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A PROCEDURE TO DETERMINE THE POTENTIAL HYDROCHEMICAL CONTAMINATION FROM COAL MINES

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ABSTRACT

The need to predict and quantify the potential water contamination from proposed and existing coal mines as led to the development of a number of geochemical procedures. These procedures involve assessing the geochemistry at a laboratory scale and extrapolation of data to the mining scale. The procedures allow for identification of potential hydrochemical contamination and as a result planning an implementation of mitigation measures.

INTRODUCTION

An integral part of any existing or proposed new mining operation is a clear understanding of the potential environmental impacts. One of the aspects is an assessment of the potential impact on water quality. The potential impacts on water quality are directly associated with the type of ore body, hosts rock and the ore to be mined. The paper discusses methods to predict the generation of acid rock drainage and poor quality leachates and associated mitigation measures. Two case studies are presented,discussing methods used to determining potential contamination from proposed greenfield coal mining operations in Africa and India.

GEOCHEMICAL PROCESSES GIVING RISE TO CONTAMINATION

Disturbance of overburden and coal seams by mining results in the introduction of oxygen and water. Air and water leads to the oxidation of sulphide minerals and generation of poor quality leachates.

The generation of poor quality leachates hinges on the quantities of salts available for direct solution or base exchange. The generation of acid rock drainage is related to the sulphide minerals in the rock. Any material above regional groundwater level is usually weathered and is unlikely to produce acid rock drainage but may produce poor quality leachate.

Management of the acid generation and the resulting leachates relies on the ability to identify potential problems before they occur and develop remedial measures to eliminate or minimise the impacts. As water is required in the generation of acidic conditions and is the transport mechanism for poor quality leachates, development of a high quality operational water management systems to mitigate or minimise the potential environmental impacts is critical.

Generation of poor quality leachates

Argillaceous sediments such as shale, coal and mudstone constitute the main source giving rise to short term contamination. The lithological units in their pristine state are largely impermeable to water but mining operations, increase the permeabilities and expose greater surface areas of the sediments to air and water. This results in the release of salts that are contained in the sediments into the water by either base exchange or direct solution.

Base exchange is a process by which ions of the same charge are exchanged. The argillaceous sediments associated with coal layers contain monovalent cations such as sodium and potassium, which are absorbed onto clay particles. These are exchanged by bivalent cations such as calcium and magnesium. As a result, the Ca and Mg content of the groundwater is decreased with a corresponding increase in the Na and K concentrations.

Ions, which *dissolve directly* into the groundwater and do not require a process of base exchange, are the second cause of short term contamination. These are predominantly Na, K, $CaCO_3$ and to a limited extent SO_4. The contribution of these elements to increasing the total dissolved solids depends on their availability. The ions are generally found within pores of sediments, as anhydrous salts and as fracture fillings.

Research projects involving laboratory tests found that certain chemical elements and compounds could be divided into leachability groups. Differing leachability characteristics depended on the degree of leachability, which is measured on a time schale. The classification fell into the following three groups:

- Group 1: The components most easily leached; Cl, SO_4, Na and K.
- Group 2: The components of medium leachability; Cu, Zn, Hg, Sr, Cd, B, Mn, Mo and CN.
- Group 3: The components characterized with the slowest leaching; Mg, Al, Cr, As, Pb, NH_4 and Ca.

Acid mine drainage

The term "acid mine drainage" originated in the United States of America in describing water of a low pH emanating from disused mines and mine spoils. The mechanisms of acid mine drainage have been studied and well documented by Boyer and Gleason (1977), Walsh (1982) and Kim et al. (1982).

Briefly defined, acid mine drainage from coal mines and coal refuse piles occurs because of the weathering of pyrite. Pyrite in coal and overlying strata, when exposed to air and water oxidizes, producing ferrous iron and sulphuric acid. The ferrous iron is further oxidized and produces anhydrous iron oxide and more acidity. The acid lowers the pH of the water making it corrosive and metals soluble. Action by certain bacteria also catalyze pyrite weathering by catalyzing ferrous iron oxidation to ferric iron and speeding up the process of acid formation.

The mechanism, principles and impacts of acid mine drainage have been studied at length during the past decade. Perhaps the most comprehensive investigation is by Walsh (1982), funded by the U.S. Bureau of Mines. Walsh (1982) found that pyrite weathered by two methods, namely oxidation and the action of bacteria in the following steps;

- Pyrite weathering, to form acid in coal mine drainage, results from chemical oxidation by either ferric iron or oxygen in presence of water.
- Under field conditions, weathering based on oxidation by ferric iron predominates, with rates varying over the range of 0.001 to 0.1 mM H+/g-pyrite/day.
- Iron bacteria, especially *Thiobacillus ferrooxidans*, catalyze pyrite weathering (by a factor of three) by catalyzing ferrous iron oxidation to ferric iron. These bacteria are ubiquitous in coal mines with significant populations observed even at the active mine face.

Oxidation of pyrite

The rate of oxidation of pyrite is shown to be related to pyrite form, to pyrite concentrations, to oxygen concentration and to ferric iron concentration.

The potential of coal refuse piles to produce acid mine drainage is directly related to the *pyrite concentration* of the coal and associated sediments. The sulphur content of coal seams does however not forecast acid production in mine drainage upon seam mining due to the presence of organic and inorganic sulphate. Pyrite concentration in coal varies and coal with pyrite is considered undesirable and is usually discarded onto waste dumps. This results in waste dumps being greater potential sources of acid mine drainage due to the increased pyrite concentrations.

PROCEDURES TO FORECAST THE GENERATION OF POOR QUALITY LEACHATE AND ACID ROCK DRAINAGE

A number of methods exists for the determination of poor quality leachates and acid rock drainage. These are namely:

- Pyrite occurrence in exploration borehole logs;
- Acid base accounting;
- Leach pads.

Pyrite occurrence in exploration borehole logs

Noting of occurrence of pyrite in exploration borehole logs or sections allows for statistical analysis of occurrence and determination of the association of pyrite with specific lithological units. Should certain lithological units be identified to contain increase pyrite concentrations, these units can be identified as units of potential contamination. This information can then used to assist in directing more detailed sampling and reduce costly laboratory procedures.

Laboratory procedures

Acid-base accounting is a method for assessing the potential for mine rock to produce acid and poor quality leachate from laboratory tests.

Coal Mines usually have a number of lithological units above and below the coal seam. These units will be disturbed at various stages as mine progress. As a result, the composition of the overburden will vary as the mine expands. In opencast operations all units to be disturbed should be assessed while in underground mines roof, floor and discards are usually assessed. In order to predict and quantify the potential of each of the lithological units to produce acid rock drainage and poor quality leachate, a number of experiments can be completed on the different lithological units. These fall into two broad groups namely leach pads and acid base accounting.

Leach pads

The work is usually undertaken on exploration core samples or bulk samples. The old core (> 3 months) is usually found to be weathered and are not suitable for analysis.

The results of the tests to be undertaken on new core will allow for an initial assessment. The selection of samples is undertaken on the basis of lithology, pyrite and proximity to the coal seam. As a result thicknesses will vary accordingly. All cores are usually bagged without splitting. The longest core sections should be no more than 5 m. Open Cast mining method do not allow for mining benches of less than 5 m and as a result further definition to below 5 m intervals may not be beneficial. However smaller sections can be taken to assess roof and floor sections in underground mining operations.Leach pads allow for an assessment of changes in water quality with time. The procedure usually involves selection of samples weighing ±20 kg. The samples are installed into leach pads and are watered at set intervals with distilled water. Water is then collected and analyzed for anions, cations and trace elements. The advantage of leach pads (presuming that there is sufficient time for analysis) are concentrations with time data which can be used in geochemical modeling.

Acid base accounting

The procedure discussed was developed by EGi, Rio Tinto and GCS and discusses six tests that can be undertaken on samples to determine the potential for the generation of AMD and poor quality leachate.

The methodology and procedure can be defined as follows:

Steps

- Selection of boreholes
- Selection of core (5 m sections)
- Crushing of core (4 mm)
- Splitting of samples
- 3 x 750 g samples
- Further crushing of 1 sample (<75 micron)
- Laboratory tests, element enrichment, ANC, LECO, NAPP, water / peroxide and NAG
- Data base
- Assessment of data
- Recommendations

Element enrichment and solubility in water

200 g of sample is added to 400 ml distilled water, mixed and left to stand for 12 hours. The element enrichment and solubility is completed on water after filtering (usually anions, cations and trace elements).

Acid Neutralizing Capacity (ANC)

ANC is determined by testing sample with known concentration of hydrochloric acid and then titration with NaOH to determine amount of residual acid.

Total Sulphur Leco Test

The maximum potential acidity (MPA) is calculated by determining total sulphur. This is determined by the Leco high temperature combustion method. The assumption is that all sulphur occurs as reactive pyrite.

Net Acid Production Potential

This is calculated from ANC and MPA tests.

Net Acid Generation (NAG) Test

NAG Acid and Base potentials. If carbonaceous material is present in overburden samples, which is quite common, a modified multiple addition NAG test should be used. This procedure ensures that all carbonaceous material is broken down (and therefore organic acids) and all reactive sulphides are oxidised.

Assessment of Element Enrichment and Solubility with Peroxide

Add 200 g of sample to 400 ml H_2O_2. (15% H_2O_2). Assessment of element enrichment and solubility is then completed on the solutions after filtering. This simulates complete weathering of the sample.

CASE STUDY 1 GOKWE NORTH OPEN CAST COAL PROJECT

Background

The Gokwe North Coal Project is a proposed open cast coal to power station mine. No washing plant (benefaction will be expected) and crushed coal will be fed directly to the Power Station. The geology consists of a mudstone (Madumabisa) overlying the Upper Wankie Sandstone sequence (40 m), upper carbonaceous shale (40 m), main coal seam (15 m) and Lower Wankie Sandstone.

The lithological units strike roughly north-south and dip to the east at 16°. As a result mining will progress from above groundwater level to approximately 60 m below groundwater level. The hydrogeology of the area is fairly complex with different lithological units having different aquifer hydraulic properties and the whole sequence being confined by the Madumabisa Mudstone (where it occurs).

Assessment of pyrite occurrences

A significant percentage of the pyrite occurrences is found within 1 meter from the contact between the carbonaceous shales and the Upper Wankie Sandstone, which indicates that the contact zone between these two formations are relatively rich in pyrite minerals.

The Madumabisa Mudstone, Upper Coal Layer and Lower Carbonaceous Shales contain relatively few pyrite occurrences (generally in less than 10-15 % of the boreholes in these formations).

It can therefore be concluded that the contact zone between the Upper Wankie Sandstone and the Upper Carbonaceous shales is the most pyrite-rich section in the overburden and most probably the most critical stratum in terms of potentially acid forming characteristics. During the field surveys, visual inspections on 3 year old core samples were made and the pyrite present in the core samples was completely weathered.

Assessment of leach pad tests

In 1994, a number of leach pad tests were initiated in order to assess the potential of the five major lithological units in the overburden for acid generation and the water quality trends that may result from their disturbance and weathering. An additional leach pad was commissioned with a composite of the five lithologies, in order to assess the net neutralising potential of the entire overburden. The objectives of the leach pad tests were:

- To investigate the water quality and contamination trends that results from dewatering and disturbance of lithological units;
- To identify the lithological units that are potentially acid forming;
- To assess the neutralising capacity of the lithological units;
- To investigate temporal variations of water quality.

The leach pad tests confirm the preliminary conclusions from the lithological observations, that the contact zone between the Upper Wankie Sandstone and the Upper Carbonaceous Shales is the most critical section in terms of acid generating potential. This zone is the most pyrite-rich section in the overburden, and therefore requires special attention during mining. In addition the lithological unit giving rise to the greatest concentration if leachable elements are the carbonaceous shales.

SAMPLE INFORMATION									ACID-BASE ANALYSIS			NAG TEST		Geochemical Classification		Formation
Drill Hole	Sample Code	Depth (m) from	to	Interval (m)	Mining Unit	Major Lithology	pH*	EC* (dS/ m)	Tot S (%S)	ANC	NAPP	NAG	NAGpH			
										(kg H2SO4/ t)						
M287	287 - A	5.92	10.3	4.38	Overburden	Mudstone	7.9	1.452	0.14	10	-6	0	5.3	NAF	☐	MMS
	287 - B	10.3	24.44	14.14	Overburden	Mudstone	8.3	0.456	0.22	3	4	0	5.7	(NAF)UC	☐	
	287 - C	24.44	27.9	3.46	Overburden	Sandstone	7.6	0.873	1.46	33	12	0	7.2	UC	☐	UWS
	287 - D	27.9	41.05	13.15	Overburden	Sandstone	8.2	0.716	0.07	27	-25	0	8.6	NAF	☐	
	287 - E	41.05	41.14	0.09	Overburden	Sandstone	8.2	0.812	25.0	0	765	552	1.7	PAF	■	
	287 - F	41.14	45.51	4.37	Overburden	Carb. shale	6.3	0.911	0.75	1	22	10	2.7	PAF	■	UCS
	287 - G	45.51	54.43	8.92	Overburden	Carb. shale	6.7	0.326	0.34	3	7	0	5.3	(NAF)UC	☐	
	287 - H	54.43	62.05	7.62	Overburden	Carb. shale	8.2	0.331	0.36	14	-3	0	5.1	NAF	☐	
	287 - I	62.05	75.38	13.33	Overburden	Carb. shale	8.3	0.476	0.06	3	-1	0	5.6	NAF	☐	
	287 - J	75.38	81.01	5.63	Overburden	Carb. shale	8.3	0.512	0.15	9	-4	0	5.3	NAF	☐	
	287 - K	81.01	89.27	8.26	Overburden	Carb. shale	5.5	0.616	0.05	5	-3	0	7.1	NAF	☐	
	287 - L	89.27	90.85	1.58	Overburden	Carb. shale	8.0	0.617	0.13	5	-1	0	5.4	NAF	☐	
	287 - M	90.85	91.91	1.06	Overburden	Carb. shale	8.3	0.912	0.10	4	-1	0	6.7	NAF	☐	
	287 - N	91.91	92.85	0.94	Roof	Carb. shale	5.5	0.992	0.08	3	-1	0	7.1	NAF	☐	
	287-O	113.30	113.43	0.13	Floor	Siltstone	8.1	0.296	0.32	2	8	1	3.8	PAF/ LC	▨	LWS
	287-P	113.43	114.43	1	Floor	Siltstone	7.6	0.441	0.90	9	19	7	2.7	PAF	■	
M289	289 - A	5.22	9.4	4.18	Overburden	Mudstone	7.4	0.948	0.33	6	4	0	5.3	NAF	☐	MMS
	289 - B	9.4	20.7	11.3	Overburden	Mudstone	7.7	0.969	0.29	10	-1	0	5.0	NAF	☐	
	289 - C	20.7	31.92	11.22	Overburden	Mudstone	8.6	0.398	0.18	9	-3	0	7.2	NAF	☐	
	289 - D	31.92	41.76	9.84	Overburden	Mudstone	8.5	0.322	0.09	6	-3	0	7.2	NAF	☐	
	289 - E	41.76	44.66	2.9	Overburden	Sandstone	7.6	0.321	0.43	1	12	10	2.6	PAF	■	UWS
	289 - F	44.66	57.87	13.21	Overburden	Sandstone	8.1	0.302	0.04	36	-35	0	8.2	NAF	☐	
	289 - G	57.87	58.25	0.38	Overburden	Sandstone	7.6	1.052	5.42	93	73	15	2.6	PAF	■	
	289 - H	58.25	62.05	3.8	Overburden	Carb. shale	7.4	1.116	0.65	10	10	3	3.1	PAF/ LC	▨	UCS
	289 - I	62.05	73.48	11.43	Overburden	Carb. shale	8.6	0.461	0.55	13	4	8	3.3	PAF	■	
	289 - J	73.48	75.9	2.42	Overburden	Carb. shale	7.8	0.651	0.11	9	-6	0	6.4	NAF	☐	
	289 - K	75.9	79.83	3.93	Overburden	Carb. shale	8.9	0.403	0.22	19	-12	0	5.6	NAF	☐	
	289 - L	79.83	84.16	4.33	Overburden	Carb. shale	9.0	0.368	0.05	6	-4	0	7.2	NAF	☐	
	289 - M	84.16	87.76	3.6	Overburden	Carb. shale	8.7	0.316	0.03	4	-3	0	6.2	NAF	☐	
	289 - N	87.76	95.5	7.74	Overburden	Carb. shale	8.7	0.252	0.78	5	19	0	5.9	UC	☐	
	289 - O	95.5	99.39	3.89	Overburden	Carb. shale	8.3	0.352	0.54	9	8	2	3.8	PAF/ LC	▨	
	289 - P	99.39	105.22	5.83	Overburden	Carb. shale	8.8	0.214	0.03	6	-5	0	7.1	NAF	☐	
	289 - Q	105.22	106.99	1.77	Overburden	Carb. shale	8.7	0.242	0.03	9	-8	0	5.4	NAF	☐	
	289 - R	106.99	107.96	0.97	Overburden	Carb. shale	8.6	0.226	0.13	8	-4	0	5.2	NAF	☐	
	289 - S	107.96	108.96	1	Roof	Carb. shale	8.6	0.213	0.10	5	-2	0	5.5	NAF	☐	
	289-T	129.60	129.75	0.15	Floor	Carb. siltstone	5.0	0.516	2.65	1	80	60	2.0	PAF	■	MCL
	289-U	129.75	130.75	1	Floor	Carb. sandstone	8.2	0.276	0.30	2	7	4	3.2	PAF/ LC	▨	LWS

*pH & EC determined on 1:2 sample/ water suspensions

GEOCHEMICAL CLASSIFICATION:

NAF = Non-Acid Forming; PAF = Potentially Acid Forming; LC = Low Capacity; (NAF)UC = uncertain most likely NAF; UC = uncertain

Table 1. Acid forming characteristics of drill-hole samples from the Gokwe Project.

Laboratory testing

A number of laboratoring tests were undertaken on specific borehole logs. The tests was described briefly before. The results of a typical analysis of two boreholes are shown in the Table 1. It must be noted that in both cases the UWS / UCS contact was below groundwater level. In cases where this is above groundwater level the pyrite is weathered and is not acid forming.

Waste management Gokwe

Field results and laboratory analysis has located a pyritically enriched overburden layer, which contains at least 80% of the identified overburden pyrite. The recommended waste management consists of the selective handling of the pyritic band which will be mixed with limestone and encapsulated in cells with a clay liner and located below a predetermined height near the base of the pit. These cells will have a sealing layer around them of at least 0.5 metres of compacted claystone or clay. The limestone and clay liner will prevent acid generation during the life of the mine and for a considerable period post mining. Within 75 to 100 years after mining has ceased, the final void water table is expected to redevelop to a level well above the clay cells containing the pyritic material. This will ensure oxygen does not come into contact with the pyritic material there by ensuring acidic conditions do not develop within the final void in the long term.

CASE STUDY 2 BARANJ COAL PROJECT (CENTRAL INDIA)

Background

The Baranj Coal Project is a proposed open cast coal to power station mine located in central India. Washing coal mined from selected seams to remove pyritic material in an endeavor to reduce power station sulphur emissions to exceptable levels. As a result, the major issue relating to Baranj environmental geochemical characterisation at Baranj is the potential for the production of acidic conditions in coal tailings. sent, heavy metal mobilisation.

Rio Tinto Technical Services undertook the field sampling of overburden and coal in India. Samples were transported to Australia and were analysed by Environmental Geochemistry International (EGi) based in Sydney.

Assesment of pyritic occurrrences

Of critical importance is the field identification and detailed description by exploration geologists of pyrite occurrences during drilling programs. This assists in the assessment of laboratory results at a latter date and provides mine planners with a tool to better manage material with the potential to produce acid rock drainage. Pyrite was observed in both the coal seams and in the sediments enclosing them. During drilling, most observations were restricted to core

SAMPLE DETAILS					Natural	Natural	ACID-BASE ANALYSIS			NAG TEST		Geochemical	
Sample	Depth		Interval	Predom.	pH	EC	Total S	ANC	NAPP	NAG	NAGpH	Classification	
No.	from	to	(m)	Lithology		(dS/ m)	(%S)	(kg H2SO4/ t)					
2G	6.0	10.0	4.0	Sandstone	9.3	0.376	<0.01	18	-18	0	8.8	NAF	
3G	11.0	15.0	4.0	Siltstone	9.2	0.486	<0.01	11	-11	0	9.4	NAF	
4G	16.0	20.0	4.0	Siltstone	9.5	0.411	<0.01	7	-7	0	7.0	NAF	
5G	21.0	25.0	4.0	Claystone	8.9	0.358	<0.01	21	-21	0	8.6	NAF	
6G	26.0	30.0	4.0	Sandstone	8.7	0.277	<0.01	4	-4	0	8.8	NAF	
7G	31.0	35.0	4.0	Sandstone	8.8	0.251	<0.01	1	-1	0	9.1	NAF	
8G	36.0	40.0	4.0	oal (Rider Seam	5.8	0.949	0.71	4	18	26	2.5	PAF	■
9G	41.0	45.0	4.0	Coal/ Sandstone	7.2	0.598	0.14	6	-2	1	4.0	UC(NAF)	
10G	46.0	50.0	4.0	Sandstone	7.8	0.344	0.04	16	-15	0	7.0	NAF	
11G	51.0	55.0	4.0	Sandstone	8.2	0.381	0.04	3	-2	0	7.3	NAF	
12G	56.0	60.0	4.0	Sandstone	8.6	0.641	0.04	3	-2	0	7.2	NAF	
13G	61.0	65.0	4.0	Sandstone	7.4	1.257	0.06	2	0	0	7.3	NAF	
14G	66.0	70.0	4.0	Sandstone	8.1	0.619	0.08	1	1	0	6.4	UC(NAF)	
15G	71.0	75.0	4.0	Sandstone	8.5	0.578	0.11	1	2	1	3.5	PAF/ LC	
16G	76.0	80.0	4.0	Sandstone	8.5	0.674	0.11	1	2	1	3.5	PAF/ LC	
17G	81.0	85.0	4.0	Sandstone	8.5	0.621	0.15	1	4	2	3.2	PAF/ LC	
18G	86.0	90.0	4.0	Sandstone	8.2	0.467	0.16	1	4	4	3.0	PAF/ LC	
19G	91.0	95.0	4.0	Sandstone	7.7	0.651	0.30	0	9	8	2.7	PAF	■
20G	96.0	100.0	4.0	Sandstone	7.9	0.518	0.16	1	4	4	2.9	PAF/ LC	
21G	101.0	105.0	4.0	Sandstone	7.8	0.622	0.21	1	5	4	2.9	PAF/ LC	
22G	106.0	110.0	4.0	Carb. Mudstone/	2.8	3.61	1.18	0	36	4	3.1	PAF/ LC	
-	-	-	-	Coal (CS1 Seam)	-	-	-	-	-	-	-	-	-

CLASSIFICATION KEY: NAF = Non-Acid Forming; PAF = Potentially Acid Forming; LC = Low Capacity; UC = Uncertain Classification

Table 2. Acid forming characteristics of overburden samples from Baranj Project.

samples only a few metres above and below the main coal seam, where pyrite nodules some as large as footballs were commonly seen replacing sandstone. In the main coal seam, pyrite occurs as nodules and lenses, and along joints, fractures and bedding planes. In addition to being deposited in the main fault zones, pyrite was present in rollover zones within vertical fracturing zones.

Based on the findings it is confirmed that a potentially acid forming (PAF) unit can be expected in the coal seam roof units. These units are likely to contain only a low capacity (less than 10 kg H_2SO_4/t) to generate acid. Additionally, PAF units may occur higher in the overburden sequence associated with a 1 metre thin coal/carbonaceous unit. Tests indicate that the coal seam floor rock is also PAF.

Additional testing, including acid-base analysis (total sulphur, ANC & NAPP) and static NAG, was performed on samples collected from a selected number of drill-holes to geochemically characterise the overburden sequence and to confirm the presence of acid generating materials at the base of the drill-hole. The results from this test work are presented on Table 2.

Higher NAG may indicate the presence of organic (carbonaceous) material in some samples. Organic acids can be generated in the NAG solution through the partial peroxide oxidation of contained organic material. Material types represented by this sample require a modified NAG test to denature the organic acids.

Coal reject samples were included in the testing program. Based on the findings it is likely that the coal reject will be PAF and will have limited buffering ability. The multi-elements scans and calculated geochemical abundance indices indicate no significant element enrichment in the samples tested, apart from sulphur.

Waste management

Acidic conditions are expected to be generated in any water in pit due to the pyritic nature of the overburden material just above and below the coal seam. To reduce this long term exposure, the mine schedule will allow for this material to be stripped off and dumped in pit at the base of the low wall. This ensures that the material will not be exposed at the surface in the long term pyrite exposure to water will only occur during the operational life of the pit.

The long term management strategy for the pyritic material dumped in the pit bottom is to allow to it be flooded by the groundwater as it re-instates itself after mining there by inhibiting the potential generation of acidic conditions in runoff waters.