waste rock samples are generally below the TCT0 threshold values set (Tables 6 a and b). The exceptions are boron, barium, magnesium and lead, which concentrations exceed the TCT0 threshold values, but not the TCT1 threshold values. The elevated boron concentrations seem to be associated with the sandstone samples, but the results are not conclusive for all samples taken. The elevated barium, magnesium and lead do not show a distinctive association with either the sandstone or the carbonaceous material sampled, but seem to occur across the board. The lead concentrations do not significantly exceed the TCT0 threshold values, in most instances by less than 10 mg/kg.
- The TCT concentrations in the discard samples indicate that most elements occur in concentrations below the TCT0 threshold values set (Table 7). The exceptions are barium, magnesium and zinc. The concentrations of these elements exceed the TCT0 threshold values, but remain below the TCT1 threshold values.
- When the whole rock analyses are compared graphically, as presented in Figures 1 and 2, the following is noted:
    - Silicon (Si) is the main element contained in the waste rock samples, exceeding 350000 mg/kg in all the samples taken.
    - The second highest elemental concentration present in the waste rock samples is aluminium (Al). Concentrations in the samples vary between 50 000 and 100 000 mg/kg for all samples taken.
    - The other main elements present in the waste rock samples include calcium (Ca), potassium (K), iron (Fe), magnesium (Mg) and titanium (Ti).

- The chemical composition of the discard material is significantly different to that of the waste rock samples. The main element present in the discard is aluminium (Al), with concentrations ranging between 8 000 and 15 000 mg/kg.
- The second highest elemental concentration is calcium (Ca) with concentrations between 3 000 and 9 000 mg/kg.
- Other elements present in significant amounts in the discard include silicon (Si), iron (Fe), magnesium (Mg), sodium (Na), potassium (K), barium (Ba), titanium (Ti), zinc (Zn), strontium (Sr) and phosphor (P).

Leach tests have an important role in providing information to support the assessment of the environmental risks associated with the material sampled as it determines the concentrations of chemical constituents in soil pore water that may come in contact with surface water bodies, groundwater, fauna and flora. In order to understand the risk of the waste rock and discard at the mine, it is important to understand whether or not the leachable chemical constituents are below the threshold values set in the Norms and Standards.

These results are discussed below.

Table 6a Results of the Total Concentration Test for waste rock samples

Units	GC01-2 Unweathered Sandstone (fair amount of silica)		GC01-4 Carbonaceous Shale & Sandstone		GC01-5 Sandstone (roof of coal seam)		GC01-6 Carbonaceous Sandstone		GC02-2 Carbonaceous Clay (roof of B seam)		GC02-3 Sandstone (floor of B-lower)		GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Ag, Silver	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Al, Aluminium	117	46800	234	93600	147	58800	115	46000	149	59600	187	74800	262	104800			
As, Arsenic	<0.001	<0.400	0,001	0,400	0,001	0,400	0,002	0,800	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	5,8	500	2000
Au, Gold	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
B, Boron	0,188	75	0,344	138	0,485	194	0,395	158	0,663	265	0,586	234	0,477	191	150	15000	6000
Ba, Barium	0,846	338	0,303	121	0,531	212	0,131	52	1,65	658	1,14	456	0,893	357	62,5	6250	25000
Be, Beryllium	0,004	1,60	0,014	5,60	0,007	2,80	0,004	1,60	0,012	4,80	0,005	2,00	0,010	4,00			
Bi, Bismuth	<0.001	<0.400	0,001	0,400	<0.001	<0.400	<0.001	<0.400	0,001	0,400	<0.001	<0.400	<0.001	<0.400			
Ca, Calcium	2	800	3	1200	3	1200	<1	<400	30	12000	13	5200	<1	<400			
Cd, Cadmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	7,5	260	1040
Ce, Cerium	0,014	5,6	0,032	12,8	0,017	6,8	0,015	6	0,007	2,8	0,009	3,6	0,036	14,4			
Co, Cobalt	0,003	1,20	0,009	3,60	0,008	3,20	0,003	1,20	0,004	1,60	0,005	2,00	0,002	0,800	50	5000	20000
CrTotal, Chromium Total	0,332	133	0,344	138	0,385	154	0,469	188	0,207	83	0,270	108	0,232	93	46000	800000	N/A
Cs, Cesium	0,001	0,400	0,003	1,20	0,002	0,800	0,001	0,400	0,001	0,400	0,003	1,20	0,002	0,800			
Cu, Copper	<0.001	<0.400	0,017	6,80	0,005	2,00	0,004	1,60	0,012	4,80	0,003	1,20	0,006	2,40	16	19500	78000
Dy, Dysprosium	0,003	1,20	0,005	2,00	0,003	1,20	0,004	1,60	0,003	1,20	0,002	0,800	0,004	1,60			
Er, Erbium	0,002	0,800	0,003	1,20	0,001	0,400	0,003	1,20	0,002	0,800	0,001	0,400	0,002	0,800			
Eu, Europium	0,001	0,400	0,001	0,400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400			
Fe, Iron	22	8800	49	19600	81	32400	55	22000	17	6800	40	16000	16	6400			
Ga, Gallium	0,015	6,00	0,015	6,00	0,020	8,00	0,008	3,20	0,041	16	0,025	10	0,019	7,60			
Gd, Gadolinium	0,002	0,800	0,005	2,00	0,002	0,800	0,003	1,20	0,002	0,800	0,001	0,400	0,004	1,60			
Ge, Germanium	<0.001	<0.400	0.001	0.400	<0.001	<0.400	0.001	0.400	0.002	0.800	0.001	0.400	0.001	0.400			
Hf, Hafnium	<0.001	<0.400	0,001	0,400	<0.001	<0.400	0,003	1,20	0,010	4,00	<0.001	<0.400	0,006	2,40			
Hg, Mercury	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400	0,93	160	640
Ho, Holium	0,001	0,400	0,001	0,400	0,001	0,400	0,001	0,400	0,001	0,400	<0.001	<0.400	0,001	0,400			
In, Indium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ir, Iridium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
K, Potassium	75	30000	44	17600	53	21200	4,3	1714	10,3	4113	73	29200	52	20800			
La, Lanthanum	0,007	2,80	0,012	4,80	0,005	2,00	0,006	2,40	0,003	1,20	0,003	1,20	0,017	6,80			
Li, Lithium	0,026	10	0,300	120	0,220	88	0,132	53	0,253	101	0,096	38	0,200	80			
Lu, Lutetium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Mg, Magnesium	3	1200	10	4000	6	2400	2	800	7	2800	10	4000	3	1200	1000	25000	100000
Mn, Manganese	0,523	209	0,633	253	1,13	454	0,212	85	0,184	74	0,641	256	0,226	90	1000	25000	100000
Mo, Molybdenum	0,005	2,00	0,002	0,800	0,004	1,60	0,009	3,60	0,001	0,400	0,003	1,20	0,002	0,800	40	1000	4000
Na, Sodium	8	3200	1	400	2	800	<1	<400	<1	<400	2	800	2	800			
Nb, Niobium	<0.001	<0.400	0,004	1,60	<0.001	<0.400	0,004	1,60	0,007	2,80	0,001	0,400	0,006	2,40			

Units	GC01-2 Unweathered Sandstone (fair amount of silica)		GC01-4 Carbonaceous Shale & Sandstone		GC01-5 Sandstone (roof of coal seam)		GC01-6 Carbonaceous Sandstone		GC02-2 Carbonaceous Clay (roof of B seam)		GC02-3 Sandstone (floor of B-lower)		GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Nd, Neodymium	0,008	3,20	0,015	6,00	0,006	2,40	0,005	2,00	0,004	1,60	0,005	2,00	0,021	8,40			
Ni, Nickel	0,004	1,60	0,018	7,20	0,017	6,80	0,019	7,60	0,022	8,80	0,008	3,20	0,007	2,80	91	10600	42400
Os, Osmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
P, Phosphorus	2,23	892	2,19	877	2,44	978	2,01	802	1,50	600	2,33	934	1,72	688			
Pb, Lead	0,071	28	0,016	6,40	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0,041	16	<0.001	<0.400	20	1900	7600
Pd, Palladium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Pr, Praseodymium	0,002	0,800	0,004	1,60	0,002	0,800	0,001	0,400	0,001	0,400	0,001	0,400	0,005	2,00			
Pt, Platinum	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Rb, Rubidium	0,047	19	0,027	11	0,045	18	0,010	4,00	0,002	0,800	0,036	14	0,035	14			
Rh, Rhodium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ru, Rubidium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Sb, Antimony	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	10	75	300
Sc, Scandium	0,017	6,80	0,033	13	0,017	6,80	0,018	7,20	0,026	10	0,019	7,60	0,030	12			
Se, Selenium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	10	50	200
Si, Silicon	918	367200	586	234400	834	333600	880	352000	382	152800	794	317600	704	281600			
Sm, Samarium	0,002	0,800	0,004	1,60	0,002	0,800	0,001	0,400	0,001	0,400	0,001	0,400	0,005	2,00			
Sn, Tin	0,001	0,400	0,003	1,20	0,001	0,400	0,001	0,400	0,005	2,00	0,002	0,800	0,005	2,00			
Sr, Strontium	0,036	14	0,030	12	0,058	23	0,012	4,80	0,180	72	0,096	38	0,031	12			
Ta, Tantalum	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Tb, Terbium	<0.001	<0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400			
Te, Tellurium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Th, Thorium	0,006	2,40	0,048	19	0,018	7,20	0,018	7,20	0,017	6,80	0,010	4,00	0,024	9,60			
Ti, Titanium	6,30	2520	12	4800	7,66	3066	11	4400	10	4000	9,74	3896	14	5612			
Tl, Thallium	0,002	0,800	0,002	0,800	0,003	1,20	0,003	1,20	0,001	0,400	0,002	0,800	0,001	0,400			
Tm, Thulium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
U, Uranium	0,004	1,60	0,024	9,60	0,009	3,60	0,009	3,60	0,025	10	0,007	2,80	0,013	5,20			
V, Vanadium	0,072	29	0,283	113	0,137	55	0,103	41	0,131	52	0,098	39	0,156	62	150	2680	10720
W, Tungsten	0,002	0,800	0,004	1,60	0,001	0,400	0,003	1,20	0,002	0,800	0,001	0,400	0,002	0,800			
Y, Yttrium	0,002	0,800	0,004	1,60	0,002	0,800	0,006	2,40	0,005	2,00	0,001	0,400	0,004	1,60			
Yb, Ytterbium	0,002	0,800	0,002	0,800	0,002	0,800	0,003	1,20	0,003	1,20	0,001	0,400	0,002	0,800			
Zn, Zinc	0,003	1,20	0,049	20	0,029	12	0,003	1,20	0,015	6,00	0,027	11	0,034	14	240	160000	640000
Zr, Zircon	0,034	14	0,094	38	0,041	16	0,116	46	0,230	92	0,049	20	0,114	46			

Table 6b Results of the Total Concentration Test for waste rock samples (continue)

Units	GC02-6 Carbonaceous Shale		GC02-7 Sandstone		GC02-9 Sandstone (roof and floor of E seam)		GC03-2 Siltstone/sandstone		GC03-3 Carbonaceous Shale and sandstone mix		GC03-4 Carbonaceous Sandstone		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Ag, Silver	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Al, Aluminium	207	82800	160	64000	88	35200	142	56800	92	36800	199	79600			
As, Arsenic	0,001	0,400	<0.001	<0.400	0,002	0,800	0,005	2,00	<0.001	<0.400	0,001	0,400	5,8	500	2000
Au, Gold	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
B, Boron	0,291	116	0,183	73	0,303	121	0,645	258	0,107	43	0,403	161	150	15000	6000
Ba, Barium	0,085	34	1,22	488	0,501	200	0,470	188	0,009	3,60	0,286	114	62,5	6250	25000
Be, Beryllium	0,017	6,80	0,005	2,00	0,003	1,20	0,007	2,80	0,014	5,60	0,014	5,60			
Bi, Bismuth	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ca, Calcium	3	1200	16	6400	9	3600	201	80400	<1	<400	3	1200			
Cd, Cadmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	7,5	260	1040
Ce, Cerium	0,009	3,6	0,009	3,6	0,009	3,6	0,027	10,8	0,001	0,4	0,016	6,4			
Co, Cobalt	0,010	4,00	0,003	1,20	0,011	4,40	0,008	3,20	0,003	1,20	0,010	4,00	50	5000	20000
CrTotal, Chromium Total	0,206	82	0,303	121	0,435	174	0,340	136	0,183	73	0,336	134	46000	800000	N/A
Cs, Cesium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Cu, Copper	0,017	6,80	<0.001	<0.400	0,001	0,400	0,002	0,800	0,018	7,20	0,017	6,80	16	19500	78000
Dy, Dysprosium	0,001	0,400	0,002	0,800	0,002	0,800	0,012	4,80	<0.001	<0.400	0,002	0,800			
Er, Erbium	0,001	0,400	0,001	0,400	0,001	0,400	0,007	2,80	<0.001	<0.400	0,001	0,400			
Eu, Europium	<0.001	<0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Fe, Iron	40	16000	36	14400	50	20000	121	48400	9	3600	70	28000			
Ga, Gallium	0,010	4,00	0,025	10	0,013	5,20	0,024	9,60	0,006	2,40	0,016	6,40			
Gd, Gadolinium	0,001	0,400	0,002	0,800	0,002	0,800	0,007	2,80	<0.001	<0.400	0,002	0,800			
Ge, Germanium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Hf, Hafnium	0,006	2,40	<0.001	<0.400	<0.001	<0.400	0,006	2,40	0,008	3,20	0,008	3,20			
Hg, Mercury	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0,93	160	640
Ho, Holium	<0.001	<0.400	0,001	0,400	<0.001	<0.400	0,003	1,20	<0.001	<0.400	<0.001	<0.400			
In, Indium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ir, Iridium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
K, Potassium	49	19600	78	31200	32	12800	43	17200	30	12000	46	18400			
La, Lanthanum	0,004	1,60	0,004	1,60	0,003	1,20	0,013	5,20	0,001	0,400	0,007	2,80			
Li, Lithium	0,170	68	0,059	24	0,103	41	0,120	48	0,222	89	0,273	109			
Lu, Lutetium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400			
Mg, Magnesium	9	3600	9	3600	4	1600	19	7600	1	400	9	3600	1000	25000	100000
Mn, Manganese	0,363	145	0,673	269	0,499	200	1,45	581	0,080	32	1,11	442	1000	25000	100000
Mo, Molybdenum	0,001	0,400	0,004	1,60	0,009	3,60	0,001	0,400	0,002	0,800	0,003	1,20	40	1000	4000
Na, Sodium	2	800	12	4800	1	400	3	1200	1	400	2	800			
Nb, Niobium	0,009	3,60	0,003	1,20	0,002	0,800	0,001	0,400	0,013	5,20	0,007	2,80			
Nd, Neodymium	0,004	1,60	0,006	2,40	0,004	1,60	0,014	5,60	0,001	0,400	0,007	2,80			
Ni, Nickel	0,024	9,60	0,007	2,80	0,016	6,40	0,014	5,60	0,014	5,60	0,020	8,00	91	10600	42400
Os, Osmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
P, Phosphorus	2,67	1068	2,17	866	2,59	1036	5,85	2339	1,57	630	3,33	1332			
Pb, Lead	0,068	27	0,075	30	0,067	27	0,054	22	0,019	7,60	0,077	31	20	1900	7600
Pd, Palladium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Pr, Praseodymium	0,001	0,400	0,002	0,800	0,001	0,400	0,003	1,20	<0.001	<0.400	0,002	0,800			
Pt, Platinum	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Rb, Rubidium	0,002	0,800	0,039	16	0,015	6,00	0,020	8,00	<0.001	<0.400	0,006	2,40			
Rh, Rhodium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			

Units	GC02-6 Carbonaceous Shale		GC02-7 Sandstone		GC02-9 Sandstone (roof and floor of E seam)		GC03-2 Siltstone/sandstone		GC03-3 Carbonaceous Shale and sandstone mix		GC03-4 Carbonaceous Sandstone		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Ru, Rubidium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Sb, Antimony	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	10	75	300
Sc, Scandium	0,022	8,80	0,022	8,80	0,014	5,60	0,032	13	0,009	3,60	0,025	10			
Se, Selenium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	10	50	200
Si, Silicon	587	234800	838	335200	945	378000	544	217600	568	227200	612	244800			
Sm, Samarium	0,001	0,400	0,002	0,800	0,001	0,400	0,004	1,60	<0.001	<0.400	0,002	0,800			
Sn, Tin	0,004	1,60	0,002	0,800	0,001	0,400	<0.001	<0.400	0,006	2,40	0,003	1,20			
Sr, Strontium	0,009	3,60	0,074	30	0,057	23	0,101	40	<0.001	<0.400	0,079	32			
Ta, Tantalum	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Tb, Terbium	<0.001	<0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400	<0.001	<0.400			
Te, Tellurium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Th, Thorium	0,008	3,20	<0.001	<0.400	<0.001	<0.400	0,004	1,60	<0.001	<0.400	0,020	8,00			
Ti, Titanium	13	5002	7,23	2892	5,88	2351	8,41	3364	13	5200	13	5200			
Tl, Thallium	0,001	0,400	0,001	0,400	0,002	0,800	0,001	0,400	<0.001	<0.400	0,001	0,400			
Tm, Thulium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400			
U, Uranium	0,015	6,00	0,004	1,60	0,005	2,00	0,008	3,20	0,014	5,60	0,015	6,00			
V, Vanadium	0,253	101	0,114	46	0,090	36	0,128	51	0,280	112	0,262	105	150	2680	10720
W, Tungsten	0,005	2,00	0,003	1,20	0,003	1,20	0,003	1,20	0,005	2,00	0,005	2,00			
Y, Yttrium	0,001	0,400	0,001	0,400	0,002	0,800	0,007	2,80	<0.001	<0.400	0,002	0,800			
Yb, Ytterbium	0,001	0,400	0,001	0,400	0,001	0,400	0,007	2,80	<0.001	<0.400	0,001	0,400			
Zn, Zinc	0,050	20	0,012	4,80	0,013	5,20	0,017	6,80	0,039	16	0,054	22	240	160000	640000
Zr, Zircon	0,103	41	0,033	13	0,031	12	0,036	14	0,153	61	0,093	37			

Table 6c Results of the Total Concentration Test for waste rock samples (continue)

Units	GC03-6 Sandstone & Shale mix		GC03-8 Carbonaceous Shale		GC03-10 Carbonaceous sand stone and Shale mix		GC04-2 Carbonaceous Shale		GC04-3 Shale and Sandstone mix		GC04-4 Sandstone		GC04-6 Sandstone		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Ag, Silver	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Al, Aluminium	199	79600	141	56400	110	44000	194	77600	191	76400	87	34800	48	19200			
As, Arsenic	0,001	0,400	0,001	0,400	0,001	0,400	<0.001	<0.400	0,001	0,400	0,001	0,400	<0.001	<0.400	5,8	500	2000
Au, Gold	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
B, Boron	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0,097	39	<0.001	<0.400	150	15000	6000
Ba, Barium	0,975	390	0,487	195	0,064	26	0,096	38	0,120	48	0,637	255	0,006	2,40	62,5	6250	25000
Be, Beryllium	0,005	2,00	0,015	6,00	0,004	1,60	0,014	5,60	0,010	4,00	0,002	0,800	0,002	0,800			
Bi, Bismuth	<0.001	<0.400	0,002	0,800	<0.001	<0.400	0,002	0,800	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ca, Calcium	13	5200	6	2400	3	1200	3	1200	4	1600	1	400	<1	<400			
Cd, Cadmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	7,5	260	1040
Ce, Cerium	0,005	2	0,003	1,2	0,003	1,2	0,013	5,2	0,008	3,2	0,014	6	<0.001	<0.400			
Co, Cobalt	0,005	2,00	0,020	8,00	0,002	0,800	0,017	6,80	0,008	3,20	0,004	1,60	0,002	0,800	50	5000	20000
CrTotal, Chromium Total	0,258	103	0,232	93	0,450	180	0,234	94	0,308	123	0,450	180	0,387	155	46000	800000	N/A
Cs, Cesium	<0.001	<0.400	0,001	0,400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Cu, Copper	0,006	2,40	0,029	12	0,007	2,80	0,027	11	0,011	4,40	0,001	0,400	0,001	0,400	16	19500	78000
Dy, Dysprosium	0,001	0,400	0,001	0,400	0,001	0,400	0,002	0,800	0,001	0,400	0,001	0,400	<0.001	<0.400			
Er, Erbium	0,001	0,400	0,001	0,400	<0.001	<0.400	0,001	0,400	0,001	0,400	0,001	0,400	<0.001	<0.400			
Eu, Europium	0.001	0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Fe, Iron	40	16000	78	31200	26	10400	72	28800	35	14000	42	16800	19	7600			
Ga, Gallium	0,028	11	0,030	12	0,005	2,00	0,014	5,60	0,011	4,40	0,014	5,60	0,003	1,20			
Gd, Gadolinium	0,001	0,400	0,001	0,400	<0.001	<0.400	0,002	0,800	0,001	0,400	0,001	0,400	<0.001	<0.400			
Ge, Germanium	0.001	0.400	0.001	0.400	0.001	0.400	0.001	0.400	<0.001	<0.400	<0.001	<0.400	0.001	0.400			
Hf, Hafnium	0,024	9,60	0,015	6,00	0,017	6,80	0,014	5,60	0,022	8,80	0,005	2,00	0,007	2,80			
Hg, Mercury	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	0,93	160	640
Ho, Holium	0.001	0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
In, Indium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ir, Iridium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
K, Potassium	66	26400	35	14000	20	8000	38	15200	51	20400	50	20000	12	4800			
La, Lanthanum	0,002	0,800	0,002	0,800	0,001	0,400	0,006	2,40	0,004	1,60	0,005	2,00	<0.001	<0.400			
Li, Lithium	0,111	44	0,138	55	0,018	7	0,241	96	0,192	77	0,078	31	0,066	26			
Lu, Lutetium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Mg, Magnesium	10	4000	7	2800	3	1200	8	3200	6	2400	2	800	<1	<400	1000	25000	100000
Mn, Manganese	0,565	226	1,86	745	0,338	135	1,81	722	0,357	143	0,520	208	0,113	45	1000	25000	100000
Mo, Molybdenum	0,004	1,60	0,001	0,400	0,014	5,60	0,001	0,400	0,003	1,20	0,008	3,20	0,015	6,00	40	1000	4000
Na, Sodium	2	800	5	2000	2	800	2	800	2	800	2	800	<1	<400			
Nb, Niobium	0,009	3,60	0,011	4,40	0,010	4,00	0,011	4,40	0,010	4,00	0,002	0,800	0,004	1,60			
Nd, Neodymium	0,003	1,20	0,002	0,800	0,001	0,400	0,006	2,40	0,003	1,20	0,005	2,00	<0.001	<0.400			
Ni, Nickel	0,009	3,60	0,033	13	0,008	3,20	0,028	11	0,035	14	0,007	2,80	0,008	3,20	91	10600	42400
Os, Osmium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
P, Phosphorus	2,22	886	2,36	942	1,90	759	2,14	855	2,22	887	2,61	1042	2,43	972			
Pb, Lead	0,076	30	0,100	40	0,028	11	0,071	28	0,069	28	0,060	24	0,031	12	20	1900	7600
Pd, Palladium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Pr, Praseodymium	0,001	0,400	0,001	0,400	<0.001	<0.400	0,002	0,800	0,001	0,400	0,001	0,400	<0.001	<0.400			
Pt, Platinum	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Rb, Rubidium	0,027	11	0,004	1,60	0,009	3,60	0,012	4,80	0,015	6,00	0,044	18	0,005	2,00			

Units	GC03-6 Sandstone & Shale mix		GC03-8 Carbonaceous Shale		GC03-10 Carbonaceous sand stone and Shale mix		GC04-2 Carbonaceous Shale		GC04-3 Shale and Sandstone mix		GC04-4 Sandstone		GC04-6 Sandstone		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Rh, Rhodium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Ru, Rubidium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Sb, Antimony	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	10	75	300
Sc, Scandium	0,024	9,60	0,019	7,60	0,009	3,60	0,029	12	0,024	9,60	0,011	4,40	0,006	2,40			
Se, Selenium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	10	50	200
Si, Silicon	747	298800	527	210800	929	371600	503	201200	637	254800	963	385200	974	389600			
Sm, Samarium	0,001	0,400	0,001	0,400	<0.001	<0.400	0,001	0,400	0,001	0,400	0,001	0,400	<0.001	<0.400			
Sn, Tin	0,004	1,60	0,004	1,60	0,003	1,20	0,004	1,60	0,008	3,20	0,001	0,400	0,001	0,400			
Sr, Strontium	0,046	18	0,094	38	0,011	4,40	0,013	5,20	0,005	2,00	0,034	14	<0.001	<0.400			
Ta, Tantalum	0,003	1,20	0,003	1,20	0,001	0,400	0,003	1,20	0,003	1,20	<0.001	<0.400	<0.001	<0.400			
Tb, Terbium	0.001	0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Te, Tellurium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
Th, Thorium	0,011	4,40	0,020	8,00	0,007	2,80	0,034	14	0,019	7,60	0,007	2,80	0,002	0,800			
Ti, Titanium	11	4400	14	5600	9,71	3884	13	5200	14	5600	3,73	1492	3,54	1414			
Tl, Thallium	0,001	0,400	0,002	0,800	0,001	0,400	0,002	0,800	0,003	1,20	0,002	0,800	0,001	0,400			
Tm, Thulium	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400			
U, Uranium	0,008	3,20	0,017	6,80	0,007	2,80	0,022	8,80	0,012	4,80	0,005	2,00	0,003	1,20			
V, Vanadium	0,126	50	0,318	127	0,119	48	0,289	116	0,273	109	0,078	31	0,045	18	150	2680	10720
W, Tungsten	0,005	2,00	0,006	2,40	0,005	2,00	0,006	2,40	0,005	2,00	0,003	1,20	0,003	1,20			
Y, Yttrium	0,001	0,400	0,001	0,400	0,001	0,400	0,002	0,800	0,001	0,400	0,002	0,800	<0.001	<0.400			
Yb, Ytterbium	0,001	0,400	0,001	0,400	0,000	0,000	0,001	0,400	0,001	0,400	0,001	0,400	<0.001	<0.400			
Zn, Zinc	0,034	14	0,066	26	0,006	2,40	0,059	24	0,059	24	0,010	4,00	<0.001	<0.400	240	160000	640000
Zr, Zircon	0,101	40	0,100	40	0,153	61	0,094	38	0,124	50	0,023	9,20	0,072	29			

Table 7 Results of the Total Concentration Test for discard samples

Units	Ant 3 (2)		Ant 110 (1)		Ant 100 (4)		Ant 105 (1)		Ant 185 (1)		Ant 105 (3)		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Ag, Silver	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	0,001	0,415	<0,001	<0,400	<0,001	<0,400			
Al, Aluminium	39	15600	27	10800	23	9200	32	12800	18	7200	35	14000			
As, Arsenic	0,003	1,40	0,005	1,91	0,004	1,49	0,007	2,61	0,005	2,11	0,004	1,45	5,8	500	2000
Au, Gold	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
B, Boron	0,034	14	0,038	15	0,044	18	0,057	23	0,021	8,34	0,025	10	150	15000	6000
Ba, Barium	0,652	261	0,687	275	0,843	337	1,57	626	0,392	157	0,288	115	62,5	6250	25000
Be, Beryllium	0,004	1,48	0,005	1,84	0,004	1,51	0,004	1,67	0,006	2,48	0,004	1,50			
Bi, Bismuth	<0,001	<0,400	<0,001	<0,400	0,001	0,423	0,003	1,21	0,001	0,560	0,002	0,649			
Ca, Calcium	9	3600	13	5200	13	5200	3	1200	23	9200	1	400			
Cd, Cadmium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	0,001	0,411	<0,001	<0,400	<0,001	<0,400	7,5	260	1040
Ce, Cerium	0,127	51	0,129	51	0,155	62	0,208	83	0,143	57	0,207	83			
Co, Cobalt	0,017	6,77	0,021	8,27	0,022	8,92	0,019	7,44	0,010	3,87	0,005	1,94	50	5000	20000
CrTotal, Chromium Total	0,128	51	0,156	62	0,094	37	0,069	28	0,075	30	0,115	46	46000	800000	N/A
Cs, Cesium	0,003	1,28	0,004	1,77	0,004	1,50	0,008	3,37	0,003	1,13	0,005	1,94			
Cu, Copper	0,026	10	0,026	11	0,028	11	0,026	10	0,037	15	0,035	14	16	19500	78000
Dy, Dysprosium	0,007	2,85	0,007	2,95	0,008	3,22	0,010	3,90	0,007	2,73	0,008	3,32			
Er, Erbium	0,004	1,54	0,004	1,61	0,005	1,82	0,005	2,06	0,003	1,36	0,004	1,53			
Eu, Europium	0,002	0,786	0,002	0,828	0,002	0,860	0,003	1,12	0,003	1,40	0,002	0,898			
Fe, Iron	5,65	2260	6,92	2767	4,47	1790	5,32	2128	4,06	1624	6,18	2473			
Ga, Gallium	0,054	22	0,059	24	0,062	25	0,099	39	0,033	13	0,024	10			
Gd, Gadolinium	0,010	3,93	0,010	4,04	0,012	4,67	0,015	6,05	0,011	4,22	0,014	5,56			
Ge, Germanium	0,004	1,51	0,005	2,06	0,003	1,40	0,001	0,529	0,002	0,855	<0,001	<0,400			
Hf, Hafnium	0,004	1,54	0,003	1,03	0,003	1,29	0,030	12	0,008	3,23	0,004	1,55			
Hg, Mercury	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	0,93	160	640
Ho, Holium	0,001	0,595	0,002	0,616	0,002	0,695	0,002	0,819	0,001	0,545	0,002	0,625			
In, Indium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	0,001	0,412	<0,001	<0,400	<0,001	<0,400			
Ir, Iridium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
K, Potassium	<0,5	<200	<0,5	<200	<0,5	<200	<0,5	<200	<0,5	<200	<0,5	<200			
La, Lanthanum	0,063	25	0,063	25	0,075	30	0,103	41	0,080	32	0,107	43			
Li, Lithium	0,032	13	0,025	9,83	0,020	8,11	0,027	11	0,015	5,86	0,016	6,37			
Lu, Lutetium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Mg, Magnesium	2	800	3	1200	3	1200	1	400	5	2000	<1	<400	1000	25000	100000
Mn, Manganese	0,125	50	0,185	74	0,106	42	<0,025	<10	0,237	95	<0,025	<10	1000	25000	100000
Mo, Molybdenum	0,003	1,24	0,005	2,13	0,003	1,23	0,003	1,25	0,002	0,897	0,003	1,31	40	1000	4000
Na, Sodium	<1	<400	<1	<400	<1	<400	<1	<400	<1	<400	<1	<400			
Nb, Niobium	0,006	2,32	0,009	3,55	0,011	4,39	0,006	2,59	0,004	1,43	0,001	0,490			
Nd, Neodymium	0,045	18	0,047	19	0,056	22	0,072	29	0,052	21	0,071	28			
Ni, Nickel	0,027	11	0,032	13	0,042	17	0,038	15	0,023	9,13	0,026	10	91	10600	42400
Os, Osmium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
P, Phosphorus	0,189	75	0,324	130	0,764	306	1,82	729	0,080	32	0,065	26			
Pb, Lead	0,036	14	0,031	13	0,030	12	0,021	8,55	0,027	11	0,051	20	20	1900	7600
Pd, Palladium	0,002	0,697	0,002	0,691	0,002	0,851	0,004	1,67	0,002	0,695	0,002	0,625			
Pr, Praseodymium	0,013	5,39	0,014	5,53	0,017	6,66	0,022	8,82	0,016	6,40	0,022	8,75			
Pt, Platinum	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Rb, Rubidium	0,012	4,70	0,013	5,27	0,014	5,65	0,028	11	0,012	4,92	0,015	5,91			
Rh, Rhodium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Ru, Rubidium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Sb, Antimony	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	10	75	300

Units	Ant 3 (2)		Ant 110 (1)		Ant 100 (4)		Ant 105 (1)		Ant 185 (1)		Ant 105 (3)		TCT0 (mg/kg)	TCT1 (mg/kg)	TCT2 (mg/kg)
	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg			
Sc, Scandium	0,017	6,86	0,018	7,20	0,015	6,10	0,016	6,49	0,014	5,51	0,017	6,65			
Se, Selenium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	0,004	1,52	<0,001	<0,400	<0,001	<0,400	10	50	200
Si, Silicon	8,9	3555	7,1	2834	6,7	2686	6,9	2752	5,6	2241	8,3	3321			
Sm, Samarium	0,009	3,55	0,009	3,60	0,011	4,22	0,014	5,44	0,010	3,81	0,013	5,10			
Sn, Tin	0,005	1,93	0,003	1,39	0,004	1,67	0,005	2,03	0,002	0,921	0,003	1,38			
Sr, Strontium	0,388	155	0,565	226	0,906	362	1,81	723	0,327	131	0,094	37			
Ta, Tantalum	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Tb, Terbium	0,001	0,565	0,001	0,590	0,002	0,652	0,002	0,842	0,002	0,603	0,002	0,731			
Te, Tellurium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Th, Thorium	0,024	9,52	0,020	7,91	0,022	8,83	0,032	13	0,020	8,16	0,034	13			
Ti, Titanium	1,05	418	1,31	524	1,32	526	1,08	433	0,759	304	0,303	121			
Tl, Thallium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	0,001	0,460	<0,001	<0,400	<0,001	<0,400			
Tm, Thulium	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
U, Uranium	0,006	2,49	0,007	2,68	0,008	3,06	0,007	2,89	0,005	1,99	0,007	3,00			
V, Vanadium	0,109	44	0,157	63	0,106	42	0,077	31	0,063	25	0,049	20	150	2680	10720
W, Tungsten	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400	<0,001	<0,400			
Y, Yttrium	0,036	14	0,037	15	0,043	17	0,050	20	0,032	13	0,037	15			
Yb, Ytterbium	0,003	1,27	0,003	1,36	0,004	1,52	0,004	1,67	0,003	1,08	0,003	1,07			
Zn, Zinc	1,30	519	0,931	373	1,27	509	1,12	446	0,589	235	1,85	739	240	160000	640000
Zr, Zircon	0,130	52	0,132	53	0,149	59	0,109	44	0,081	32	0,088	35			

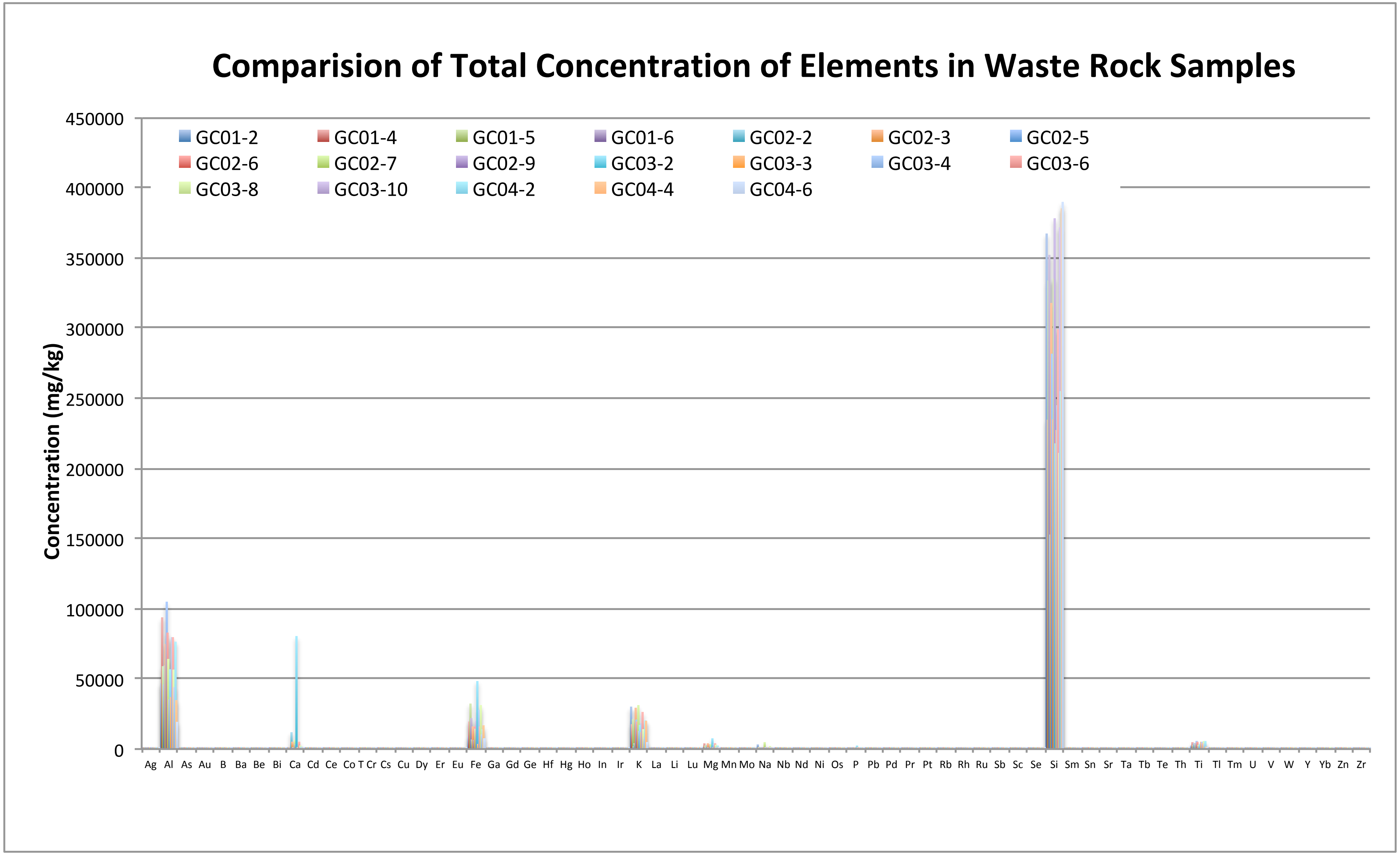

Figure 1 Comparison of Total Concentration of Elements in Waste Rock Samples

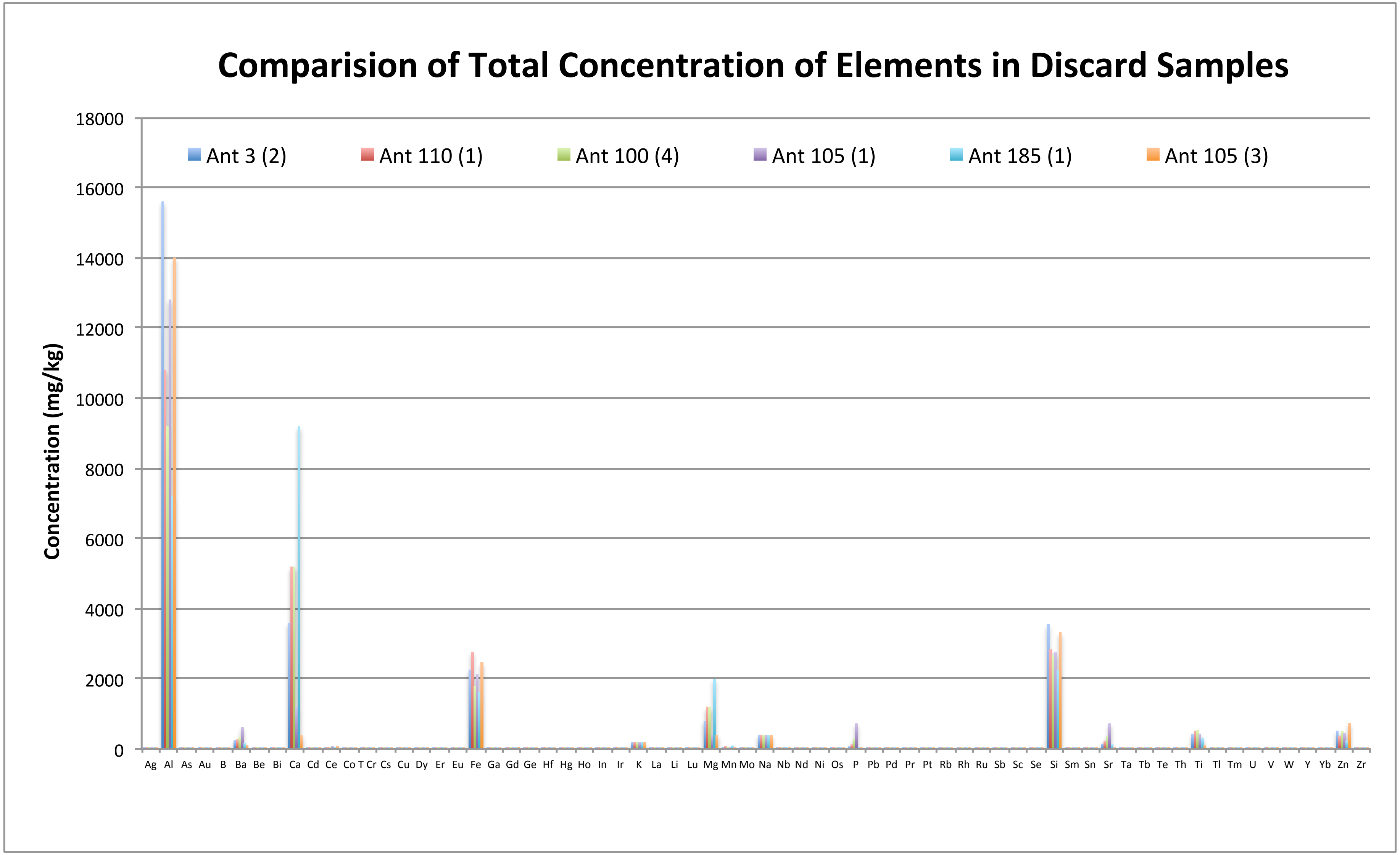

Figure 2 Comparison of Total Concentration of Elements in Discard Samples

The results of deionised water leach tests for the waste rock and discard samples are presented in Tables 8 and 9. The following can be concluded from the analyses presented:

- Water leachable concentrations for the waste rock samples generally fall below the LCT0 threshold values set. The exceptions are nickel in one sample (GC01-6 – Carbonaceous sandstone) and arsenic in one sample (GC03-8 – Carbonaceous shale). None of the sandstone samples yielded concentrations that exceeded the LCT0 threshold values.
- Water leachable concentrations for the discard material generally comply with the LCT0 threshold values. The exceptions are arsenic (As), nickel (Ni), lead (Pb), and Zinc (Zn). The concentrations for these elements exceed the LCT0 concentration threshold values, but not the LCT1 threshold values. Only one of the samples (Ant3(2)) yielded elevated arsenic and lead concentrations.
- When the water leachable concentrations of all elements are compared graphically, as presented in Figures 3 and 4, it is shown that:
  - The waste rock material yielded comparatively higher concentrations of total dissolved solids (TDS) (up to 160 mg/l), sulphate (SO_4) (up to 40 mg/l) and calcium (Ca) (up to 20 mg/l). It is noted that leachate with these concentrations are not considered of poor quality. Noticeable concentrations of potassium (K), magnesium (Mg), silicon (Si), sodium (Na) and iron (Fe) were also recorded in the analyses.
  - The discard samples also exhibited elevated TDS (up to 400 mg/g), SO_4 (up to 250 mg/l), Fe (up t0 110 mg/l), Ca, Mg, and K. It is noted that water leachable elements associated with the discard yielded higher concentrations compared to that of the waste rock samples.

The results of the TCLP leach tests are presented in Tables 10 and 11. The results indicate the following:

- Under the conditions of this test, more elements leach from both the discard and the waste rock material compared to the water leachable tests. This is due to the more aggressive reagents used during the test.
- As reported for the water leachable tests, there is no clear distinction between the elements that leach from the carbonaceous and non-carbonaceous material in the waste rock sampled.
- The waste rock samples yielded concentrations above the LCT0 threshold value for barium (Ba), manganese (Mn), lead (Pb) and total dissolved solids (TDS).
- The discard samples leached concentrations of lead (Pb) and zinc (Zn) above the LCT0 threshold values for all samples. Some samples also yielded concentrations exceeding the LCT0 threshold values for arsenic (As), barium (Ba), manganese (Mn), nickel (Ni) and total dissolved solids (TDS). It is noted that only one discard sample (Ant 3 (2)) yielded As concentrations above the LCT0 threshold value.
- The concentrations of all elements analysed are presented graphically in Figures 5 and 6. The following is concluded from the figures:
  - The most dominant concentration from the waste rock samples is TDS concentrations (up to 7000 mg/l) and calcium (Ca) (up to 3000 mg/l). Comparatively minor concentrations of magnesium (Mg) leaches from the waste rock.
  - The discard material exhibit similar leachable concentration patterns, with elevated concentrations of TDS (up to 3700 mg/l), calcium (Ca), sulphate (SO_4), magnesium (Mg), chloride (Cl), zinc (Zn) and iron (Fe). It is noted that some of the waste rock samples yield higher concentrations of TDS compared to the discard material, which is an unexpected outcome.

Table 8a Results of the Distilled Water Leach Test for waste rock samples

Elements	GC01-2 Unweathered Sandstone	GC01-4 Carbonaceous Shale & Sandstone	GC01-5 Sandstone (roof)	GC01-6 Carbonaceous Sandstone	GC02-2 Carbonaceous Clay (roof B Seam)	GC02-3 Sandstone (floor B-Lower)	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	<0.100	0,363	0,105	<0.100	0,639	0,175				
As, Arsenic	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,01	0,5	1	4
B, Boron	0,004	0,007	0,006	0,007	0,033	0,006	0,5	25	50	200
Ba, Barium	0,055	0,026	0,046	0,159	0,084	0,094	0,7	35	70	280
Ca, Calcium	2	1	3	7	2	6				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	0,003	<0.001	0,004	0,053	<0.001	<0.001	0,5	25	50	200
Cr (Total)l, Chromium Total	<0.001	<0.001	<0.001	<0.001	0,005	<0.001	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	<0.001	<0.001	<0.001	0,030	0,001	<0.001	2	100	200	800
Fe, Iron	<0.025	0,095	<0.025	4,478	0,197	<0.025				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,006	0,3	0,6	2,4
K, Potassium	1,4	2,3	2,0	1,6	3,2	2,3				
Mg, Magnesium	1	<1	1	2	2	2				
Mn, Manganese	0,102	<0.025	0,055	0,447	<0.025	<0.025	0,5	25	50	200
Mo, Molybdenum	<0.001	0,003	0,014	<0.001	0,002	0,005	0,07	3,5	7	28
Na, Sodium	<1	<1	<1	<1	4	<1				
Ni, Nickel	0,002	<0.001	0,003	0,139	0,002	<0.001	0,07	3,5	7	28
Pb, Lead	<0.001	<0.001	<0.001	0,003	<0.001	<0.001	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,02	1	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
Si, Silicon	1,0	2,3	1,3	1,4	2,4	1,3				
Sr, Strontium	0,014	0,012	0,023	0,063	0,027	0,083				
U, Uranium	<0.001	<0.001	<0.001	0,002	<0.001	<0.001				
V, Vanadium	<0.001	0,002	<0.001	<0.001	0,051	<0.001	0,2	10	20	80
Zn, Zinc	<0.001	<0.001	0,00	0	<0.001	<0.001	5	250	500	2000
Total Dissolved Solids	20	20	30	78	170	72	1000	12500	25000	100000
Chloride as Cl	<2	<2	<2	<2	6	<2	300	15000	30000	120000
Sulphate as SO_4	7	3	13	46	6	5	250	12500	25000	100000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	3,3	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	0,4	<0.2	1,5	75	150	600
Ortho-Phosphate, P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide, CN	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	6,1	6,2	6	3,3	5,5	7,1				

Table 8b Results of the Distilled Water Leach Test for waste rock samples (continue)

Elements	GC02-5 Mix Sandstone/siltstone & clay (floor C-Seam)	GC02-6 Carbonaceous Shale	GC02-7 Sandstone	GC02-9 Sandstone (roof and floor E-Seam)	GC03-2 Siltstone/sandstone	GC03-3 Carbonaceous Shale & Sandstone	GC03-4 Carbonaceous Sandstone	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,149	0,157	0,224	<0.100	0,157	0,427	0,130				
As, Arsenic	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,01	0,5	1	4
B, Boron	0,015	0,041	0,005	0,009	0,006	0,019	0,007	0,5	25	50	200
Ba, Barium	0,082	0,053	0,048	0,141	0,086	0,021	0,071	0,7	35	70	280
Ca, Calcium	1	4	7	24	21	1	3				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	<0.001	<0.001	<0.001	0,001	<0.001	<0.001	<0.001	0,5	25	50	200
Cr (Total)l, Chromium Total	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	2	100	200	800
Fe, Iron	0	0,025	<0.025	<0.025	<0.025	0,031	0				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,006	0,3	0,6	2,4
K, Potassium	1,5	2,9	1,7	1,1	2,7	1,4	2,5				
Mg, Magnesium	<1	2	2	3	4	<1	1				
Mn, Manganese	<0.025	<0.025	<0.025	0,061	<0.025	<0.025	<0.025	0,5	25	50	200
Mo, Molybdenum	0,003	0,006	0,003	0,006	0,006	0,003	0,012	0,07	3,5	7	28
Na, Sodium	<1	1	<1	1	<1	1	<1				
Ni, Nickel	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,07	3,5	7	28
Pb, Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,02	1	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
Si, Silicon	2,0	2,0	1,3	0,8	1,2	2,5	2,1				
Sr, Strontium	0,043	0,098	0,181	0,376	0,060	0,012	0,028				
U, Uranium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001				
V, Vanadium	<0.001	0,004	<0.001	<0.001	<0.001	0,005	<0.001	0,2	10	20	80
Zn, Zinc	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	5	250	500	2000
Total Dissolved Solids	18	24	36	96	88	22	30	1000	12500	25000	100000
Chloride as Cl	<2	<2	<2	4	3	<2	<2	300	15000	30000	120000
Sulphate as SO_4	5	8	7	44	32	6	8	250	12500	25000	100000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	0,5	<0.2	<0.2	<0.2	<0.2	<0.2	1,5	75	150	600
Ortho-Phosphate, P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide, CN	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	6,4	6,6	7,1	7,4	7,4	6,5	6,7				

Table 8c Results of the Distilled Water Leach Test for waste rock samples (continue)

Elements	GC03-6 Sandstone & Shale	GC03-8 Carbonaceous Shale	GC03-10 Carbonaceous sandstone and shale	GC04-2 Carbonaceous Shale	GC04-3 Shale & Sandstone	GC04-4 Sandstone	GC04-6 Sandstone	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,126	0,574	0,455	1,964	<0.100	0,241	0,136				
As, Arsenic	<0.010	0,016	0,004	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
B, Boron	0,005	0,065	0,030	0,014	0,004	0,002	0,008	0,5	25	50	200
Ba, Barium	0,135	0,138	0,046	0,028	0,182	0,038	0,157	0,7	35	70	280
Ca, Calcium	8	2	<1	1	6	2	3				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	<0.001	0,002	<0.001	0,001	<0.001	0,002	0,065	0,5	25	50	200
Cr (Total)l, Chromium Total	<0.001	0,003	<0.001	<0.001	<0.001	<0.001	<0.001	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	<0.001	0,003	0,001	<0.001	<0.001	<0.001	<0.001	2	100	200	800
Fe, Iron	<0.025	0,105	0,206	2,923	<0.025	0,120	2,615				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,006	0,3	0,6	2,4
K, Potassium	2,1	2,5	0,6	0,8	1,9	1,3	<0.5				
Mg, Magnesium	2	<1	<1	<1	2	<1	1				
Mn, Manganese	<0.025	<0.025	<0.025	0,072	<0.025	0,126	0,631	0,5	25	50	200
Mo, Molybdenum	0,005	0,026	0,022	0,010	0,005	0,003	<0.001	0,07	3,5	7	28
Na, Sodium	<1	1	10	11	<1	<1	<1				
Ni, Nickel	<0.001	0,004	0,002	<0.001	<0.001	0,002	0,122	0,07	3,5	7	28
Pb, Lead	<0.001	0,006	0,003	<0.001	<0.001	<0.001	0,006	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,02	1	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
Si, Silicon	1,4	2,5	2,1	3,8	1,4	1,3	0,6				
Sr, Strontium	0,060	0,049	0,017	0,013	0,051	0,021	0,059				
U, Uranium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,001				
V, Vanadium	0,001	0,007	0,001	0,001	0,004	<0.001	<0.001	0,2	10	20	80
Zn, Zinc	<0.001	0,01	<0.001	<0.001	<0.001	0	0	5	250	500	2000
Total Dissolved Solids	32	138	98	28	32	18	50	1000	12500	25000	100000
Chloride as Cl	<2	5	2	<2	<2	<2	<2	300	15000	30000	120000
Sulphate as SO_4	7	10	6	7	6	9	26	250	12500	25000	100000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1,5	75	150	600
Ortho-Phosphate, P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide, CN	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	7,3	6,7	6,6	6,2	7,1	6	3,5				

Table 9 Results of the Distilled Water Leach Test for discard samples

Elements	Ant 3 (2)	Ant 110 (1)	Ant 100 (4)	Ant 105 (1)	Ant 185 (1)	Ant 105 (3)	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,537	<0,100	<0,100	<0,100	<0,100	<0,100				
As, Arsenic	0,032	<0,001	<0,001	<0,001	0,002	<0,001	0,01	0,5	1	4
B, Boron	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,5	25	50	200
Ba, Barium	0,088	0,285	0,467	0,170	0,150	0,120	0,7	35	70	280
Ca, Calcium	11	48	22	11	30	7				
Cd, Cadmium	0,003	<0,001	<0,001	<0,001	<0,001	<0,001	0,003	0,15	0,3	1,2
Co, Cobalt	0,244	0,028	0,002	0,040	0,007	0,016	0,5	25	50	200
Cr (Total)l, Chromium Total	0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,1	5	10	40
Cr(VI), Chromium (VI)	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	0,05	2,5	5	20
Cu, Copper	0,019	<0,001	<0,001	0,001	<0,001	0,002	2	100	200	800
Fe, Iron	114	0,027	<0,025	<0,025	<0,025	0,128				
Hg, Mercury	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,006	0,3	0,6	2,4
K, Potassium	1,7	1,0	0,6	2,4	0,8	1,0				
Mg, Magnesium	4	6	3	5	5	3				
Mn, Manganese	0,277	0,405	0,099	0,151	0,158	0,113	0,5	25	50	200
Mo, Molybdenum	<0,001	<0,001	<0,001	<0,001	0,001	<0,001	0,07	3,5	7	28
Na, Sodium	1	<1	2	2	<1	<1				
Ni, Nickel	0,188	0,025	0,002	0,039	0,006	0,038	0,07	3,5	7	28
Pb, Lead	0,040	<0,001	<0,001	<0,001	<0,001	0,002	0,01	0,5	1	4
Sb, Antimony	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,02	1	2	8
Se, Selenium	<0,001	<0,001	<0,001	0,002	0,001	<0,001	0,01	0,5	1	4
Si, Silicon	0,7	0,3	0,2	1,1	0,3	0,4				
Sr, Strontium	0,105	0,410	0,513	0,082	0,327	0,063				
U, Uranium	0,006	<0,001	<0,001	<0,001	<0,001	<0,001				
V, Vanadium	0,003	<0,001	<0,001	<0,001	0,001	<0,001	0,2	10	20	80
Zn, Zinc	79	3,38	1,19	19	0,635	24	5	250	500	2000
Total Dissolved Solids	424	268	122	80	166	18	1000	12500	25000	100000
Chloride as Cl	63	48	28	38	20	34	300	15000	30000	120000
Sulphate as SO_4	249	52	12	25	39	21	250	12500	25000	100000
Nitrate as N	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	11	550	1100	4400
Fluoride as F	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	1,5	75	150	600
Ortho-Phosphate, P	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1				
Total Cyanide, CN	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	0,07	3,5	7	28
pH	2,8	6,9	7,1	6,0	7,1	4,7				

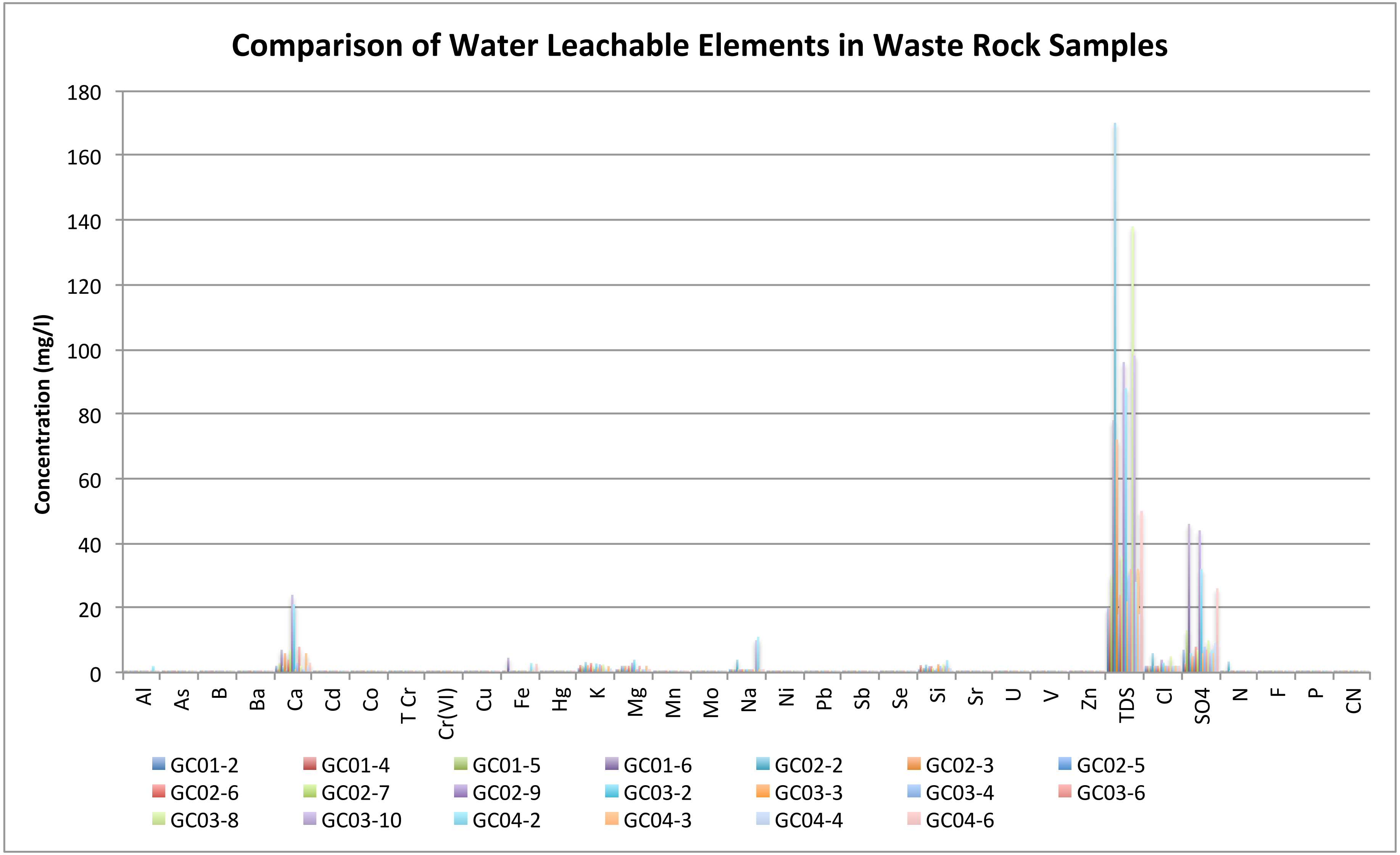

Figure 3 Comparison of Water Leachable Elements in Waste Rock Samples

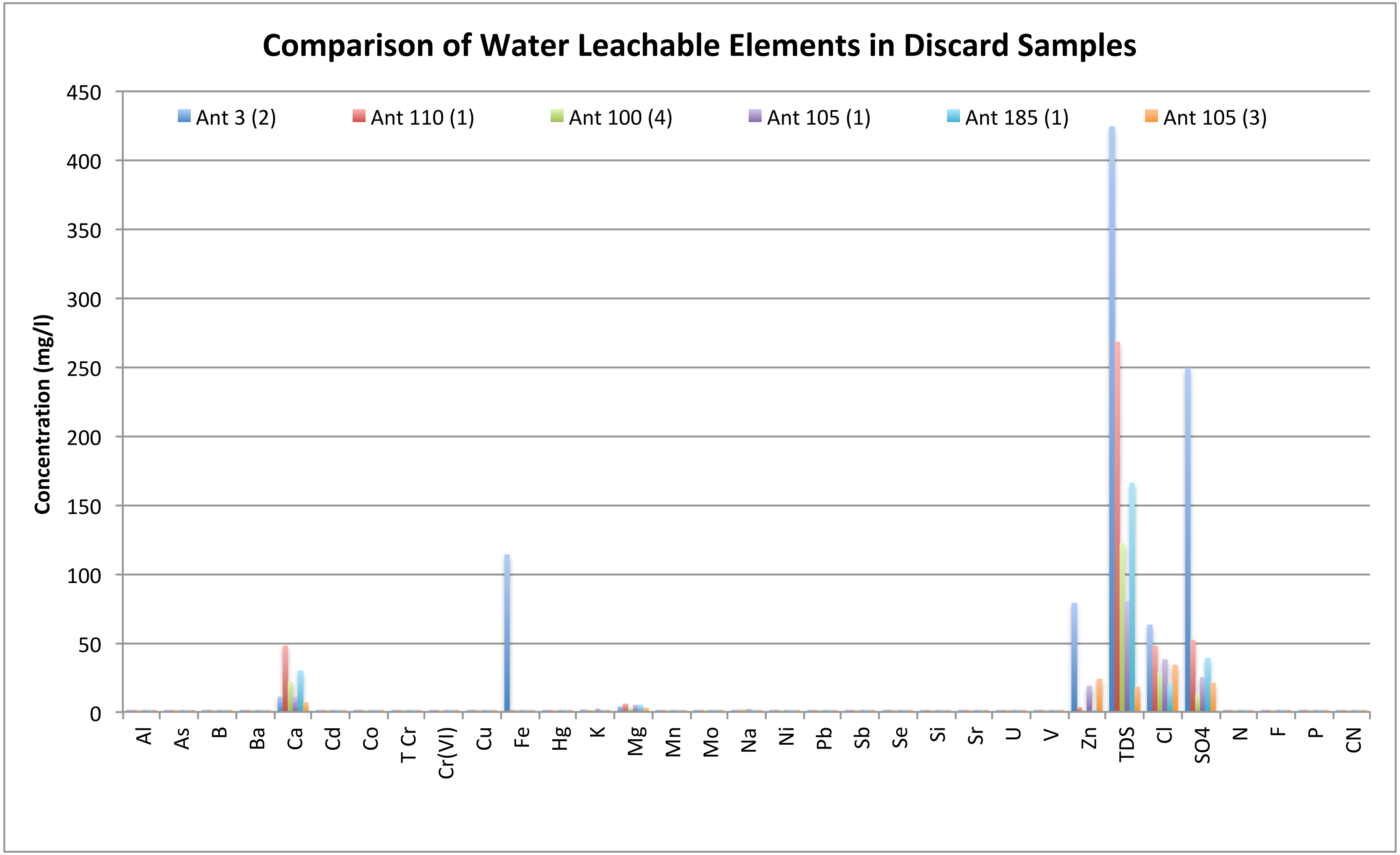

Figure 4 Comparison of Water Leachable Elements in Discard Samples

Table 10a Results of the TCLP Leach Test for waste rock samples

Elements	GC01-2 Unweathered Sandstone	GC01-4 Carbonaceous Shale & Sandstone	GC01-5 Sandstone (roof)	GC01-6 Carbonaceous Sandstone	GC02-2 Carbonaceous Clay (roof B Seam)	GC02-3 Sandstone (floor B-Lower)	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,250	0,148	0,212	0,268	0,114	0,246				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
B, Boron	0,001	0,009	0,001	<0.001	0,011	0,006	0,5	25	50	200
Ba, Barium	0,397	0,863	0,553	0,361	1,650	1,194	0,7	35	70	280
Ca, Calcium	4	20	11	6	97	113				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	0,009	0,018	0,019	0,018	0,001	0,018	0,5	25	50	200
Cr (Total)l, Chromium Total	0,007	<0.001	0,003	0,009	<0.001	0,005	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	<0.001	0,001	0,007	0,007	<0.001	0,001	2	100	200	800
Fe, Iron	3	0,579	2,812	0,278	<0.025	23,000				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,006	0,3	0,6	2,4
K, Potassium	1,2	4,6	2,5	0,5	5,6	2,8				
Mg, Magnesium	2	8	5	3	57	39				
Mn, Manganese	0,756	0,348	0,520	0,559	0,234	1,922	0,5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,07	3,5	7	28
Na, Sodium	35	8	<1	17	<1	<1				
Ni, Nickel	0,007	0,010	0,014	0,046	0,001	0,010	0,07	3,5	7	28
Pb, Lead	0,018	0,009	0,034	0,014	<0.001	0,023	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,02	1	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
Si, Silicon	0,8	3,1	1,7	1,1	1,6	2,1				
Sr, Strontium	0,039	0,162	0,102	0,086	0,344	0,639				
U, Uranium	0,002	0,003	0,002	0,007	<0.001	0,004				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	0,003	<0.001	0,2	10	20	80
Zn, Zinc	0	0,02	0,09	0	<0.001	0	5	250	500	2000
Total Dissolved Solids	124	110	162	28	396	942	1000	12500	25000	100000
Chloride as Cl	<2	<2	<2	<2	2	2	300	15000	30000	120000
Sulphate as SO_4	6	2	14	61	<2	6	250	12500	25000	100000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	4	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1,5	75	150	600
Ortho-Phosphate, P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide, CN	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	4,8	4,8	4,8	4,8	4,8	4,9				

Table 10b Results of the TCLP Leach Test for waste rock samples (continue)

Elements	GC02-5 Mix Sandstone/siltstone & clay (floor C-Seam)	GC02-6 Carbonaceous Shale	GC02-7 Sandstone	GC02-9 Sandstone (roof and floor E-Seam)	GC03-2 Siltstone/sandstone	GC03-3 Carbonaceous Shale & Sandstone	GC03-4 Carbonaceous Sandstone	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,277	0,488	0,313	0,242	0,835	0,118	0,405				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
B, Boron	0,013	0,034	0,002	<0.001	0,012	0,003	<0.001	0,5	25	50	200
Ba, Barium	1,679	0,803	0,450	0,453	0,942	0,714	1,022	0,7	35	70	280
Ca, Calcium	13	22	133	154	3249	21	18				
Cd, Cadmium	0,001	0,001	<0.001	<0.001	<0.001	0,001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	0,008	0,041	0,012	0,035	0,028	0,008	0,021	0,5	25	50	200
Cr (Total)l, Chromium Total	0,003	0,002	0,006	0,004	0,001	0,001	0,002	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	0,011	0,005	<0.001	<0.001	<0.001	0,009	0,005	2	100	200	800
Fe, Iron	1	0,957	38,000	0,577	23,000	0,105	2				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0,00	<0.001	0,006	0,3	0,6	2,4
K, Potassium	2,3	4,8	2,2	1,0	9,0	2,7	4,1				
Mg, Magnesium	7	10	41	6	98	7	8				
Mn, Manganese	0,345	0,176	2,828	1,538	4,601	0,279	0,570	0,5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,07	3,5	7	28
Na, Sodium	<1	<1	17	30	3	<1	<1				
Ni, Nickel	0,006	0,051	0,008	0,037	0,044	0,012	0,011	0,07	3,5	7	28
Pb, Lead	0,027	0,030	0,020	0,023	0,001	0,005	0,013	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,02	1	2	8
Se, Selenium	<0.001	0,001	<0.001	<0.001	<0.001	0,001	<0.001	0,01	0,5	1	4
Si, Silicon	3,4	3,1	1,9	1,1	4,0	3,2	3,2				
Sr, Strontium	0,483	0,497	0,373	0,624	0,174	0,172	0,148				
U, Uranium	0,003	0,013	0,002	0,003	0,005	0,005	0,007				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,2	10	20	80
Zn, Zinc	0	0,03	0,04	0	<0.001	0	0	5	250	500	2000
Total Dissolved Solids	244	296	1080	890	7328	314	202	1000	12500	25000	100000
Chloride as Cl	<2	<2	2	2	<2	<2	<2	300	15000	30000	120000
Sulphate as SO_4	4	8	10	55	<2	4	6	250	12500	25000	100000
Nitrate as N	<0.1	<0.1	0,5	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	0,2	<0.2	<0.2	0,3	<0.2	<0.2	1,5	75	150	600
Ortho-Phosphate, P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide, CN	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	4,8	4,8	5	4,9	5,4	4,8	4,8				

Table 10c Results of the TCLP Leach Test for waste rock samples (continue)

Elements	GC03-6 Sandstone & Shale	GC03-8 Carbonaceous Shale	GC03-10 Carbonaceous sandstone and shale	GC04-2 Carbonaceous Shale	GC04-3 Shale & Sandstone	GC04-4 Sandstone	GC04-6 Sandstone	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,206	0,138	<0.100	0,484	0,293	0,229	0,491				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
B, Boron	<0.001	0,044	<0.001	<0.001	<0.001	<0.001	<0.001	0,5	25	50	200
Ba, Barium	1,096	1,956	1,220	0,850	1,152	0,371	0,213	0,7	35	70	280
Ca, Calcium	130	36	18	19	48	6	10				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	0,014	0,011	0,007	0,048	0,011	0,007	0,015	0,5	25	50	200
Cr (Total)l, Chromium Total	0,003	<0.001	0,002	0,001	0,003	0,008	0,005	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	0,001	0,015	0,010	0,014	0,006	0,001	<0.001	2	100	200	800
Fe, Iron	12,000	0,621	0,973	2,703	3,061	2,533	0,575				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	0,00	<0.001	<0.001	0,006	0,3	0,6	2,4
K, Potassium	3,0	9,5	5,2	4,6	2,6	0,7	<0.5				
Mg, Magnesium	34	15	7	9	12	3	<1				
Mn, Manganese	2,116	0,374	0,520	0,710	0,771	0,759	0,656	0,5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,07	3,5	7	28
Na, Sodium	<1	<1	<1	<1	9	<1	15				
Ni, Nickel	0,009	0,008	0,018	0,045	0,013	0,007	0,031	0,07	3,5	7	28
Pb, Lead	0,019	0,069	0,035	0,020	0,038	0,020	0,027	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	0,001	<0.001	<0.001	0,02	1	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,01	0,5	1	4
Si, Silicon	2,3	3,9	1,9	3,4	2,2	1,2	0,5				
Sr, Strontium	0,228	1,755	1,036	0,135	0,201	0,071	0,053				
U, Uranium	0,004	0,009	0,003	0,013	0,005	0,004	0,002				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,2	10	20	80
Zn, Zinc	0,03	0,01	0	0,032	0	0	0	5	250	500	2000
Total Dissolved Solids	752	192	187	180	490	192	84	1000	12500	25000	100000
Chloride as Cl	<2	<2	<2	<2	<2	<2	<2	300	15000	30000	120000
Sulphate as SO_4	7	<2	2	7	6	10	34	250	12500	25000	100000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1,5	75	150	600
Ortho-Phosphate, P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide, CN	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	5	4,8	4,8	4,8	4,8	4,8	4,8				

Table 11 Results of the TCLP Leach Test for discard rock samples

Elements	Ant 3 (2)	Ant 110 (1)	Ant 100 (4)	Ant 105 (1)	Ant 185 (1)	Ant 105 (3)	LCT0 (mg/l)	LCT1 (mg/l)	LCT2 (mg/)l	LCT3 (mg/l)
Al, Aluminium	0,718	0,626	0,377	0,555	0,303	0,281				
As, Arsenic	0,040	0,009	<0,001	<0,001	0,003	0,002	0,01	0,5	1	4
B, Boron	0,002	0,003	0,005	0,003	<0,001	<0,001	0,5	25	50	200
Ba, Barium	0,180	2,02	2,56	0,591	1,15	0,301	0,7	35	70	280
Ca, Calcium	12	618	372	24	566	13				
Cd, Cadmium	0,002	0,001	<0,001	0,001	<0,001	<0,001	0,003	0,15	0,3	1,2
Co, Cobalt	0,177	0,146	0,010	0,069	0,032	0,020	0,5	25	50	200
Cr (Total)l, Chromium Total	0,003	0,009	0,007	0,005	0,012	0,006	0,1	5	10	40
Cr(VI), Chromium (VI)	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010	0,05	2,5	5	20
Cu, Copper	0,031	<0,001	<0,001	0,003	<0,001	<0,001	2	100	200	800
Fe, Iron	78	10	7,35	1,88	14	2,81				
Hg, Mercury	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	0,006	0,3	0,6	2,4
K, Potassium	<0,5	<0,5	<0,5	2,0	<0,5	<0,5				
Mg, Magnesium	3	142	79	8	56	3				
Mn, Manganese	0,304	10	3,30	0,373	4,11	0,252	0,5	25	50	200
Mo, Molybdenum	0,002	<0,001	<0,001	<0,001	<0,001	<0,001	0,07	3,5	7	28
Na, Sodium	<1	<1	<1	<1	<1	<1				
Ni, Nickel	0,166	0,179	0,026	0,067	0,066	0,042	0,07	3,5	7	28
Pb, Lead	0,121	0,091	0,047	0,021	0,056	0,107	0,01	0,5	1	4
Sb, Antimony	0,002	0,001	<0,001	<0,001	<0,001	<0,001	0,02	1	2	8
Se, Selenium	0,005	<0,001	<0,001	0,004	0,001	0,004	0,01	0,5	1	4
Si, Silicon	0,5	0,3	0,2	1,8	0,2	0,4				
Sr, Strontium	0,147	6,15	4,08	0,210	3,93	0,106				
U, Uranium	0,002	0,003	0,002	0,009	0,004	0,001				
V, Vanadium	<0,001	0,001	0,004	<0,001	<0,001	<0,001	0,2	10	20	80
Zn, Zinc	51	30	17	30	12	21	5	250	500	2000
Total Dissolved Solids	240	3836	2264	190	3210	128	1000	12500	25000	100000
Chloride as Cl	66	50	25	39	23	28	300	15000	30000	120000
Sulphate as SO_4	210	64	7	30	34	22	250	12500	25000	100000
Nitrate as N	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	11	550	1100	4400
Fluoride as F	<0,2	<0,2	<0,2	<0,2	<0,2	<0,2	1,5	75	150	600
Ortho-Phosphate, P	0,1	0,1	0,1	<0,1	<0,1	<0,1				
Total Cyanide, CN	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	0,07	3,5	7	28
pH	4,1	4,5	4,4	4,2	4,5	4,2				

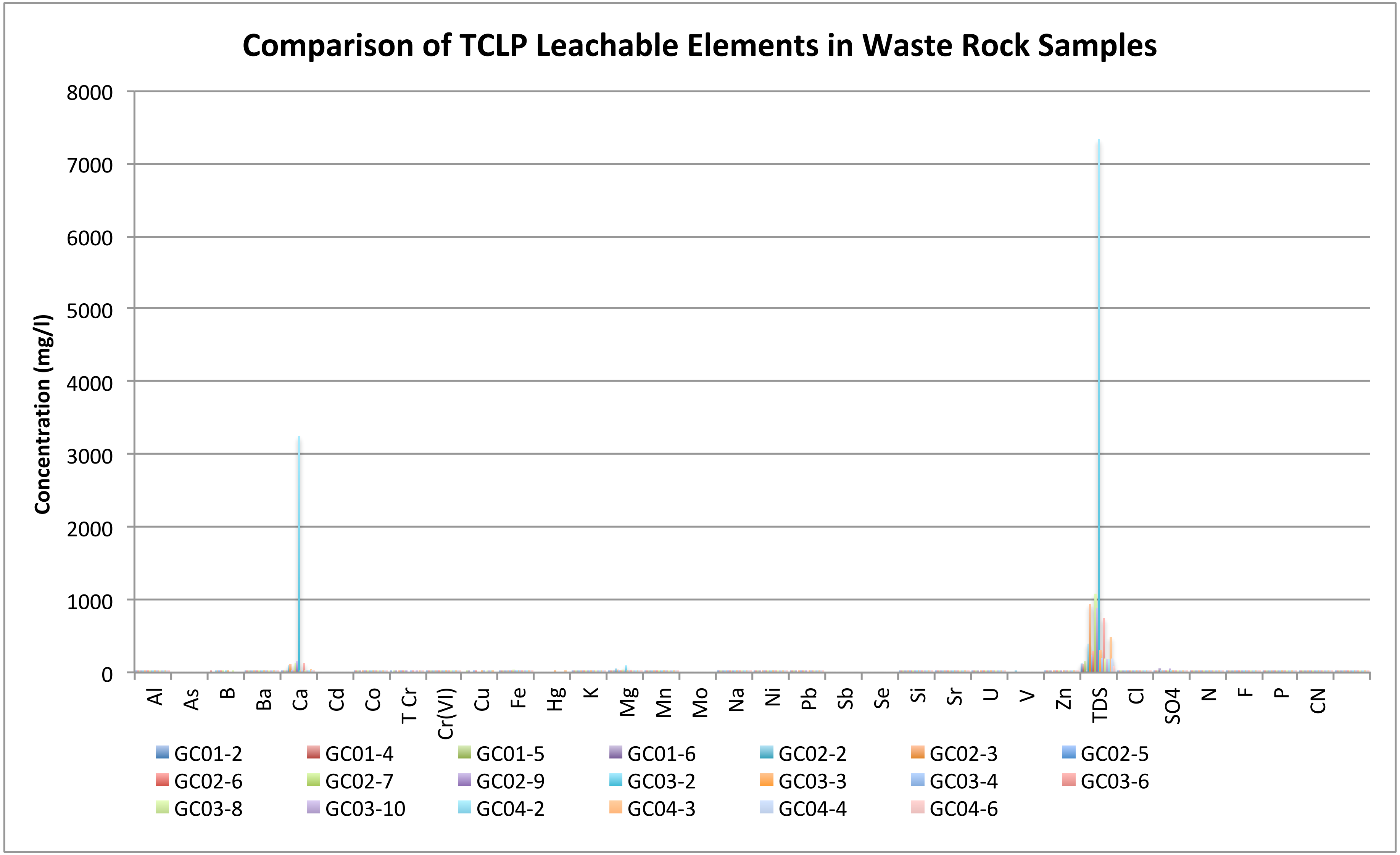

Figure 5 Comparison of TCLP Leachable Elements in Waste Rock Samples

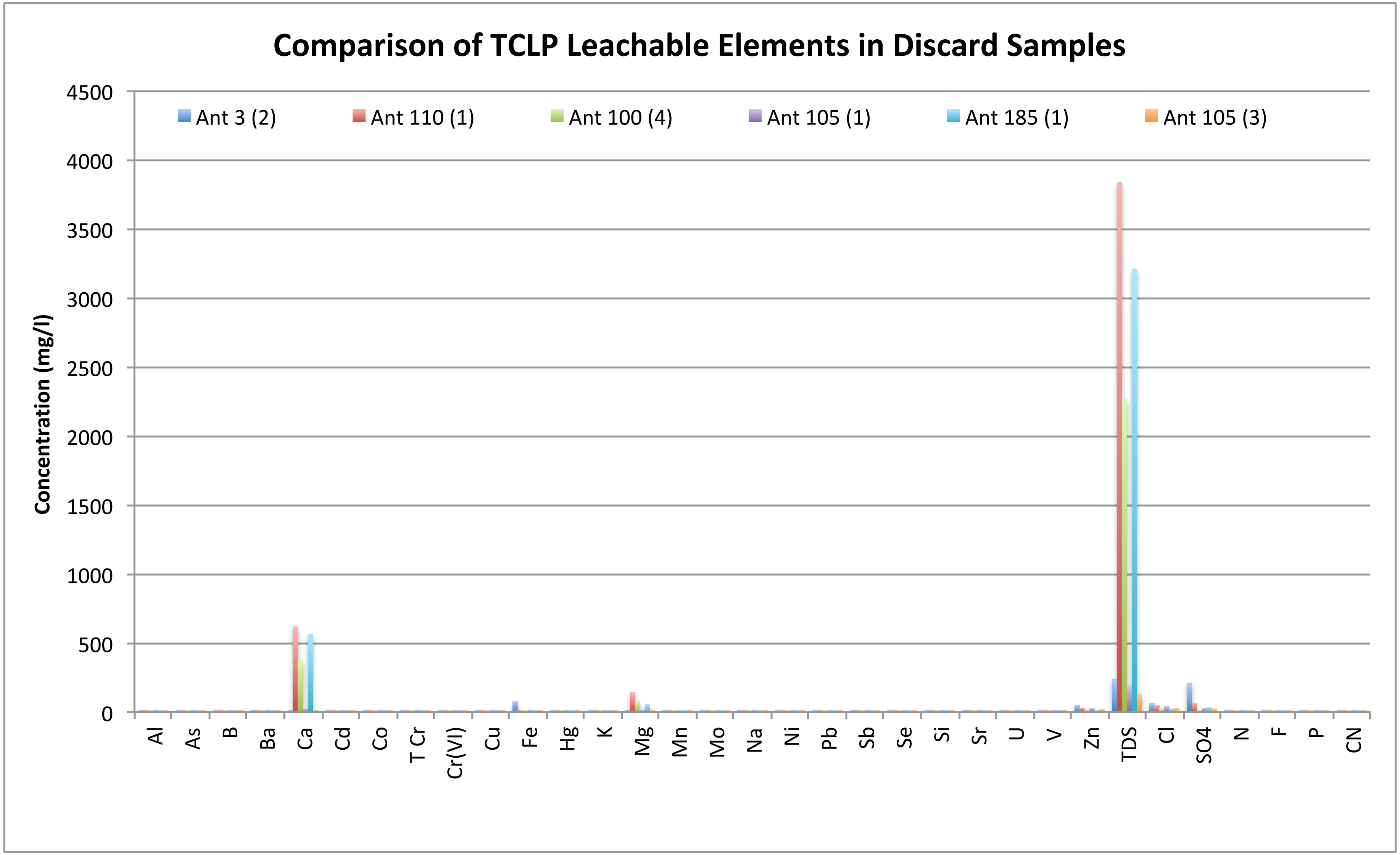

Figure 6 Comparison of TCLP Leachable Elements in Discard Samples

4.2 Definition of the Kranspan waste type

The definition of the Kranspan waste rock and discard material sampled, based on the outcome of both the Total Concentration and Leachable Concentration Tests, is presented in Table 12. The definition is based on the criteria presented in Table 3.

The results indicate that all of the samples taken have Total Concentration (TC) values below the Total Concentration Threshold (TCT) 1 level. Concentrations of barium, boron, magnesium, lead and zinc exceed the TCT0 threshold values in some of the samples taken, but none of the concentrations exceed the TCT1 threshold values set.

The results further indicate that the Leachable Concentrations (LC) for both the water soluble and TCLP tests are generally below the Leachable Concentration Threshold LCT0 value. Exceptions are concentrations of arsenic (As), barium (Ba), manganese (Mn), nickel (Ni), lead (Pb), Zinc (Zn), TDS, which exceed the LCT0 concentration threshold values for some samples, but do not exceed the LCT1 threshold values.

Based on this outcome, both the discard and the waste rock samples assessed in this report are classified as a Type 3 waste.

Table 12 Kranspan waste type definition

Sample ID	TCT classification	LCT classification	Waste definition
Discard	TC < TCT1	LCT0 < LC ≤ LCT1	Type 3
Waste rock	TC < TCT1	LCT0 < LC ≤ LCT1	Type 3

* Even though the LC ≤ LCT0 for these samples, the TC > TCT0, which discounts the classification of the waste as Type 4.

5 CONCLUSION OF THE TEST RESULTS

The outcome of the assessment indicates the following:

- The TC concentrations from the tests are all below the TCT1 threshold values for all elements analysed.
- The LC concentrations exceed the LCT0 threshold values for some samples in both deionised water and TCLP leach tests for some elements in some samples, but do not exceed LCT1 threshold values.
- The discard and waste rock are therefore both classified as Type 3.
- No slurry was analysed as part of this assessment, as this material is not yet available.

6 RECOMMENDATIONS

It is recommended that:

- Once slurry material is available from the Kranspan project, it must be submitted for analysis and waste classification. If the outcome of this assessment yields a differently waste type than Type 3, as was obtained for the discard samples, suitable measures must be put in place to contain leachate and prevent contamination associated with the slurry material.
- The type of barrier containment (liner) as well as any other pollution control measures that will be required for the surface discard stockpile, in-pit discard disposal or waste rock handling must be determined as part of a risk assessment.
- A water containment and management programme must be put in place to contain leachate, seepage and runoff associated with the mining areas to avoid adverse health hazards.
- Monitoring of leachate, seepage and runoff should be considered to ensure that water containment and management measures implemented are effective in reducing the health hazard of the material.
- Sub-regulation 2 of the Waste Classification Regulations (R634) requires that the mine waste material must be re-classified every five years, or within 30 days of modification to the treatment process or if changes to the raw material input are made.
- It is recommended that the following records be kept by Kranspan mine:
    - A copy of this waste classification report.
    - A record to the quantity of coal reprocessed, product sold and the amount of discard and slurry generated and disposed of.
    - A record of who managed the waste during reprocessing.
    - These records must be kept for a minimum of 5 years.

7 REFERENCES

DEAT, 2010. Framework for the Management of Contaminated Land, Department of Environmental Affairs, dated May 2010.

DER-WA, 2015. Background paper on the use of leaching tests for assessing the disposal and re-use of waste-derived materials, Department of Environmental Regulation, Government of Western Australia, dated July 2015.

SANS 241-1:2015, 2015. South African National Standard – Drinking water – Part 1: Microbiological, physical, aesthetic and chemical determinants, ISBN 978-0-626-29841-8.

Van Hille, R. 2019. Report on Static Test Data for Discard Coal and Waste Rock Samples – Kranspan, dated April 2019.

APPENDIX 1

Laboratory Certificates of Analyses

WATERLAB (PTY) LTD

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Persequor Techno Park,
Meiring Naudé Road, Pretoria
P.O. Box 283, 0020

Telephone: +2712 – 349 – 1066
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Email: accounts@waterlab.co.za

CERTIFICATE OF ANALYSES
EXTRACTIONS AS 4439.3

Date received:	**30-01-19**		**Date completed:**	**12-03-19**
Project number:	**1000**	**Report number: 80505**	**Order number:**	**---**

Client name:	**ABS Africa (Pty) Ltd.**	**Contact person:**	**Paul Furniss**
Address:	**PO Box 14003, Vorna Valley, 1686**	**Email:**	**paul@abs-africa.com**
Telephone:	**011 805 0061**	**Contact person:**	**Rob van Hille**
		Email:	**rob@mossgroup.co.za**

Analyses	**GC01-2 Unweathered Sandstone (fair amount of silica)**	**GC01-4 Carbonaceous Shale & Sandstone**	**GC01-5 Sandstone (roof of coal seam)**	**GC01-6 Carbonaceous Sandstone**	**GC02-2 Carbonaceous Clay (roof of B seam)**				
Sample Number	**53621**	**53622**	**53623**	**53624**	**53625**				
TCLP / Borax / Distilled Water	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	<0.100	0.363	0.105	<0.100	0.639				
As, Arsenic	<0.010	<0.010	<0.010	<0.010	<0.010	0.01	0.5	1	4
B, Boron	0.004	0.007	0.006	0.007	0.033	0.5	25	50	200
Ba, Barium	0.055	0.026	0.046	0.159	0.084	0.7	35	70	280
Ca, Calcium	2	1	3	7	2				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	0.003	<0.001	0.004	0.053	<0.001	0.5	25	50	200
$Cr_{Total,}$ Chromium Total	<0.001	<0.001	<0.001	<0.001	0.005	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	<0.001	<0.001	<0.001	0.030	0.001	2.0	100	200	800
Fe, Iron	<0.025	0.095	<0.025	4.48	0.197				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	1.4	2.3	2.0	1.6	3.2				
Mg, Magnesium	1	<1	1	2	2				
Mn, Manganese	0.102	<0.025	0.055	0.447	<0.025	0.5	25	50	200
Mo, Molybdenum	<0.001	0.003	0.014	<0.001	0.002	0.07	3.5	7	28
Na, Soduim	<1	<1	<1	<1	4				
Ni, Nickel	0.002	<0.001	0.003	0.139	0.002	0.07	3.5	7	28
Pb, Lead	<0.001	<0.001	<0.001	0.003	<0.001	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	1.0	2.3	1.3	1.4	2.4				
Sr, Strontium	0.014	0.012	0.023	0.063	0.027				
U, Uranium	<0.001	<0.001	<0.001	0.002	<0.001				
V, Vanadium	<0.001	0.002	<0.001	<0.001	0.051	0.2	10	20	80
Zn, Zinc	<0.001	<0.001	0.003	0.081	<0.001	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	20	20	30	78	170	1000	12,500	25,000	100,000
Chloride as Cl	<2	<2	<2	<2	6	300	15,000	30,000	120,000
Sulphate as SO4	7	3	13	46	6	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	3.3	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	0.4	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	6.1	6.2	6.0	3.3	5.5				
% Solids	---	---	---	---	---				
Acid Base Accounting	See attached report 80505 ABA								
X-ray Fluorescence [s]	See attached report 80505 XRF								

***Please note:**

1. The samples were used as received.
2. A moisture content were determined for wet or moist samples.
3. In cases where the sample were a slurry, a solid to liquid ratio were done (reported). Moisture content were determined after filtration
4. The results are reported as received. The moisture content were not taken into account.

Analyses	GC02-3 Sandstone (floor of B-lower)	GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	GC02-6 Carbonaceous Shale	GC02-7 Sandstone	GC02-9 Sandstone (roof and floor of E seam)				
Sample Number	**53626**	**53627**	**53628**	**53629**	**53630**				
TCLP / Borax / Distilled Water	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	0.175	0.149	0.157	0.224	<0.100				
As, Arsenic	<0.010	<0.010	<0.010	<0.010	<0.010	0.01	0.5	1	4
B, Boron	0.006	0.015	0.041	0.005	0.009	0.5	25	50	200
Ba, Barium	0.094	0.082	0.053	0.048	0.141	0.7	35	70	280
Ca, Calcium	6	1	4	7	24				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	<0.001	<0.001	<0.001	<0.001	0.001	0.5	25	50	200
Cr_{Total}, Chromium Total	<0.001	<0.001	<0.001	<0.001	<0.001	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	<0.001	<0.001	<0.001	<0.001	<0.001	2.0	100	200	800
Fe, Iron	<0.025	0.027	0.025	<0.025	<0.025				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	2.3	1.5	2.9	1.7	1.1				
Mg, Magnesium	2	<1	2	2	3				
Mn, Manganese	<0.025	<0.025	<0.025	<0.025	0.061	0.5	25	50	200
Mo, Molybdenum	0.005	0.003	0.006	0.003	0.006	0.07	3.5	7	28
Na, Soduim	<1	<1	1	<1	1				
Ni, Nickel	<0.001	<0.001	<0.001	<0.001	<0.001	0.07	3.5	7	28
Pb, Lead	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	1.3	2.0	2.0	1.3	0.8				
Sr, Strontium	0.083	0.043	0.098	0.181	0.376				
U, Uranium	<0.001	<0.001	<0.001	<0.001	<0.001				
V, Vanadium	<0.001	<0.001	0.004	<0.001	<0.001	0.2	10	20	80
Zn, Zinc	<0.001	<0.001	<0.001	<0.001	<0.001	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	72	18	24	36	96	1000	12,500	25,000	100,000
Chloride as Cl	<2	<2	<2	<2	4	300	15,000	30,000	120,000
Sulphate as SO4	5	5	8	7	44	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	0.5	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	7.1	6.4	6.6	7.1	7.4				
% Solids	---	---	---	---	---				
Acid Base Accounting	See attached report 80505 ABA								
X-ray Fluorescence [s]	See attached report 80505 XRF								

Analyses	GC03-2 Siltstone/sandstone	GC03-3 Carbonaceous Shale and sandstone mix	GC03-4 Carbonaceous Sandstone	GC03-6 Sandstone & Shale mix	GC03-8 Carbonaceous Shale				
Sample Number	**53631**	**53632**	**53633**	**53634**	**53635**				
TCLP / Borax / Distilled Water	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	0.157	0.427	0.130	0.126	0.574				
As, Arsenic	<0.010	<0.010	<0.010	<0.010	0.016	0.01	0.5	1	4
B, Boron	0.006	0.019	0.007	0.005	0.065	0.5	25	50	200
Ba, Barium	0.086	0.021	0.071	0.135	0.138	0.7	35	70	280
Ca, Calcium	21	1	3	8	2				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	<0.001	<0.001	<0.001	<0.001	0.002	0.5	25	50	200
Cr_{Total}, Chromium Total	<0.001	<0.001	<0.001	<0.001	0.003	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	<0.001	<0.001	<0.001	<0.001	0.003	2.0	100	200	800
Fe, Iron	<0.025	0.031	0.031	<0.025	0.105				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	2.7	1.4	2.5	2.1	2.5				
Mg, Magnesium	4	<1	1	2	<1				
Mn, Manganese	<0.025	<0.025	<0.025	<0.025	<0.025	0.5	25	50	200
Mo, Molybdenum	0.006	0.003	0.012	0.005	0.026	0.07	3.5	7	28
Na, Soduim	<1	1	<1	<1	1				
Ni, Nickel	<0.001	<0.001	<0.001	<0.001	0.004	0.07	3.5	7	28
Pb, Lead	<0.001	<0.001	<0.001	<0.001	0.006	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	1.2	2.5	2.1	1.4	2.5				
Sr, Strontium	0.060	0.012	0.028	0.060	0.049				
U, Uranium	<0.001	<0.001	<0.001	<0.001	<0.001				
V, Vanadium	<0.001	0.005	<0.001	0.001	0.007	0.2	10	20	80
Zn, Zinc	<0.001	<0.001	<0.001	<0.001	0.008	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	88	22	30	32	138	1000	12,500	25,000	100,000
Chloride as Cl	3	<2	<2	<2	5	300	15,000	30,000	120,000
Sulphate as SO4	32	6	8	7	10	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	7.4	6.5	6.7	7.3	6.7				
% Solids	---	---	---	---	---				
Acid Base Accounting	See attached report 80505 ABA								
X-ray Fluorescence [s]	See attached report 80505 XRF								

Analyses	GC03-10 Carbonaceous sand stone and Shale mix	GC04-2 Carbonaceous Shale	GC04-3 Shale and Sandstone mix	GC04-4 Sandstone	GC04-6 Sandstone				
Sample Number	**53636**	**53637**	**53638**	**53639**	**53640**				
TCLP / Borax / Distilled Water	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	0.455	1.96	<0.100	0.241	0.136				
As, Arsenic	0.004	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
B, Boron	0.030	0.014	0.004	0.002	0.008	0.5	25	50	200
Ba, Barium	0.046	0.028	0.182	0.038	0.157	0.7	35	70	280
Ca, Calcium	<1	1	6	2	3				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	<0.001	0.001	<0.001	0.002	0.065	0.5	25	50	200
Cr_{Total}, Chromium Total	<0.001	<0.001	<0.001	<0.001	<0.001	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	0.001	<0.001	<0.001	<0.001	<0.001	2.0	100	200	800
Fe, Iron	0.206	2.92	<0.025	0.120	2.62				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	0.6	0.8	1.9	1.3	<0.5				
Mg, Magnesium	<1	<1	2	<1	1				
Mn, Manganese	<0.025	0.072	<0.025	0.126	0.631	0.5	25	50	200
Mo, Molybdenum	0.022	0.010	0.005	0.003	<0.001	0.07	3.5	7	28
Na, Soduim	10	11	<1	<1	<1				
Ni, Nickel	0.002	<0.001	<0.001	0.002	0.122	0.07	3.5	7	28
Pb, Lead	0.003	<0.001	<0.001	<0.001	0.006	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	2.1	3.8	1.4	1.3	0.6				
Sr, Strontium	0.017	0.013	0.051	0.021	0.059				
U, Uranium	<0.001	<0.001	<0.001	<0.001	0.001				
V, Vanadium	0.001	0.001	0.004	<0.001	<0.001	0.2	10	20	80
Zn, Zinc	<0.001	<0.001	<0.001	0.001	0.074	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	98	28	32	18	50	1000	12,500	25,000	100,000
Chloride as Cl	2	<2	<2	<2	<2	300	15,000	30,000	120,000
Sulphate as SO4	6	7	6	9	26	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	6.6	6.2	7.1	6.0	3.5				
% Solids	---	---	---	---	---				
Acid Base Accounting	See attached report 80505 ABA								
X-ray Fluorescence [s]	See attached report 80505 XRF								

[s] = Subcontracted

E. Botha

Geochemistry Project Manager

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CERTIFICATE OF ANALYSES
EXTRACTIONS AS 4439.3

Date received:	**30-01-19**		**Date completed:**	**12-03-19**
Project number:	**1000**	**Report number: 80505**	**Order number:**	**---**

Client name:	**ABS Africa (Pty) Ltd.**	**Contact person:**	**Paul Furniss**
Address:	**PO Box 14003, Vorna Valley, 1686**	**Email:**	**paul@abs-africa.com**
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		Email:	**rob@mossgroup.co.za**

Analyses	GC01-2 Unweathered Sandstone (fair amount of silica)	GC01-4 Carbonaceous Shale & Sandstone	GC01-5 Sandstone (roof of coal seam)	GC01-6 Carbonaceous Sandstone	GC02-2 Carbonaceous Clay (roof of B seam)				
Sample Number	**53621**	**53622**	**53623**	**53624**	**53625**				
TCLP / Borax / Distilled Water	**TCLP**	**TCLP**	**TCLP**	**TCLP**	**TCLP**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	0.250	0.148	0.212	0.268	0.114				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
B, Boron	0.001	0.009	0.001	<0.001	0.011	0.5	25	50	200
Ba, Barium	0.397	0.863	0.553	0.361	1.65	0.7	35	70	280
Ca, Calcium	4	20	11	6	97				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	0.009	0.018	0.019	0.018	0.001	0.5	25	50	200
Cr_{Total}, Chromium Total	0.007	<0.001	0.003	0.009	<0.001	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	<0.001	0.001	0.007	0.007	<0.001	2.0	100	200	800
Fe, Iron	2.65	0.579	2.81	0.278	<0.025				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	1.2	4.6	2.5	0.5	5.6				
Mg, Magnesium	2	8	5	3	57				
Mn, Manganese	0.756	0.348	0.520	0.559	0.234	0.5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	0.07	3.5	7	28
Na, Soduim	35	8	<1	17	<1				
Ni, Nickel	0.007	0.010	0.014	0.046	0.001	0.07	3.5	7	28
Pb, Lead	0.018	0.009	0.034	0.014	<0.001	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	0.8	3.1	1.7	1.1	1.6				
Sr, Strontium	0.039	0.162	0.102	0.086	0.344				
U, Uranium	0.002	0.003	0.002	0.007	<0.001				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	0.003	0.2	10	20	80
Zn, Zinc	0.046	0.022	0.093	0.023	<0.001	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	124	110	162	28	396	1000	12,500	25,000	100,000
Chloride as Cl	<2	<2	<2	<2	2	300	15,000	30,000	120,000
Sulphate as SO4	6	2	14	61	<2	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	4.0	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	4.8	4.8	4.8	4.8	4.8				
% Solids	---	---	---	---	---				

***Please note:**

1. The samples were used as received.
2. A moisture content were determined for wet or moist samples.
3. In cases where the sample were a slurry, a solid to liquid ratio were done (re
   Moisture content were determined after filtration
4. The results are reported as received. The moisture content were not taken i

Analyses	GC02-3 Sandstone (floor of B-lower)	GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	GC02-6 Carbonaceous Shale	GC02-7 Sandstone	GC02-9 Sandstone (roof and floor of E seam)				
Sample Number	**53626**	**53627**	**53628**	**53629**	**53630**				
TCLP / Borax / Distilled Water	**TCLP**	**TCLP**	**TCLP**	**TCLP**	**TCLP**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	0.246	0.277	0.488	0.313	0.242				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
B, Boron	0.006	0.013	0.034	0.002	<0.001	0.5	25	50	200
Ba, Barium	1.19	1.68	0.803	0.450	0.453	0.7	35	70	280
Ca, Calcium	113	13	22	133	154				
Cd, Cadmium	<0.001	0.001	0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	0.018	0.008	0.041	0.012	0.035	0.5	25	50	200
Cr_{Total}, Chromium Total	0.005	0.003	0.002	0.006	0.004	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	0.001	0.011	0.005	<0.001	<0.001	2.0	100	200	800
Fe, Iron	23	0.502	0.957	38	0.577				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	2.8	2.3	4.8	2.2	1.0				
Mg, Magnesium	39	7	10	41	6				
Mn, Manganese	1.92	0.345	0.176	2.83	1.54	0.5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	0.07	3.5	7	28
Na, Soduim	<1	<1	<1	17	30				
Ni, Nickel	0.010	0.006	0.051	0.008	0.037	0.07	3.5	7	28
Pb, Lead	0.023	0.027	0.030	0.020	0.023	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	2.1	3.4	3.1	1.9	1.1				
Sr, Strontium	0.639	0.483	0.497	0.373	0.624				
U, Uranium	0.004	0.003	0.013	0.002	0.003				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	<0.001	0.2	10	20	80
Zn, Zinc	0.038	0.118	0.029	0.037	0.040	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	942	244	296	1080	890	1000	12,500	25,000	100,000
Chloride as Cl	2	<2	<2	2	2	300	15,000	30,000	120,000
Sulphate as SO4	6	4	8	10	55	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	0.5	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	0.2	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	4.9	4.8	4.8	5.0	4.9				
% Solids	---	---	---	---	---				

Analyses	GC03-2 Siltstone/sandstone	GC03-3 Carbonaceous Shale and sandstone mix	GC03-4 Carbonaceous Sandstone	GC03-6 Sandstone & Shale mix	GC03-8 Carbonaceous Shale				
Sample Number	53631	53632	53633	53634	53635				
TCLP / Borax / Distilled Water	TCLP	TCLP	TCLP	TCLP	TCLP				
Ratio*	1:20	1:20	1:20	1:20	1:20				
Units	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	LCT0 mg/l	LCT1 mg/l	LCT2 mg/l	LCT3 mg/l
Al, Aluminium	0.835	0.118	0.405	0.206	0.138				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
B, Boron	0.012	0.003	<0.001	<0.001	0.044	0.5	25	50	200
Ba, Barium	0.942	0.714	1.02	1.10	1.96	0.7	35	70	280
Ca, Calcium	3249	21	18	130	36				
Cd, Cadmium	<0.001	0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	0.028	0.008	0.021	0.014	0.011	0.5	25	50	200
Cr_{Total}, Chromium Total	0.001	0.001	0.002	0.003	<0.001	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	<0.001	0.009	0.005	0.001	0.015	2.0	100	200	800
Fe, Iron	23	0.105	1.96	12	0.621				
Hg, Mercury	<0.001	0.002	<0.001	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	9.0	2.7	4.1	3.0	9.5				
Mg, Magnesium	98	7	8	34	15				
Mn, Manganese	4.60	0.279	0.570	2.12	0.374	0.5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	0.07	3.5	7	28
Na, Soduim	3	<1	<1	<1	<1				
Ni, Nickel	0.044	0.012	0.011	0.009	0.008	0.07	3.5	7	28
Pb, Lead	0.001	0.005	0.013	0.019	0.069	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	4.0	3.2	3.2	2.3	3.9				
Sr, Strontium	0.174	0.172	0.148	0.228	1.76				
U, Uranium	0.005	0.005	0.007	0.004	0.009				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	<0.001	0.2	10	20	80
Zn, Zinc	<0.001	0.034	0.043	0.034	0.014	5	250	500	2000
Inorganic Anions	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ				
Total Dissolved Solids*	7328	314	202	752	192	1000	12,500	25,000	100,000
Chloride as Cl	<2	<2	<2	<2	<2	300	15,000	30,000	120,000
Sulphate as SO4	<2	4	6	7	<2	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	0.3	<0.2	<0.2	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	5.4	4.8	4.8	5.0	4.8				
% Solids	---	---	---	---	---				

Analyses	GC03-10 Carbonaceous sand stone and Shale mix	GC04-2 Carbonaceous Shale	GC04-3 Shale and Sandstone mix	GC04-4 Sandstone	GC04-6 Sandstone				
Sample Number	53636	53637	53638	53639	53640				
TCLP / Borax / Distilled Water	TCLP	TCLP	TCLP	TCLP	TCLP				
Ratio*	1:20	1:20	1:20	1:20	1:20				
Units	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	LCT0 mg/l	LCT1 mg/l	LCT2 mg/l	LCT3 mg/l
Al, Aluminium	<0.100	0.484	0.293	0.229	0.491				
As, Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
B, Boron	<0.001	<0.001	<0.001	<0.001	<0.001	0.5	25	50	200
Ba, Barium	1.22	0.850	1.15	0.371	0.213	0.7	35	70	280
Ca, Calcium	18	19	48	6	10				
Cd, Cadmium	<0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.15	0.3	1.2
Co, Cobalt	0.007	0.048	0.011	0.007	0.015	0.5	25	50	200
Cr_{Total}, Chromium Total	0.002	0.001	0.003	0.008	0.005	0.1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	0.05	2.5	5	20
Cu, Copper	0.010	0.014	0.006	0.001	<0.001	2.0	100	200	800
Fe, Iron	0.973	2.70	3.06	2.53	0.575				
Hg, Mercury	<0.001	<0.001	0.002	<0.001	<0.001	0.006	0.3	0.6	2.4
K, Potassium	5.2	4.6	2.6	0.7	<0.5				
Mg, Magnesium	7	9	12	3	<1				
Mn, Manganese	0.520	0.710	0.771	0.759	0.656	0.5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	<0.001	0.07	3.5	7	28
Na, Soduim	<1	<1	9	<1	15				
Ni, Nickel	0.018	0.045	0.013	0.007	0.031	0.07	3.5	7	28
Pb, Lead	0.035	0.020	0.038	0.020	0.027	0.01	0.5	1	4
Sb, Antimony	<0.001	<0.001	0.001	<0.001	<0.001	0.02	1.0	2	8
Se, Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	0.01	0.5	1	4
Si, Silicon	1.9	3.4	2.2	1.2	0.5				
Sr, Strontium	1.04	0.135	0.201	0.071	0.053				
U, Uranium	0.003	0.013	0.005	0.004	0.002				
V, Vanadium	<0.001	<0.001	<0.001	<0.001	<0.001	0.2	10	20	80
Zn, Zinc	0.017	0.032	0.058	0.062	0.016	5	250	500	2000
Inorganic Anions	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ				
Total Dissolved Solids*	187	180	490	192	84	1000	12,500	25,000	100,000
Chloride as Cl	<2	<2	<2	<2	<2	300	15,000	30,000	120,000
Sulphate as SO4	2	7	6	10	34	250	12,500	25,000	100,000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	1.5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	0.07	3.5	7	28
pH	4.8	4.8	4.8	4.8	4.8				
% Solids	---	---	---	---	---				

[s] = Subcontracted

E. Botha
Geochemistry Project Manager

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CERTIFICATE OF ANALYSES
NAG EXTRACTION

Date received:	**30-01-19**		**Date completed:**	**13-03-19**
Project number:	**1000**	**Report number: 80505**	**Order number:**	**---**

Client name:	**ABS Africa (Pty) Ltd.**	**Contact person:**	**Paul Furniss**
Address:	**PO Box 14003, Vorna Valley, 1686**	**Email:**	**paul@abs-africa.com**
Telephone:	**011 805 0061**	**Contact person:**	**Rob van Hille**
		Email:	**rob@mossgroup.co.za**

Analyses	GC01-2 Unweathered Sandstone (fair amount of silica)		GC01-4 Carbonaceous Shale & Sandstone		GC01-5 Sandstone (roof of coal seam)		GC01-6 Carbonaceous Sandstone		GC02-2 Carbonaceous Clay (roof of B seam)	
Sample Number	53621		53622		53623		53624		53625	
TCLP / Acid Rain / Distilled Water / H_2O_2	NAG Leachate (Peroxide)		NAG Leachate (Peroxide)		NAG Leachate (Peroxide)		NAG Leachate (Peroxide)		NAG Leachate (Peroxide)	
Dry Mass Used (g)	5		5		5		5		5	
Volume Used (mℓ)	500		500		500		500		500	
Inorganic Anions	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg
Chloride as Cl	4	400	3	300	2	200	<2	<200	2	200
Sulphate as SO4	28	2800	49	4900	198	19800	542	54200	27	2700
Nitrate as N	0.1	10	0.4	40	0.2	20	<0.1	<10	2.3	230
Fluoride as F	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20
Ortho-Phosphate as P	<0.1	<10	0.1	10	<0.1	<10	<0.1	<10	<0.1	<10
ICP-OES Quant	See ICP - NAG tab									
ICP-MS Quant										

Analyses	GC02-3 Sandstone (floor of B-lower)		GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)		GC02-6 Carbonaceous Shale		GC02-7 Sandstone		GC02-9 Sandstone (roof and floor of E seam)	
Sample Number	53626		53627		53628		53629		53630	
TCLP / Acid Rain / Distilled Water / H_2O_2	NAG Leachate (Peroxide)		NAG Leachate (Peroxide)		NAG Leachate (Peroxide)		NAG Leachate (Peroxide)		NAG Leachate (Peroxide)	
Dry Mass Used (g)	5		5		5		5		5	
Volume Used (mℓ)	500		500		500		500		500	
Inorganic Anions	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg	mg/ℓ	mg/kg
Chloride as Cl	<2	<200	<2	<200	2	200	4	400	2	200
Sulphate as SO4	54	5400	52	5200	36	3600	39	3900	358	35800
Nitrate as N	<0.1	<10	0.3	30	0.7	70	0.3	30	0.1	10
Fluoride as F	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20
Ortho-Phosphate as P	<0.1	<10	<0.1	<10	<0.1	<10	<0.1	<10	<0.1	<10
ICP-OES Quant	See ICP - NAG tab									
ICP-MS Quant										

Analyses	GC03-2 Siltstone/sandstone		GC03-3 Carbonaceous Shale and sandstone mix		GC03-4 Carbonaceous Sandstone		GC03-6 Sandstone & Shale mix		GC03-8 Carbonaceous Shale	
Sample Number	**53631**		**53632**		**53633**		**53634**		**53635**	
TCLP / Acid Rain / Distilled Water / H_2O_2	**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**	
Dry Mass Used (g)	**5**		**5**		**5**		**5**		**5**	
Volume Used (mℓ)	**500**		**500**		**500**		**500**		**500**	
Inorganic Anions	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Chloride as Cl	2	200	<2	<200	<2	<200	<2	<200	2	200
Sulphate as SO4	180	18000	77	7700	146	14600	99	9900	18	1800
Nitrate as N	0.1	10	1.6	160	0.2	20	0.2	20	0.2	20
Fluoride as F	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20
Ortho-Phosphate as P	<0.1	<10	<0.1	<10	<0.1	<10	<0.1	<10	<0.1	<10
ICP-OES Quant	See ICP - NAG tab									
ICP-MS Quant										

Analyses	GC03-10 Carbonaceous sand stone and Shale mix		GC04-2 Carbonaceous Shale		GC04-3 Shale and Sandstone mix		GC04-4 Sandstone		GC04-6 Sandstone	
Sample Number	**53636**		**53637**		**53638**		**53639**		**53640**	
TCLP / Acid Rain / Distilled Water / H_2O_2	**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**		**NAG Leachate (Peroxide)**	
Dry Mass Used (g)	**5**		**5**		**5**		**5**		**5**	
Volume Used (mℓ)	**500**		**500**		**500**		**500**		**500**	
Inorganic Anions	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**	**mg/ℓ**	**mg/kg**
Chloride as Cl	<2	<200	3	300	<2	<200	<2	<200	<2	<200
Sulphate as SO4	90	9000	30	3000	145	14500	80	8000	175	17500
Nitrate as N	0.2	20	0.6	60	0.3	30	<0.1	<10	0.2	20
Fluoride as F	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20	<0.2	<20
Ortho-Phosphate as P	<0.1	<10	<0.1	<10	<0.1	<10	<0.1	<10	<0.1	<10
ICP-OES Quant	See ICP - NAG tab									
ICP-MS Quant										

E. Botha
Geochemistry Project Manager

CERTIFICATE OF ANALYSES

ICP-MS QUANTITATIVE ANALYSIS

Date received:	30-01-19	Date completed:	13-03-19
Project number:	1000	Report number:	80505

Client name:	ABS Africa (Pty) Ltd.	Contact person:	Paul Furniss
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Telephone:	011 805 0061	Contact person:	Rob van Hille
		Email:	rob@mossgroup.co.za

Extract	Sample Mass (g)	Volume (ml)	Factor
NAG Leachate (Peroxide)	5	500	100

Sample Id	Sample Number	Al*	Al*	As	As	B	B
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.100	<10	<0.001	<0.100	<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.100	<10	<0.001	<0.100	<0.001	<0.100
GC01-4 Carbonaceous Shale & Sandstone	53622	10	1000	<0.001	<0.100	<0.001	<0.100
GC01-5 Sandstone (roof of coal seam)	53623	5.83	583	<0.001	<0.100	<0.001	<0.100
GC01-6 Carbonaceous Sandstone	53624	7.77	777	<0.001	<0.100	<0.001	<0.100
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.100	<10	<0.001	<0.100	<0.001	<0.100
GC02-3 Sandstone (floor of B-lower)	53626	<0.100	<10	<0.001	<0.100	0.043	4.32
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	1.46	146	<0.001	<0.100	<0.001	<0.100
GC02-6 Carbonaceous Shale	53628	0.128	13	<0.001	<0.100	<0.001	<0.100
GC02-7 Sandstone	53629	<0.100	<10	<0.001	<0.100	0.189	19
GC02-9 Sandstone (roof and floor of E seam)	53630	9.55	955	<0.001	<0.100	0.021	2.12
GC03-2 Siltstone/sandstone	53631	1.65	165	<0.001	<0.100	0.205	20
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.230	23	<0.001	<0.100	0.025	2.51
GC03-4 Carbonaceous Sandstone	53633	11	1100	<0.001	<0.100	0.067	6.72
GC03-6 Sandstone & Shale mix	53634	<0.100	<10	<0.001	<0.100	0.006	0.606
GC03-8 Carbonaceous Shale	53635	0.564	56	<0.001	<0.100	0.034	3.43
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.598	60	<0.001	<0.100	0.025	2.50
GC04-2 Carbonaceous Shale	53637	9.24	924	<0.001	<0.100	0.019	1.86
GC04-3 Shale and Sandstone mix	53638	10	1000	<0.001	<0.100	0.013	1.29
GC04-4 Sandstone	53639	1.71	171	<0.001	<0.100	0.075	7.53
GC04-6 Sandstone	53640	6.54	654	<0.001	<0.100	0.009	0.913

Sample Id	Sample Number	Ba	Ba	Ca*	Ca*	Cd	Cd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.100	<1	<100	<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.013	1.30	2	200	<0.001	<0.100
GC01-4 Carbonaceous Shale & Sandstone	53622	0.166	17	6	600	0.002	0.202
GC01-5 Sandstone (roof of coal seam)	53623	0.076	7.56	14	1400	<0.001	<0.100
GC01-6 Carbonaceous Sandstone	53624	0.042	4.23	3	300	<0.001	<0.100
GC02-2 Carbonaceous Clay (roof of B seam)	53625	1.95	195	35	3500	<0.001	<0.100
GC02-3 Sandstone (floor of B-lower)	53626	0.054	5.43	27	2700	<0.001	<0.100
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.045	4.45	2	200	<0.001	<0.100
GC02-6 Carbonaceous Shale	53628	0.109	11	5	500	<0.001	<0.100
GC02-7 Sandstone	53629	0.012	1.20	18	1800	<0.001	<0.100
GC02-9 Sandstone (roof and floor of E seam)	53630	0.079	7.94	35	3500	<0.001	<0.100
GC03-2 Siltstone/sandstone	53631	0.071	7.09	81	8100	<0.001	<0.100
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.108	11	4	400	<0.001	<0.100
GC03-4 Carbonaceous Sandstone	53633	0.037	3.73	9	900	0.001	0.137
GC03-6 Sandstone & Shale mix	53634	0.056	5.57	26	2600	<0.001	<0.100
GC03-8 Carbonaceous Shale	53635	0.073	7.33	2	200	<0.001	<0.100
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.112	11	6	600	<0.001	<0.100
GC04-2 Carbonaceous Shale	53637	0.172	17	5	500	0.002	0.194
GC04-3 Shale and Sandstone mix	53638	0.037	3.71	15	1500	0.002	0.188
GC04-4 Sandstone	53639	0.058	5.78	4	400	<0.001	<0.100
GC04-6 Sandstone	53640	0.091	9.15	3	300	<0.001	<0.100

Sample Id	Sample Number	Co	Co	Cr	Cr	Cu	Cu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.100	<0.001	<0.100	<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.100	0.042	4.20	<0.001	<0.100
GC01-4 Carbonaceous Shale & Sandstone	53622	0.060	5.99	0.180	18	0.225	22
GC01-5 Sandstone (roof of coal seam)	53623	0.068	6.78	0.143	14	0.022	2.15
GC01-6 Carbonaceous Sandstone	53624	0.036	3.57	0.717	72	0.076	7.60
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.100	0.444	44	<0.001	<0.100
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.100	0.034	3.42	<0.001	<0.100
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.013	1.34	0.090	9.04	0.079	7.94
GC02-6 Carbonaceous Shale	53628	0.004	0.439	0.154	15	0.008	0.778
GC02-7 Sandstone	53629	<0.001	<0.100	0.051	5.07	<0.001	<0.100
GC02-9 Sandstone (roof and floor of E seam)	53630	0.120	12	0.555	56	0.025	2.53
GC03-2 Siltstone/sandstone	53631	<0.001	<0.100	<0.001	<0.100	<0.001	<0.100
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.001	0.131	0.294	29	0.015	1.46
GC03-4 Carbonaceous Sandstone	53633	0.076	7.58	0.259	26	0.179	18
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.100	<0.001	<0.100	<0.001	<0.100
GC03-8 Carbonaceous Shale	53635	0.005	0.495	0.003	0.345	0.016	1.58
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.013	1.30	0.049	4.88	0.036	3.65
GC04-2 Carbonaceous Shale	53637	0.127	13	0.106	11	0.265	26
GC04-3 Shale and Sandstone mix	53638	0.080	7.98	0.099	9.88	0.160	16
GC04-4 Sandstone	53639	0.042	4.24	0.165	16	0.001	0.134
GC04-6 Sandstone	53640	0.036	3.64	0.438	44	0.019	1.85

Sample Id	Sample Number	Fe*	Fe*	Hg	Hg	K*	K*
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<2.50	<0.001	<0.100	<0.5	<50
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.025	<2.50	<0.001	<0.100	2.6	264
GC01-4 Carbonaceous Shale & Sandstone	53622	17	1700	<0.001	<0.100	3.9	389
GC01-5 Sandstone (roof of coal seam)	53623	16	1600	<0.001	<0.100	4.5	454
GC01-6 Carbonaceous Sandstone	53624	45	4500	<0.001	<0.100	1.5	146
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.062	6.20	<0.001	<0.100	3.4	342
GC02-3 Sandstone (floor of B-lower)	53626	<0.025	<2.50	0.003	0.252	3.1	305
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.047	4.70	<0.001	<0.100	2.0	196
GC02-6 Carbonaceous Shale	53628	<0.025	<2.50	<0.001	<0.100	4.2	421
GC02-7 Sandstone	53629	<0.025	<2.50	<0.001	<0.100	3.4	342
GC02-9 Sandstone (roof and floor of E seam)	53630	21	2100	0.002	0.231	4.2	419
GC03-2 Siltstone/sandstone	53631	<0.025	<2.50	<0.001	<0.100	3.3	328
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.036	3.60	<0.001	<0.100	3.0	303
GC03-4 Carbonaceous Sandstone	53633	39	3900	<0.001	<0.100	4.5	445
GC03-6 Sandstone & Shale mix	53634	0.046	4.60	<0.001	<0.100	2.6	264
GC03-8 Carbonaceous Shale	53635	0.232	23	<0.001	<0.100	5.7	569
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.091	9.10	<0.001	<0.100	6.6	657
GC04-2 Carbonaceous Shale	53637	12	1200	<0.001	<0.100	3.9	385
GC04-3 Shale and Sandstone mix	53638	29	2900	<0.001	<0.100	3.3	335
GC04-4 Sandstone	53639	0.154	15	<0.001	<0.100	3.1	314
GC04-6 Sandstone	53640	11	1100	<0.001	<0.100	1.3	132

Sample Id	Sample Number	Mg*	Mg*	Mn*	Mn*	Mo	Mo
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<1	<100	<0.025	<2.50	<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	3	300	<0.025	<2.50	0.005	0.517
GC01-4 Carbonaceous Shale & Sandstone	53622	3	300	0.993	99	<0.001	<0.100
GC01-5 Sandstone (roof of coal seam)	53623	5	500	3.72	372	<0.001	<0.100
GC01-6 Carbonaceous Sandstone	53624	<1	<100	0.198	20	<0.001	<0.100
GC02-2 Carbonaceous Clay (roof of B seam)	53625	19	1900	<0.025	<2.50	0.003	0.335
GC02-3 Sandstone (floor of B-lower)	53626	<1	<100	<0.025	<2.50	0.004	0.396
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	2	200	0.196	20	0.004	0.379
GC02-6 Carbonaceous Shale	53628	3	300	0.036	3.60	0.006	0.636
GC02-7 Sandstone	53629	<1	<100	<0.025	<2.50	0.003	0.309
GC02-9 Sandstone (roof and floor of E seam)	53630	6	600	1.64	164	<0.001	<0.100
GC03-2 Siltstone/sandstone	53631	<1	<100	<0.025	<2.50	0.002	0.250
GC03-3 Carbonaceous Shale and sandstone mix	53632	2	200	0.034	3.40	0.013	1.33
GC03-4 Carbonaceous Sandstone	53633	6	600	2.75	275	<0.001	<0.100
GC03-6 Sandstone & Shale mix	53634	11	1100	0.031	3.10	0.004	0.361
GC03-8 Carbonaceous Shale	53635	2	200	0.340	34	0.007	0.700
GC03-10 Carbonaceous sand stone and Shale mix	53636	3	300	0.474	47	0.010	1.02
GC04-2 Carbonaceous Shale	53637	4	400	4.23	423	<0.001	<0.100
GC04-3 Shale and Sandstone mix	53638	6	600	0.568	57	<0.001	<0.100
GC04-4 Sandstone	53639	3	300	1.68	168	0.018	1.85
GC04-6 Sandstone	53640	<1	<100	0.241	24	<0.001	<0.100

Sample Id	Sample Number	Na*	Na*	Ni	Ni	Pb	Pb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<1	<100	<0.001	<0.100	<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<1	<100	<0.001	<0.100	<0.001	<0.100
GC01-4 Carbonaceous Shale & Sandstone	53622	<1	<100	0.084	8.41	0.003	0.291
GC01-5 Sandstone (roof of coal seam)	53623	<1	<100	0.138	14	0.013	1.34
GC01-6 Carbonaceous Sandstone	53624	<1	<100	0.254	25	0.085	8.55
GC02-2 Carbonaceous Clay (roof of B seam)	53625	1	100	<0.001	<0.100	<0.001	<0.100
GC02-3 Sandstone (floor of B-lower)	53626	<1	<100	<0.001	<0.100	0.001	0.115
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<1	<100	0.014	1.37	0.001	0.139
GC02-6 Carbonaceous Shale	53628	<1	<100	0.004	0.387	<0.001	<0.100
GC02-7 Sandstone	53629	1	100	<0.001	<0.100	<0.001	<0.100
GC02-9 Sandstone (roof and floor of E seam)	53630	1	100	0.182	18	0.070	6.97
GC03-2 Siltstone/sandstone	53631	<1	<100	<0.001	<0.100	<0.001	<0.100
GC03-3 Carbonaceous Shale and sandstone mix	53632	<1	<100	0.002	0.241	<0.001	<0.100
GC03-4 Carbonaceous Sandstone	53633	<1	<100	0.099	9.92	0.001	0.111
GC03-6 Sandstone & Shale mix	53634	<1	<100	<0.001	<0.100	<0.001	<0.100
GC03-8 Carbonaceous Shale	53635	10	1000	0.005	0.470	<0.001	<0.100
GC03-10 Carbonaceous sand stone and Shale mix	53636	6	600	0.044	4.38	<0.001	<0.100
GC04-2 Carbonaceous Shale	53637	<1	<100	0.181	18	0.001	0.100
GC04-3 Shale and Sandstone mix	53638	<1	<100	0.366	37	0.010	1.00
GC04-4 Sandstone	53639	<1	<100	0.058	5.84	0.003	0.303
GC04-6 Sandstone	53640	<1	<100	0.139	14	0.085	8.50

Sample Id	Sample Number	Sb	Sb	Se	Se	Si*	Si*
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.100	<0.001	<0.100	<0.2	<20
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.100	<0.001	<0.100	5.1	509
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.100	0.007	0.746	11.5	1154
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.100	0.001	0.127	12.9	1290
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.100	<0.001	<0.100	9.3	934
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.100	0.014	1.43	1.7	167
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.100	0.001	0.101	3.3	327
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.100	0.001	0.114	8.1	812
GC02-6 Carbonaceous Shale	53628	<0.001	<0.100	0.007	0.724	6.2	617
GC02-7 Sandstone	53629	<0.001	<0.100	<0.001	<0.100	6.7	666
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.100	<0.001	<0.100	15.7	1571
GC03-2 Siltstone/sandstone	53631	<0.001	<0.100	0.003	0.256	0.8	78
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.100	0.006	0.639	9.2	923
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.100	0.002	0.202	13.0	1303
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.100	0.001	0.109	3.1	308
GC03-8 Carbonaceous Shale	53635	<0.001	<0.100	0.004	0.407	5.9	594
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.100	0.003	0.262	7.0	705
GC04-2 Carbonaceous Shale	53637	0.002	0.215	<0.001	<0.100	10.7	1068
GC04-3 Shale and Sandstone mix	53638	0.001	0.133	<0.001	<0.100	11.7	1170
GC04-4 Sandstone	53639	<0.001	<0.100	<0.001	<0.100	8.0	800
GC04-6 Sandstone	53640	<0.001	<0.100	<0.001	<0.100	8.0	800

Sample Id	Sample Number	Sr	Sr	U	U	V	V
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.100	<0.001	<0.100	<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.018	1.80	<0.001	<0.100	0.002	0.187
GC01-4 Carbonaceous Shale & Sandstone	53622	0.060	5.96	0.016	1.60	0.036	3.61
GC01-5 Sandstone (roof of coal seam)	53623	0.055	5.52	0.005	0.457	0.002	0.206
GC01-6 Carbonaceous Sandstone	53624	0.028	2.82	0.007	0.676	0.018	1.77
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.558	56	<0.001	<0.100	0.217	22
GC02-3 Sandstone (floor of B-lower)	53626	0.310	31	<0.001	<0.100	0.005	0.486
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.088	8.79	<0.001	<0.100	0.088	8.80
GC02-6 Carbonaceous Shale	53628	0.128	13	<0.001	<0.100	0.183	18
GC02-7 Sandstone	53629	0.146	15	<0.001	<0.100	0.015	1.54
GC02-9 Sandstone (roof and floor of E seam)	53630	0.315	32	0.006	0.587	0.005	0.507
GC03-2 Siltstone/sandstone	53631	0.117	12	<0.001	<0.100	0.001	0.133
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.069	6.87	<0.001	<0.100	0.440	44
GC03-4 Carbonaceous Sandstone	53633	0.085	8.48	0.013	1.33	0.014	1.37
GC03-6 Sandstone & Shale mix	53634	0.134	13	<0.001	<0.100	<0.001	<0.100
GC03-8 Carbonaceous Shale	53635	0.143	14	0.001	0.144	0.001	0.124
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.264	26	<0.001	<0.100	0.020	2.00
GC04-2 Carbonaceous Shale	53637	0.059	5.91	0.020	2.01	0.005	0.464
GC04-3 Shale and Sandstone mix	53638	0.141	14	0.007	0.705	0.031	3.10
GC04-4 Sandstone	53639	0.041	4.10	<0.001	<0.100	0.049	4.91
GC04-6 Sandstone	53640	0.028	2.82	0.003	0.264	0.005	0.485

Sample Id	Sample Number	Zn	Zn
		mg/l	mg/kg
Det Limit		<0.001	<0.100
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.010	0.952
GC01-4 Carbonaceous Shale & Sandstone	53622	0.585	58
GC01-5 Sandstone (roof of coal seam)	53623	0.410	41
GC01-6 Carbonaceous Sandstone	53624	0.108	11
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.100
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.100
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.283	28
GC02-6 Carbonaceous Shale	53628	0.010	1.04
GC02-7 Sandstone	53629	<0.001	<0.100
GC02-9 Sandstone (roof and floor of E seam)	53630	0.216	22
GC03-2 Siltstone/sandstone	53631	<0.001	<0.100
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.012	1.17
GC03-4 Carbonaceous Sandstone	53633	0.640	64
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.100
GC03-8 Carbonaceous Shale	53635	0.009	0.911
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.032	3.24
GC04-2 Carbonaceous Shale	53637	0.517	52
GC04-3 Shale and Sandstone mix	53638	1.07	107
GC04-4 Sandstone	53639	0.207	21
GC04-6 Sandstone	53640	0.067	6.69

[*] = Samples analysed on ICP-OES Instrument

CERTIFICATE OF ANALYSES
ICP-MS QUANTITATIVE ANALYSIS

Date received:	30-01-19	Date completed:	12-03-19
Project number:	1000	Report number:	80505
Client name:	ABS Africa (Pty) Ltd.	Contact person:	Paul Furniss
Address:	PO Box 14003, Vorna Valley, 1686	Email:	paul@abs-africa.com
Telephone:	011 805 0061	Contact person:	Rob van Hille
		Email:	rob@mossgroup.co.za

Extract	Sample Mass (g)	Volume (ml)	Factor
HNO3 : HF	0.25	100	400

Sample Id	Sample Number	Ag	Ag	Al	Al	As	As
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.100	<40	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	117	46800	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.400	234	93600	0.001	0.400
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	147	58800	0.001	0.400
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.400	115	46000	0.002	0.800
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.400	149	59600	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	187	74800	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.400	262	104800	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	207	82800	0.001	0.400
GC02-7 Sandstone	53629	<0.001	<0.400	160	64000	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	88	35200	0.002	0.800
GC03-2 Siltstone/sandstone	53631	<0.001	<0.400	142	56800	0.005	2.00
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	92	36800	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	199	79600	0.001	0.400
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.400	209	83600	0.001	0.400
GC03-8 Carbonaceous Shale	53635	<0.001	<0.400	141	56400	0.001	0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	110	44000	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	<0.001	<0.400	194	77600	0.001	0.400
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	191	76400	0.001	0.400
GC04-4 Sandstone	53639	<0.001	<0.400	87	34800	<0.001	<0.400
GC04-6 Sandstone	53640	<0.001	<0.400	48	19200	<0.001	<0.400

Sample Id	Sample Number	Au	Au	B	B	Ba	Ba
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	0.188	75	0.846	338
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.400	0.344	138	0.303	121
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	0.485	194	0.531	212
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.400	0.395	158	0.131	52
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.400	0.663	265	1.65	658
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	0.586	234	1.14	456
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.400	0.477	191	0.893	357
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	0.291	116	0.085	34
GC02-7 Sandstone	53629	<0.001	<0.400	0.183	73	1.22	488
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	0.303	121	0.501	200
GC03-2 Siltstone/sandstone	53631	<0.001	<0.400	0.645	258	0.470	188
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	0.107	43	0.009	3.60
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	0.403	161	0.286	114
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.400	<0.001	<0.400	0.975	390
GC03-8 Carbonaceous Shale	53635	<0.001	<0.400	<0.001	<0.400	0.487	195
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	<0.001	<0.400	0.064	26
GC04-2 Carbonaceous Shale	53637	<0.001	<0.400	<0.001	<0.400	0.096	38
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	<0.001	<0.400	0.120	48
GC04-4 Sandstone	53639	<0.001	<0.400	0.097	39	0.637	255
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	0.006	2.40

Sample Id	Sample Number	Be	Be	Bi	Bi	Ca	Ca
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<1	<400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.004	1.60	<0.001	<0.400	2	800
GC01-4 Carbonaceous Shale & Sandstone	53622	0.014	5.60	0.001	0.400	3	1200
GC01-5 Sandstone (roof of coal seam)	53623	0.007	2.80	<0.001	<0.400	3	1200
GC01-6 Carbonaceous Sandstone	53624	0.004	1.60	<0.001	<0.400	<1	<400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.012	4.80	0.001	0.400	30	12000
GC02-3 Sandstone (floor of B-lower)	53626	0.005	2.00	<0.001	<0.400	13	5200
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.010	4.00	<0.001	<0.400	<1	<400
GC02-6 Carbonaceous Shale	53628	0.017	6.80	<0.001	<0.400	3	1200
GC02-7 Sandstone	53629	0.005	2.00	<0.001	<0.400	16	6400
GC02-9 Sandstone (roof and floor of E seam)	53630	0.003	1.20	<0.001	<0.400	9	3600
GC03-2 Siltstone/sandstone	53631	0.007	2.80	<0.001	<0.400	201	80400
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.014	5.60	<0.001	<0.400	<1	<400
GC03-4 Carbonaceous Sandstone	53633	0.014	5.60	<0.001	<0.400	3	1200
GC03-6 Sandstone & Shale mix	53634	0.005	2.00	<0.001	<0.400	13	5200
GC03-8 Carbonaceous Shale	53635	0.015	6.00	0.002	0.800	6	2400
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.004	1.60	<0.001	<0.400	3	1200
GC04-2 Carbonaceous Shale	53637	0.014	5.60	0.002	0.800	3	1200
GC04-3 Shale and Sandstone mix	53638	0.010	4.00	<0.001	<0.400	4	1600
GC04-4 Sandstone	53639	0.002	0.800	<0.001	<0.400	1	400
GC04-6 Sandstone	53640	0.002	0.800	<0.001	<0.400	<1	<400

Sample Id	Sample Number	Cd	Cd	Ce	Ce	Co	Co
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	0.014	5.60	0.003	1.20
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.400	0.032	13	0.009	3.60
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	0.017	6.80	0.008	3.20
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.400	0.015	6.00	0.003	1.20
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.400	0.007	2.80	0.004	1.60
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	0.009	3.60	0.005	2.00
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.400	0.036	14	0.002	0.800
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	0.009	3.60	0.010	4.00
GC02-7 Sandstone	53629	<0.001	<0.400	0.009	3.60	0.003	1.20
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	0.009	3.60	0.011	4.40
GC03-2 Siltstone/sandstone	53631	<0.001	<0.400	0.027	11	0.008	3.20
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	0.001	0.400	0.003	1.20
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	0.016	6.40	0.010	4.00
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.400	0.005	2.00	0.005	2.00
GC03-8 Carbonaceous Shale	53635	<0.001	<0.400	0.003	1.20	0.020	8.00
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	0.003	1.20	0.002	0.800
GC04-2 Carbonaceous Shale	53637	<0.001	<0.400	0.013	5.20	0.017	6.80
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	0.008	3.20	0.008	3.20
GC04-4 Sandstone	53639	<0.001	<0.400	0.014	5.60	0.004	1.60
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	0.002	0.800

Sample Id	Sample Number	Cr	Cr	Cs	Cs	Cu	Cu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.332	133	0.001	0.400	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	0.344	138	0.003	1.20	0.017	6.80
GC01-5 Sandstone (roof of coal seam)	53623	0.385	154	0.002	0.800	0.005	2.00
GC01-6 Carbonaceous Sandstone	53624	0.469	188	0.001	0.400	0.004	1.60
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.207	83	0.001	0.400	0.012	4.80
GC02-3 Sandstone (floor of B-lower)	53626	0.270	108	0.003	1.20	0.003	1.20
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.232	93	0.002	0.800	0.006	2.40
GC02-6 Carbonaceous Shale	53628	0.206	82	<0.001	<0.400	0.017	6.80
GC02-7 Sandstone	53629	0.303	121	<0.001	<0.400	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	0.435	174	<0.001	<0.400	0.001	0.400
GC03-2 Siltstone/sandstone	53631	0.340	136	<0.001	<0.400	0.002	0.800
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.183	73	<0.001	<0.400	0.018	7.20
GC03-4 Carbonaceous Sandstone	53633	0.336	134	<0.001	<0.400	0.017	6.80
GC03-6 Sandstone & Shale mix	53634	0.258	103	<0.001	<0.400	0.006	2.40
GC03-8 Carbonaceous Shale	53635	0.232	93	0.001	0.400	0.029	12
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.450	180	<0.001	<0.400	0.007	2.80
GC04-2 Carbonaceous Shale	53637	0.234	94	<0.001	<0.400	0.027	11
GC04-3 Shale and Sandstone mix	53638	0.308	123	<0.001	<0.400	0.011	4.40
GC04-4 Sandstone	53639	0.450	180	<0.001	<0.400	0.001	0.400
GC04-6 Sandstone	53640	0.387	155	<0.001	<0.400	0.001	0.400

Sample Id	Sample Number	Dy	Dy	Er	Er	Eu	Eu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.003	1.20	0.002	0.800	0.001	0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	0.005	2.00	0.003	1.20	0.001	0.400
GC01-5 Sandstone (roof of coal seam)	53623	0.003	1.20	0.001	0.400	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	0.004	1.60	0.003	1.20	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.003	1.20	0.002	0.800	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	0.002	0.800	0.001	0.400	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.004	1.60	0.002	0.800	0.001	0.400
GC02-6 Carbonaceous Shale	53628	0.001	0.400	0.001	0.400	<0.001	<0.400
GC02-7 Sandstone	53629	0.002	0.800	0.001	0.400	0.001	0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	0.002	0.800	0.001	0.400	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	0.012	4.80	0.007	2.80	0.001	0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	<0.001	<0.400	<0.010	<4.00
GC03-4 Carbonaceous Sandstone	53633	0.002	0.800	0.001	0.400	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	0.001	0.400	0.001	0.400	0.001	0.400
GC03-8 Carbonaceous Shale	53635	0.001	0.400	0.001	0.400	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	0.002	0.800	0.001	0.400	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	0.001	0.400	0.001	0.400	<0.001	<0.400
GC04-4 Sandstone	53639	0.001	0.400	0.001	0.400	<0.001	<0.400
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400

Sample Id	Sample Number	Fe	Fe	Ga	Ga	Gd	Gd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<10	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	22	8800	0.015	6.00	0.002	0.800
GC01-4 Carbonaceous Shale & Sandstone	53622	49	19600	0.015	6.00	0.005	2.00
GC01-5 Sandstone (roof of coal seam)	53623	81	32400	0.020	8.00	0.002	0.800
GC01-6 Carbonaceous Sandstone	53624	55	22000	0.008	3.20	0.003	1.20
GC02-2 Carbonaceous Clay (roof of B seam)	53625	17	6800	0.041	16	0.002	0.800
GC02-3 Sandstone (floor of B-lower)	53626	40	16000	0.025	10	0.001	0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	16	6400	0.019	7.60	0.004	1.60
GC02-6 Carbonaceous Shale	53628	40	16000	0.010	4.00	0.001	0.400
GC02-7 Sandstone	53629	36	14400	0.025	10	0.002	0.800
GC02-9 Sandstone (roof and floor of E seam)	53630	50	20000	0.013	5.20	0.002	0.800
GC03-2 Siltstone/sandstone	53631	121	48400	0.024	9.60	0.007	2.80
GC03-3 Carbonaceous Shale and sandstone mix	53632	9	3600	0.006	2.40	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	70	28000	0.016	6.40	0.002	0.800
GC03-6 Sandstone & Shale mix	53634	40	16000	0.028	11	0.001	0.400
GC03-8 Carbonaceous Shale	53635	78	31200	0.030	12	0.001	0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	26	10400	0.005	2.00	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	72	28800	0.014	5.60	0.002	0.800
GC04-3 Shale and Sandstone mix	53638	35	14000	0.011	4.40	0.001	0.400
GC04-4 Sandstone	53639	42	16800	0.014	5.60	0.001	0.400
GC04-6 Sandstone	53640	19	7600	0.003	1.20	<0.001	<0.400

Sample Id	Sample Number	Ge	Ge	Hf	Hf	Hg	Hg
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	0.001	0.400	0.001	0.400	<0.001	<0.400
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	0.001	0.400	0.003	1.20	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.002	0.800	0.010	4.00	0.001	0.400
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.001	0.400	0.006	2.40	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	0.001	0.400	0.006	2.40	<0.001	<0.400
GC02-7 Sandstone	53629	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	<0.001	<0.400	0.006	2.40	<0.001	<0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	0.008	3.20	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	0.001	0.400	0.008	3.20	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	0.001	0.400	0.024	9.60	<0.001	<0.400
GC03-8 Carbonaceous Shale	53635	0.001	0.400	0.015	6.00	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.001	0.400	0.017	6.80	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	0.001	0.400	0.014	5.60	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	0.022	8.80	<0.001	<0.400
GC04-4 Sandstone	53639	<0.001	<0.400	0.005	2.00	<0.001	<0.400
GC04-6 Sandstone	53640	0.001	0.400	0.007	2.80	<0.001	<0.400

Sample Id	Sample Number	Ho	Ho	In	In	Ir	Ir
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC01-5 Sandstone (roof of coal seam)	53623	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-7 Sandstone	53629	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	0.003	1.20	<0.001	<0.400	<0.001	<0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC03-8 Carbonaceous Shale	53635	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-4 Sandstone	53639	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400

Sample Id	Sample Number	K	K	La	La	Li	Li
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.5	<200	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	75	30000	0.007	2.80	0.026	10
GC01-4 Carbonaceous Shale & Sandstone	53622	44	17600	0.012	4.80	0.300	120
GC01-5 Sandstone (roof of coal seam)	53623	53	21200	0.005	2.00	0.220	88
GC01-6 Carbonaceous Sandstone	53624	4.3	1714	0.006	2.40	0.132	53
GC02-2 Carbonaceous Clay (roof of B seam)	53625	10.3	4113	0.003	1.20	0.253	101
GC02-3 Sandstone (floor of B-lower)	53626	73	29200	0.003	1.20	0.096	38
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	52	20800	0.017	6.80	0.200	80
GC02-6 Carbonaceous Shale	53628	49	19600	0.004	1.60	0.170	68
GC02-7 Sandstone	53629	78	31200	0.004	1.60	0.059	24
GC02-9 Sandstone (roof and floor of E seam)	53630	32	12800	0.003	1.20	0.103	41
GC03-2 Siltstone/sandstone	53631	43	17200	0.013	5.20	0.120	48
GC03-3 Carbonaceous Shale and sandstone mix	53632	30	12000	0.001	0.400	0.222	89
GC03-4 Carbonaceous Sandstone	53633	46	18400	0.007	2.80	0.273	109
GC03-6 Sandstone & Shale mix	53634	66	26400	0.002	0.800	0.111	44
GC03-8 Carbonaceous Shale	53635	35	14000	0.002	0.800	0.138	55
GC03-10 Carbonaceous sand stone and Shale mix	53636	20	8000	0.001	0.400	0.018	7
GC04-2 Carbonaceous Shale	53637	38	15200	0.006	2.40	0.241	96
GC04-3 Shale and Sandstone mix	53638	51	20400	0.004	1.60	0.192	77
GC04-4 Sandstone	53639	50	20000	0.005	2.00	0.078	31
GC04-6 Sandstone	53640	12	4800	<0.001	<0.400	0.066	26

Sample Id	Sample Number	Nd	Nd	Ni	Ni	Os	Os
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.008	3.20	0.004	1.60	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	0.015	6.00	0.018	7.20	<0.001	<0.400
GC01-5 Sandstone (roof of coal seam)	53623	0.006	2.40	0.017	6.80	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	0.005	2.00	0.019	7.60	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.004	1.60	0.022	8.80	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	0.005	2.00	0.008	3.20	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.021	8.40	0.007	2.80	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	0.004	1.60	0.024	9.60	<0.001	<0.400
GC02-7 Sandstone	53629	0.006	2.40	0.007	2.80	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	0.004	1.60	0.016	6.40	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	0.014	5.60	0.014	5.60	<0.001	<0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.001	0.400	0.014	5.60	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	0.007	2.80	0.020	8.00	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	0.003	1.20	0.009	3.60	<0.001	<0.400
GC03-8 Carbonaceous Shale	53635	0.002	0.800	0.033	13	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.001	0.400	0.008	3.20	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	0.006	2.40	0.028	11	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	0.003	1.20	0.035	14	<0.001	<0.400
GC04-4 Sandstone	53639	0.005	2.00	0.007	2.80	<0.001	<0.400
GC04-6 Sandstone	53640	<0.001	<0.400	0.008	3.20	<0.001	<0.400

Sample Id	Sample Number	P	P	Pb	Pb	Pd	Pd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	2.23	892	0.071	28	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	2.19	877	0.016	6.40	<0.001	<0.400
GC01-5 Sandstone (roof of coal seam)	53623	2.44	978	<0.001	<0.400	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	2.01	802	<0.001	<0.400	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	1.50	600	<0.001	<0.400	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	2.33	934	0.041	16	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	1.72	688	<0.001	<0.400	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	2.67	1068	0.068	27	<0.001	<0.400
GC02-7 Sandstone	53629	2.17	866	0.075	30	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	2.59	1036	0.067	27	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	5.85	2339	0.054	22	<0.001	<0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	1.57	630	0.019	7.60	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	3.33	1332	0.077	31	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	2.22	886	0.076	30	<0.001	<0.400
GC03-8 Carbonaceous Shale	53635	2.36	942	0.100	40	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	1.90	759	0.028	11	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	2.14	855	0.071	28	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	2.22	887	0.069	28	<0.001	<0.400
GC04-4 Sandstone	53639	2.61	1042	0.060	24	<0.001	<0.400
GC04-6 Sandstone	53640	2.43	972	0.031	12	<0.001	<0.400

Sample Id	Sample Number	Pr	Pr	Pt	Pt	Rb	Rb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.002	0.800	<0.001	<0.400	0.047	19
GC01-4 Carbonaceous Shale & Sandstone	53622	0.004	1.60	<0.001	<0.400	0.027	11
GC01-5 Sandstone (roof of coal seam)	53623	0.002	0.800	<0.001	<0.400	0.045	18
GC01-6 Carbonaceous Sandstone	53624	0.001	0.400	<0.001	<0.400	0.010	4.00
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.001	0.400	<0.001	<0.400	0.002	0.800
GC02-3 Sandstone (floor of B-lower)	53626	0.001	0.400	<0.001	<0.400	0.036	14
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.005	2.00	<0.001	<0.400	0.035	14
GC02-6 Carbonaceous Shale	53628	0.001	0.400	<0.001	<0.400	0.002	0.800
GC02-7 Sandstone	53629	0.002	0.800	<0.001	<0.400	0.039	16
GC02-9 Sandstone (roof and floor of E seam)	53630	0.001	0.400	<0.001	<0.400	0.015	6.00
GC03-2 Siltstone/sandstone	53631	0.003	1.20	<0.001	<0.400	0.020	8.00
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	0.002	0.800	<0.001	<0.400	0.006	2.40
GC03-6 Sandstone & Shale mix	53634	0.001	0.400	<0.001	<0.400	0.027	11
GC03-8 Carbonaceous Shale	53635	0.001	0.400	<0.001	<0.400	0.004	1.60
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	<0.001	<0.400	0.009	3.60
GC04-2 Carbonaceous Shale	53637	0.002	0.800	<0.001	<0.400	0.012	4.80
GC04-3 Shale and Sandstone mix	53638	0.001	0.400	<0.001	<0.400	0.015	6.00
GC04-4 Sandstone	53639	0.001	0.400	<0.001	<0.400	0.044	18
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	0.005	2.00

Sample Id	Sample Number	Rh	Rh	Ru	Ru	Sb	Sb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-7 Sandstone	53629	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-8 Carbonaceous Shale	53635	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-4 Sandstone	53639	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400

Sample Id	Sample Number	Sc	Sc	Se	Se	Si	Si
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.2	<80
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.017	6.80	<0.001	<0.400	918	367200
GC01-4 Carbonaceous Shale & Sandstone	53622	0.033	13	<0.001	<0.400	586	234400
GC01-5 Sandstone (roof of coal seam)	53623	0.017	6.80	<0.001	<0.400	834	333600
GC01-6 Carbonaceous Sandstone	53624	0.018	7.20	<0.001	<0.400	880	352000
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.026	10	<0.001	<0.400	382	152800
GC02-3 Sandstone (floor of B-lower)	53626	0.019	7.60	<0.001	<0.400	794	317600
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.030	12	<0.001	<0.400	704	281600
GC02-6 Carbonaceous Shale	53628	0.022	8.80	<0.001	<0.400	587	234800
GC02-7 Sandstone	53629	0.022	8.80	<0.001	<0.400	838	335200
GC02-9 Sandstone (roof and floor of E seam)	53630	0.014	5.60	<0.001	<0.400	945	378000
GC03-2 Siltstone/sandstone	53631	0.032	13	<0.001	<0.400	544	217600
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.009	3.60	<0.001	<0.400	568	227200
GC03-4 Carbonaceous Sandstone	53633	0.025	10	<0.001	<0.400	612	244800
GC03-6 Sandstone & Shale mix	53634	0.024	9.60	<0.001	<0.400	747	298800
GC03-8 Carbonaceous Shale	53635	0.019	7.60	<0.001	<0.400	527	210800
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.009	3.60	<0.001	<0.400	929	371600
GC04-2 Carbonaceous Shale	53637	0.029	12	<0.001	<0.400	503	201200
GC04-3 Shale and Sandstone mix	53638	0.024	9.60	<0.001	<0.400	637	254800
GC04-4 Sandstone	53639	0.011	4.40	<0.001	<0.400	963	385200
GC04-6 Sandstone	53640	0.006	2.40	<0.001	<0.400	974	389600

Sample Id	Sample Number	Sm	Sm	Sn	Sn	Sr	Sr
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.002	0.800	0.001	0.400	0.036	14
GC01-4 Carbonaceous Shale & Sandstone	53622	0.004	1.60	0.003	1.20	0.030	12
GC01-5 Sandstone (roof of coal seam)	53623	0.002	0.800	0.001	0.400	0.058	23
GC01-6 Carbonaceous Sandstone	53624	0.001	0.400	0.001	0.400	0.012	4.80
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.001	0.400	0.005	2.00	0.180	72
GC02-3 Sandstone (floor of B-lower)	53626	0.001	0.400	0.002	0.800	0.096	38
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.005	2.00	0.005	2.00	0.031	12
GC02-6 Carbonaceous Shale	53628	0.001	0.400	0.004	1.60	0.009	3.60
GC02-7 Sandstone	53629	0.002	0.800	0.002	0.800	0.074	30
GC02-9 Sandstone (roof and floor of E seam)	53630	0.001	0.400	0.001	0.400	0.057	23
GC03-2 Siltstone/sandstone	53631	0.004	1.60	<0.001	<0.400	0.101	40
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	0.006	2.40	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	0.002	0.800	0.003	1.20	0.079	32
GC03-6 Sandstone & Shale mix	53634	0.001	0.400	0.004	1.60	0.046	18
GC03-8 Carbonaceous Shale	53635	0.001	0.400	0.004	1.60	0.094	38
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	0.003	1.20	0.011	4.40
GC04-2 Carbonaceous Shale	53637	0.001	0.400	0.004	1.60	0.013	5.20
GC04-3 Shale and Sandstone mix	53638	0.001	0.400	0.008	3.20	0.005	2.00
GC04-4 Sandstone	53639	0.001	0.400	0.001	0.400	0.034	14
GC04-6 Sandstone	53640	<0.001	<0.400	0.001	0.400	<0.001	<0.400

Sample Id	Sample Number	Ta	Ta	Tb	Tb	Te	Te
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.400	0.001	0.400	<0.001	<0.400
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.400	0.001	0.400	<0.001	<0.400
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC02-7 Sandstone	53629	<0.001	<0.400	0.001	0.400	<0.001	<0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-2 Siltstone/sandstone	53631	<0.001	<0.400	0.001	0.400	<0.001	<0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC03-6 Sandstone & Shale mix	53634	0.003	1.20	0.001	0.400	<0.001	<0.400
GC03-8 Carbonaceous Shale	53635	0.003	1.20	<0.001	<0.400	<0.001	<0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.001	0.400	<0.001	<0.400	<0.001	<0.400
GC04-2 Carbonaceous Shale	53637	0.003	1.20	<0.001	<0.400	<0.001	<0.400
GC04-3 Shale and Sandstone mix	53638	0.003	1.20	<0.001	<0.400	<0.001	<0.400
GC04-4 Sandstone	53639	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC04-6 Sandstone	53640	<0.001	<0.400	<0.001	<0.400	<0.001	<0.400

Sample Id	Sample Number	Th	Th	Ti	Ti	Tl	Tl
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.006	2.40	6.30	2520	0.002	0.800
GC01-4 Carbonaceous Shale & Sandstone	53622	0.048	19	12	4800	0.002	0.800
GC01-5 Sandstone (roof of coal seam)	53623	0.018	7.20	7.66	3066	0.003	1.20
GC01-6 Carbonaceous Sandstone	53624	0.018	7.20	11	4400	0.003	1.20
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.017	6.80	10	4000	0.001	0.400
GC02-3 Sandstone (floor of B-lower)	53626	0.010	4.00	9.74	3896	0.002	0.800
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.024	9.60	14	5612	0.001	0.400
GC02-6 Carbonaceous Shale	53628	0.008	3.20	13	5002	0.001	0.400
GC02-7 Sandstone	53629	<0.001	<0.400	7.23	2892	0.001	0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	5.88	2351	0.002	0.800
GC03-2 Siltstone/sandstone	53631	0.004	1.60	8.41	3364	0.001	0.400
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	13	5200	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	0.020	8.00	13	5200	0.001	0.400
GC03-6 Sandstone & Shale mix	53634	0.011	4.40	11	4400	0.001	0.400
GC03-8 Carbonaceous Shale	53635	0.020	8.00	14	5600	0.002	0.800
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.007	2.80	9.71	3884	0.001	0.400
GC04-2 Carbonaceous Shale	53637	0.034	14	13	5200	0.002	0.800
GC04-3 Shale and Sandstone mix	53638	0.019	7.60	14	5600	0.003	1.20
GC04-4 Sandstone	53639	0.007	2.80	3.73	1492	0.002	0.800
GC04-6 Sandstone	53640	0.002	0.800	3.54	1414	0.001	0.400

Sample Id	Sample Number	Tm	Tm	U	U	V	V
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	<0.001	<0.400	0.004	1.60	0.072	29
GC01-4 Carbonaceous Shale & Sandstone	53622	<0.001	<0.400	0.024	9.60	0.283	113
GC01-5 Sandstone (roof of coal seam)	53623	<0.001	<0.400	0.009	3.60	0.137	55
GC01-6 Carbonaceous Sandstone	53624	<0.001	<0.400	0.009	3.60	0.103	41
GC02-2 Carbonaceous Clay (roof of B seam)	53625	<0.001	<0.400	0.025	10	0.131	52
GC02-3 Sandstone (floor of B-lower)	53626	<0.001	<0.400	0.007	2.80	0.098	39
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	<0.001	<0.400	0.013	5.20	0.156	62
GC02-6 Carbonaceous Shale	53628	<0.001	<0.400	0.015	6.00	0.253	101
GC02-7 Sandstone	53629	<0.001	<0.400	0.004	1.60	0.114	46
GC02-9 Sandstone (roof and floor of E seam)	53630	<0.001	<0.400	0.005	2.00	0.090	36
GC03-2 Siltstone/sandstone	53631	0.001	0.400	0.008	3.20	0.128	51
GC03-3 Carbonaceous Shale and sandstone mix	53632	<0.001	<0.400	0.014	5.60	0.280	112
GC03-4 Carbonaceous Sandstone	53633	<0.001	<0.400	0.015	6.00	0.262	105
GC03-6 Sandstone & Shale mix	53634	<0.001	<0.400	0.008	3.20	0.126	50
GC03-8 Carbonaceous Shale	53635	<0.001	<0.400	0.017	6.80	0.318	127
GC03-10 Carbonaceous sand stone and Shale mix	53636	<0.001	<0.400	0.007	2.80	0.119	48
GC04-2 Carbonaceous Shale	53637	<0.001	<0.400	0.022	8.80	0.289	116
GC04-3 Shale and Sandstone mix	53638	<0.001	<0.400	0.012	4.80	0.273	109
GC04-4 Sandstone	53639	<0.001	<0.400	0.005	2.00	0.078	31
GC04-6 Sandstone	53640	<0.001	<0.400	0.003	1.20	0.045	18

Sample Id	Sample Number	W	W	Y	Y	Yb	Yb
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.002	0.800	0.002	0.800	0.002	0.800
GC01-4 Carbonaceous Shale & Sandstone	53622	0.004	1.60	0.004	1.60	0.002	0.800
GC01-5 Sandstone (roof of coal seam)	53623	0.001	0.400	0.002	0.800	0.002	0.800
GC01-6 Carbonaceous Sandstone	53624	0.003	1.20	0.006	2.40	0.003	1.20
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.002	0.800	0.005	2.00	0.003	1.20
GC02-3 Sandstone (floor of B-lower)	53626	0.001	0.400	0.001	0.400	0.001	0.400
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.002	0.800	0.004	1.60	0.002	0.800
GC02-6 Carbonaceous Shale	53628	0.005	2.00	0.001	0.400	0.001	0.400
GC02-7 Sandstone	53629	0.003	1.20	0.001	0.400	0.001	0.400
GC02-9 Sandstone (roof and floor of E seam)	53630	0.003	1.20	0.002	0.800	0.001	0.400
GC03-2 Siltstone/sandstone	53631	0.003	1.20	0.007	2.80	0.007	2.80
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.005	2.00	<0.001	<0.400	<0.001	<0.400
GC03-4 Carbonaceous Sandstone	53633	0.005	2.00	0.002	0.800	0.001	0.400
GC03-6 Sandstone & Shale mix	53634	0.005	2.00	0.001	0.400	0.001	0.400
GC03-8 Carbonaceous Shale	53635	0.006	2.40	0.001	0.400	0.001	0.400
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.005	2.00	0.001	0.400	0.000	0.000
GC04-2 Carbonaceous Shale	53637	0.006	2.40	0.002	0.800	0.001	0.400
GC04-3 Shale and Sandstone mix	53638	0.005	2.00	0.001	0.400	0.001	0.400
GC04-4 Sandstone	53639	0.003	1.20	0.002	0.800	0.001	0.400
GC04-6 Sandstone	53640	0.003	1.20	<0.001	<0.400	<0.001	<0.400

Sample Id	Sample Number	Zn	Zn	Zr	Zr
		mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400
GC01-2 Unweathered Sandstone (fair amount of silica)	53621	0.003	1.20	0.034	14
GC01-4 Carbonaceous Shale & Sandstone	53622	0.049	20	0.094	38
GC01-5 Sandstone (roof of coal seam)	53623	0.029	12	0.041	16
GC01-6 Carbonaceous Sandstone	53624	0.003	1.20	0.116	46
GC02-2 Carbonaceous Clay (roof of B seam)	53625	0.015	6.00	0.230	92
GC02-3 Sandstone (floor of B-lower)	53626	0.027	11	0.049	20
GC02-5 Mix of sandstone/siltstone and clay (floor of C seam)	53627	0.034	14	0.114	46
GC02-6 Carbonaceous Shale	53628	0.050	20	0.103	41
GC02-7 Sandstone	53629	0.012	4.80	0.033	13
GC02-9 Sandstone (roof and floor of E seam)	53630	0.013	5.20	0.031	12
GC03-2 Siltstone/sandstone	53631	0.017	6.80	0.036	14
GC03-3 Carbonaceous Shale and sandstone mix	53632	0.039	16	0.153	61
GC03-4 Carbonaceous Sandstone	53633	0.054	22	0.093	37
GC03-6 Sandstone & Shale mix	53634	0.034	14	0.101	40
GC03-8 Carbonaceous Shale	53635	0.066	26	0.100	40
GC03-10 Carbonaceous sand stone and Shale mix	53636	0.006	2.40	0.153	61
GC04-2 Carbonaceous Shale	53637	0.059	24	0.094	38
GC04-3 Shale and Sandstone mix	53638	0.059	24	0.124	50
GC04-4 Sandstone	53639	0.010	4.00	0.023	9.20
GC04-6 Sandstone	53640	<0.001	<0.400	0.072	29

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CERTIFICATE OF ANALYSES
EXTRACTIONS AS 4439.3

Date received:	**19/01/16**		**Date completed:**	**19/02/18**
Project number:	**1000**	**Report number: 80069**	**Order number:**	**---**

Client name:	**ABS Africa (Pty) Ltd.**	**Contact person:**	**Paul Furniss**
Address:	**PO Box 14003, Vorna Valley, 1686**	**Email:**	**paul@abs-africa.com**
Telephone:	**011 805 0061**	**Contact person:**	**Rob van Hille**
		Email:	**rob@mossgroup.co.za**

Analyses	**Ant 3 (2) 51,74 18/12/18 (0,306)**	**Ant 110 (1) ESEAM 51,57 18/12/18 (0,582)**	**Ant 100 (4) ESEAM 51,57 18/12/18 (0,876)**	**Ant 105 (1) BSEAM 51,72 18/12/18 (1,012)**	**Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)**	**Ant 105 (3) CU 51,47 18/12/18 (0,856)**				
Sample Number	**52256**	**52257**	**52258**	**52259**	**52260**	**52261**				
TCLP / Borax / Distilled Water	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**	**Distilled Water**				
Ratio*	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**	**1:20**				
Units	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**LCT0 mg/l**	**LCT1 mg/l**	**LCT2 mg/l**	**LCT3 mg/l**
Al, Aluminium	0,537	<0.100	<0.100	<0.100	<0.100	<0.100				
As, Arsenic	0,032	<0.001	<0.001	<0.001	0,002	<0.001	0,01	0,5	1	4
B, Boron	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,5	25	50	200
Ba, Barium	0,088	0,285	0,467	0,170	0,150	0,120	0,7	35	70	280
Ca, Calcium	11	48	22	11	30	7				
Cd, Cadmium	0,003	<0.001	<0.001	<0.001	<0.001	<0.001	0,003	0,15	0,3	1,2
Co, Cobalt	0,244	0,028	0,002	0,040	0,007	0,016	0,5	25	50	200
$Cr_{Total,}$ Chromium Total	0,001	<0.001	<0.001	<0.001	<0.001	<0.001	0,1	5	10	40
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0,05	2,5	5	20
Cu, Copper	0,019	<0.001	<0.001	0,001	<0.001	0,002	2,0	100	200	800
Fe, Iron	114	0,027	<0.025	<0.025	<0.025	0,128				
Hg, Mercury	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,006	0,3	0,6	2,4
K, Potassium	1,7	1,0	0,6	2,4	0,8	1,0				
Mg, Magnesium	4	6	3	5	5	3				
Mn, Manganese	0,277	0,405	0,099	0,151	0,158	0,113	0,5	25	50	200
Mo, Molybdenum	<0.001	<0.001	<0.001	<0.001	0,001	<0.001	0,07	3,5	7	28
Na, Soduim	1	<1	2	2	<1	<1				
Ni, Nickel	0,188	0,025	0,002	0,039	0,006	0,038	0,07	3,5	7	28
Pb, Lead	0,040	<0.001	<0.001	<0.001	<0.001	0,002	0,01	0,5	1	4
Sb, Antimony	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0,02	1,0	2	8
Se, Selenium	<0.001	<0.001	<0.001	0,002	0,001	<0.001	0,01	0,5	1	4
Si, Silicon	0,7	0,3	0,2	1,1	0,3	0,4				
Sr, Strontium	0,105	0,410	0,513	0,082	0,327	0,063				
U, Uranium	0,006	<0.001	<0.001	<0.001	<0.001	<0.001				
V, Vanadium	0,003	<0.001	<0.001	<0.001	0,001	<0.001	0,2	10	20	80
Zn, Zinc	79	3,38	1,19	19	0,635	24	5	250	500	2000
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**				
Total Dissolved Solids*	424	268	122	80	166	18	1000	12 500	25 000	100 000
Chloride as Cl	63	48	28	38	20	34	300	15 000	30 000	120 000
Sulphate as SO4	249	52	12	25	39	21	250	12 500	25 000	100 000
Nitrate as N	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	11	550	1100	4400
Fluoride as F	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	1,5	75	150	600
Ortho-Phosphate as P	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1				
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0,07	3,5	7	28
pH	2,8	6,9	7,1	6,0	7,1	4,7				
% Solids	---	---	---	---	---	---				
Acid Base Accounting	See attached report 80069 ABA									
X-ray Fluorescence [s]	See attached report 80069 XRF									

***Please note:**

1. The samples were used as received.
2. A moisture content were determined for wet or moist samples.
3. In cases where the sample were a slurry, a solid to liquid ratio were done (reported).
   Moisture content were determined after filtration
4. The results are reported as received. The moisture content were not taken into account.

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CERTIFICATE OF AN

EXTRACTIONS AS

Date received:	19/01/16	
Project number:	1000	Report number: 8

Client name:	ABS Africa (Pty) Ltd.
Address:	PO Box 14003, Vorna Valley, 1686
Telephone:	011 805 0061

Analyses	Ant 3 (2) 51,74 18/12/18 (0,306)	Ant 110 (1) ESEAM 51,57 18/12/18 (0,582)	Ant 100 (4) ESEAM 51,57 18/12/18 (0,876)	Ant 105 (1) BSEAM 51,72 18/12/18 (1,012)
Sample Number	52256	52257	52258	52259
TCLP / Borax / Distilled Water	TCLP	TCLP	TCLP	TCLP
Ratio*	1:20	1:20	1:20	1:20
Units	mg/ℓ	mg/ℓ	mg/ℓ	mg/ℓ
Al, Aluminium	0,718	0,626	0,377	0,555
As, Arsenic	0,040	0,009	<0.001	<0.001
B, Boron	0,002	0,003	0,005	0,003
Ba, Barium	0,180	2,02	2,56	0,591
Ca, Calcium	12	618	372	24
Cd, Cadmium	0,002	0,001	<0.001	0,001
Co, Cobalt	0,177	0,146	0,010	0,069
Cr_{Total}, Chromium Total	0,003	0,009	0,007	0,005
Cr(VI), Chromium (VI)	<0.010	<0.010	<0.010	<0.010
Cu, Copper	0,031	<0.001	<0.001	0,003
Fe, Iron	78	10	7,35	1,88
Hg, Mercury	<0.001	<0.001	<0.001	<0.001
K, Potassium	<0.5	<0.5	<0.5	2,0
Mg, Magnesium	3	142	79	8
Mn, Manganese	0,304	10	3,30	0,373
Mo, Molybdenum	0,002	<0.001	<0.001	<0.001
Na, Soduim	<1	<1	<1	<1
Ni, Nickel	0,166	0,179	0,026	0,067
Pb, Lead	0,121	0,091	0,047	0,021
Sb, Antimony	0,002	0,001	<0.001	<0.001
Se, Selenium	0,005	<0.001	<0.001	0,004
Si, Silicon	0,5	0,3	0,2	1,8
Sr, Strontium	0,147	6,15	4,08	0,210
U, Uranium	0,002	0,003	0,002	0,009
V, Vanadium	<0.001	0,001	0,004	<0.001

Zn, Zinc	51	30	17	30
Inorganic Anions	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**	**mg/ℓ**
Total Dissolved Solids*	240	3836	2264	190
Chloride as Cl	66	50	25	39
Sulphate as SO4	210	64	7	30
Nitrate as N	<0.1	<0.1	<0.1	<0.1
Fluoride as F	<0.2	<0.2	<0.2	<0.2
Ortho-Phosphate as P	0,1	0,1	0,1	<0.1
Total Cyanide as CN [s]	<0.02	<0.02	<0.02	<0.02
pH	4,1	4,5	4,4	4,2
% Solids	---	---	---	---

[s] = Subcontracted

E. Botha ___________________
Geochemistry Project Manager

Y) LTD

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ALYSES
4439.3

	Date completed:	19/02/18
·0069	Order number:	---
	Contact person:	Paul Furniss
	Email:	paul@abs-africa.com
	Contact person:	Rob van Hille
	Email:	rob@mossgroup.co.za

Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	Ant 105 (3) CU 51,47 18/12/18 (0,856)				
52260	52261				
TCLP	TCLP				
1:20	1:20				
mg/ℓ	mg/ℓ	LCT0 mg/l	LCT1 mg/l	LCT2 mg/l	LCT3 mg/l
0,303	0,281				
0,003	0,002	0,01	0,5	1	4
<0.001	<0.001	0,5	25	50	200
1,15	0,301	0,7	35	70	280
566	13				
<0.001	<0.001	0,003	0,15	0,3	1,2
0,032	0,020	0,5	25	50	200
0,012	0,006	0,1	5	10	40
<0.010	<0.010	0,05	2,5	5	20
<0.001	<0.001	2,0	100	200	800
14	2,81				
<0.001	<0.001	0,006	0,3	0,6	2,4
<0.5	<0.5				
56	3				
4,11	0,252	0,5	25	50	200
<0.001	<0.001	0,07	3,5	7	28
<1	<1				
0,066	0,042	0,07	3,5	7	28
0,056	0,107	0,01	0,5	1	4
<0.001	<0.001	0,02	1,0	2	8
0,001	0,004	0,01	0,5	1	4
0,2	0,4				
3,93	0,106				
0,004	0,001				
<0.001	<0.001	0,2	10	20	80

12	21	5	250	500	2000
mg/ℓ	**mg/ℓ**				
3210	128	1000	12 500	25 000	100 000
23	28	300	15 000	30 000	120 000
34	22	250	12 500	25 000	100 000
<0.1	<0.1	11	550	1100	4400
<0.2	<0.2	1,5	75	150	600
<0.1	<0.1				
<0.02	<0.02	0,07	3,5	7	28
4,5	4,2				
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***Please note:**

1. The samples were used as received.
2. A moisture content were determined for wet or moist samples.
3. In cases where the sample were a slurry, a solid to liquid ratio were done (reported). Moisture content were determined after filtration
4. The results are reported as received. The moisture content were not taken into account

CERTIFICATE OF ANALYSES
ICP-MS QUANTITATIVE ANALYSIS

Date received:	19/01/16	Date completed:	19/03/01
Project number:	1000	Report number:	80069

Client name:	ABS Africa (Pty) Ltd.	Contact person:	Paul Furniss
Address:	PO Box 14003, Vorna Valley, 1686	Email:	paul@abs-africa.com
Telephone:	011 805 0061	Contact person:	Rob van Hille
		Email:	rob@mossgroup.co.za

Extract	Sample Mass (g)	Volume (ml)	Factor
HNO3 : HF	0,25	100	400

Sample Id	Sample Number	Ag	Ag	Al*	Al*	As	As
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.100	<40	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	<0.001	<0.400	39	15600	0,003	1,40
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	<0.001	<0.400	27	10800	0,005	1,91
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	<0.001	<0.400	23	9200	0,004	1,49
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,001	0,415	32	12800	0,007	2,61
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	<0.001	<0.400	18	7200	0,005	2,11
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	<0.001	<0.400	35	14000	0,004	1,45

Sample Id	Sample Number	Au	Au	B	B	Ba	Ba
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	<0.001	<0.400	0,034	14	0,652	261
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	<0.001	<0.400	0,038	15	0,687	275
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	<0.001	<0.400	0,044	18	0,843	337
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	<0.001	<0.400	0,057	23	1,57	626
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	<0.001	<0.400	0,021	8,34	0,392	157
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	<0.001	<0.400	0,025	10	0,288	115

Sample Id	Sample Number	Be	Be	Bi	Bi	Ca*	Ca*
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<1	<400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,004	1,48	<0.001	<0.400	9	3600
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,005	1,84	<0.001	<0.400	13	5200
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,004	1,51	0,001	0,423	13	5200
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,004	1,67	0,003	1,21	3	1200
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,006	2,48	0,001	0,560	23	9200
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,004	1,50	0,002	0,649	1	400

Sample Id	Sample Number	Cd	Cd	Ce	Ce	Co	Co
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	<0.001	<0.400	0,127	51	0,017	6,77
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	<0.001	<0.400	0,129	51	0,021	8,27
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	<0.001	<0.400	0,155	62	0,022	8,92
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,001	0,411	0,208	83	0,019	7,44
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	<0.001	<0.400	0,143	57	0,010	3,87
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	<0.001	<0.400	0,207	83	0,005	1,94

Sample Id	Sample Number	Cr	Cr	Cs	Cs	Cu	Cu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,128	51	0,003	1,28	0,026	10
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,156	62	0,004	1,77	0,026	11
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,094	37	0,004	1,50	0,028	11
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,069	28	0,008	3,37	0,026	10
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,075	30	0,003	1,13	0,037	15
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,115	46	0,005	1,94	0,035	14

Sample Id	Sample Number	Dy	Dy	Er	Er	Eu	Eu
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,007	2,85	0,004	1,54	0,002	0,786
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,007	2,95	0,004	1,61	0,002	0,828
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,008	3,22	0,005	1,82	0,002	0,860
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,010	3,90	0,005	2,06	0,003	1,12
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,007	2,73	0,003	1,36	0,003	1,40
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,008	3,32	0,004	1,53	0,002	0,898

Sample Id	Sample Number	Fe*	Fe*	Ga	Ga	Gd	Gd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.025	<10	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	5,65	2260	0,054	22	0,010	3,93
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	6,92	2767	0,059	24	0,010	4,04
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	4,47	1790	0,062	25	0,012	4,67
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	5,32	2128	0,099	39	0,015	6,05
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	4,06	1624	0,033	13	0,011	4,22
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	6,18	2473	0,024	10	0,014	5,56

Sample Id	Sample Number	Ge	Ge	Hf	Hf	Hg	Hg
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,004	1,51	0,004	1,54	<0.001	<0.400
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,005	2,06	0,003	1,03	<0.001	<0.400
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,003	1,40	0,003	1,29	<0.001	<0.400
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,001	0,529	0,030	12	<0.001	<0.400
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,002	0,855	0,008	3,23	<0.001	<0.400
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	<0.001	<0.400	0,004	1,55	<0.001	<0.400

Sample Id	Sample Number	Ho	Ho	In	In	Ir	Ir
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,001	0,595	<0.001	<0.400	<0.001	<0.400
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,002	0,616	<0.001	<0.400	<0.001	<0.400
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,002	0,695	<0.001	<0.400	<0.001	<0.400
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,002	0,819	0,001	0,412	<0.001	<0.400
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,001	0,545	<0.001	<0.400	<0.001	<0.400
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,002	0,625	<0.001	<0.400	<0.001	<0.400

Sample Id	Sample Number	K*	K*	La	La	Li	Li
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.5	<200	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	<0.5	<200	0,063	25	0,032	13
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	<0.5	<200	0,063	25	0,025	9,83
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	<0.5	<200	0,075	30	0,020	8,11
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	<0.5	<200	0,103	41	0,027	11
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	<0.5	<200	0,080	32	0,015	5,86
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	<0.5	<200	0,107	43	0,016	6,37

Sample Id	Sample Number	Lu	Lu	Mg*	Mg*	Mn*	Mn*
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<1	<400	<0.025	<10
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	<0.001	<0.400	2	800	0,125	50
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	<0.001	<0.400	3	1200	0,185	74
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	<0.001	<0.400	3	1200	0,106	42
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	<0.001	<0.400	1	400	<0.025	<10
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	<0.001	<0.400	5	2000	0,237	95
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	<0.001	<0.400	<1	<400	<0.025	<10

Sample Id	Sample Number	Mo	Mo	Na*	Na*	Nb	Nd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<1	<400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,003	1,24	<1	<400	0,006	2,32
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,005	2,13	<1	<400	0,009	3,55
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,003	1,23	<1	<400	0,011	4,39
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,003	1,25	<1	<400	0,006	2,59
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,002	0,897	<1	<400	0,004	1,43
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,003	1,31	<1	<400	0,001	0,490

Sample Id	Sample Number	Nd	Nd	Ni	Ni	Os	Os
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,045	18	0,027	11	<0.001	<0.400
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,047	19	0,032	13	<0.001	<0.400
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,056	22	0,042	17	<0.001	<0.400
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	0,072	29	0,038	15	<0.001	<0.400
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,052	21	0,023	9,13	<0.001	<0.400
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,071	28	0,026	10	<0.001	<0.400

Sample Id	Sample Number	P	P	Pb	Pb	Pd	Pd
		mg/l	mg/kg	mg/l	mg/kg	mg/l	mg/kg
Det Limit		<0.001	<0.400	<0.001	<0.400	<0.001	<0.400
Ant 3 (2) 51.74 18/12/18 (0,306)	52256	0,189	75	0,036	14	0,002	0,697
Ant 110 (1) ESEAM 51.57 18/12/18 (0,582)	52257	0,324	130	0,031	13	0,002	0,691
Ant 100 (4) ESEAM 51.57 18/12/18 (0,876)	52258	0,764	306	0,030	12	0,002	0,851
Ant 105 (1) BSEAM 51.72 18/12/18 (1,012)	52259	1,82	729	0,021	8,55	0,004	1,67
Ant 185 (1) ESEAM 51,56 18/12/18 (0,832)	52260	0,080	32	0,027	11	0,002	0,695
Ant 105 (3) CU 51,47 18/12/18 (0,856)	52261	0,065	26	0,051	20	0,002	0,625

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