WILPINJONG COAL PROJECT

APPENDIX C

Assessment of the Acid Forming Potential and Salinity of Overburden, Coal and Coal Washery Waste

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Wilpinjong Coal Project

ASSESSMENT OF THE ACID FORMING POTENTIAL AND SALINITY OF OVERBURDEN, COAL AND COAL WASHERY WASTE

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1.0 Introduction

Environmental Geochemistry International Pty Ltd (EGi) was commissioned by Wilpinjong Coal Pty Ltd (WCPL) to assess the acid forming characteristics of samples representing overburden, coal and coal washery waste that will be produced at the Wilpinjong Coal Project, located near Mudgee in central New South Wales (Figure 1). The main aims of the testwork carried out by EGi were as follows:

- To identify any sulphide mineralisation in overburden (including interburden) or coal washery waste materials (including coarse rejects and tailings) and assess whether there is potential for generation of acid rock drainage (ARD) by such materials as a consequence of mining or coal processing.
- To assess the inherent salinity of freshly mined overburden, coal and coal washery waste materials and whether there is potential for leaching of soluble salts during or after mining.

This report describes the geochemical testwork carried out by EGi, the results obtained, and implications for the management of overburden and coal washery waste materials from the Coal Handling and Processing Plant (CHPP). Recommendations for the management of overburden and coal washery waste materials are also provided, where necessary.

2.0 Geochemical Test Program

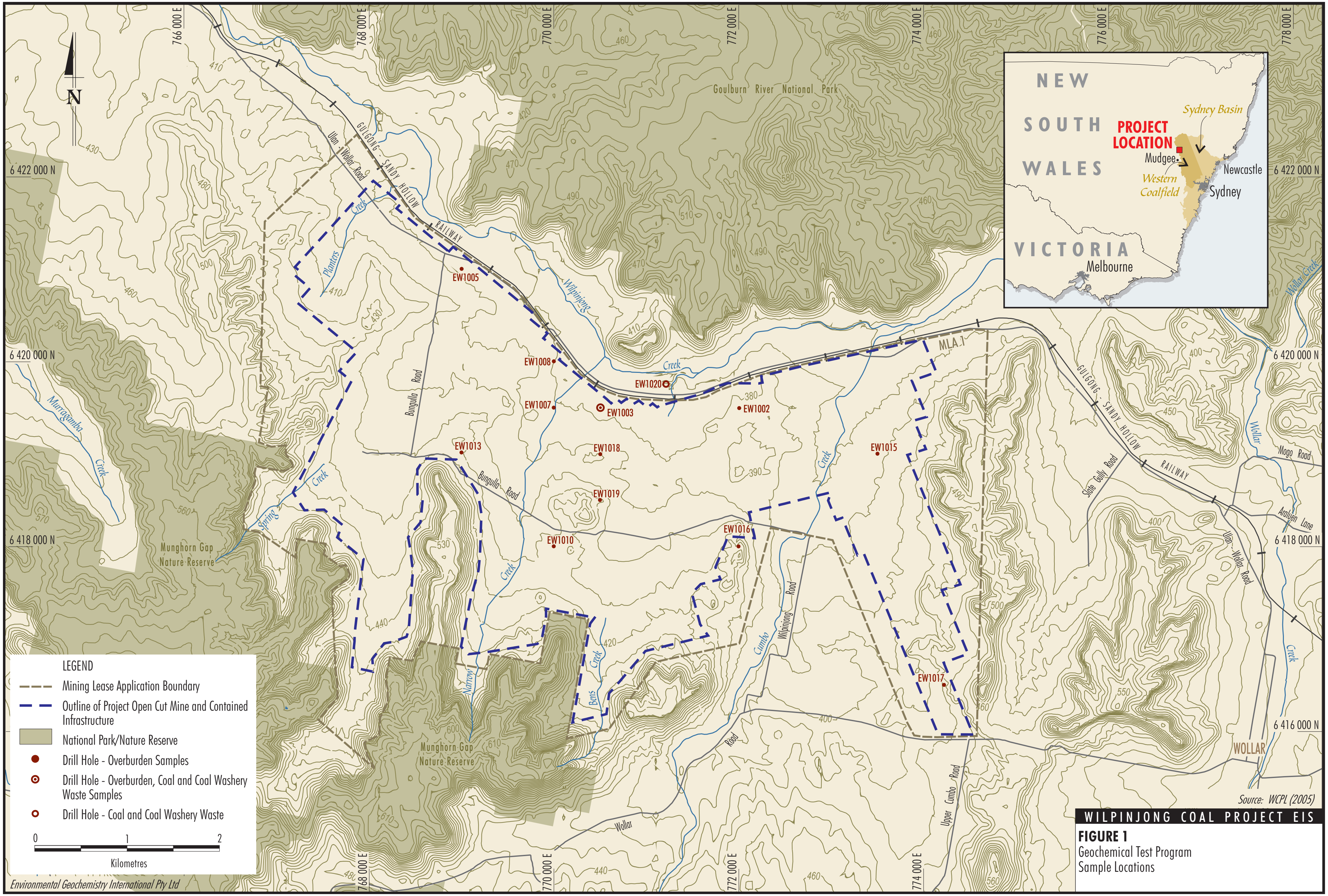
2.1 Selection and Preparation of Overburden Samples

The geochemical test program included testing of 50 drill core intervals from the Wilpinjong coal deposit. The sample intervals were selected by EGi in consultation with WCPL's Project geologist and included between one and eight samples from each the following 12 drill holes: EW1002, EW1003, EW1005, EW1007, EW1008, EW1010, EW1013, EW1015, EW1016, EW1017, EW1018 and EW1019. The locations of the 12 drill holes are shown on Figure 1. Most samples were representative of between 0.2 to 0.7 m interval of core and typically comprised 2 to 3 kg of rock.

The preparation of drill core samples for geochemical testing was carried out by Sydney Environmental and Soil Laboratory Pty Ltd. Sample preparation included jaw crushing of core to minus 2 mm, sub-sampling of approximately 200 grams by riffle splitter, and pulverisation of the sub-sample.

2.2 Preparation of Coal and Coal Washery Waste Samples

Coal washability tests were carried out by SGS Australia Pty Ltd on drill core samples representing raw coal from the A, B, D, E and G seams. Samples from the A and B seams were sourced from drill hole EW1020 and all other samples were from drill hole EW1003. The locations of the two drill holes are shown on Figure 1. A summary description of the stratigraphy of the Ulan Seam is provided in Section 2 (Figure 2-1) of the Environmental Impact Statement (EIS).



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The raw coal samples were initially dry screened to remove material less than 0.125 mm (*i.e.* the fine rejects) then wet tumbled for 5 minutes and wet screened at 0.125 mm to remove the slimes. The slimes and the fine rejects were subsequently combined to given a single tailings sample representing the minus 0.125 mm fractions. The +0.125 mm material was then passed through a dense medium separation to produce a product coal (i.e. floats with density less than 1.6) and a coarse reject (i.e. sinks with density greater than 1.6). Sub-samples representing the raw coal, product coal, coarse reject and tailings from each washability test were provided to EGi for geochemical testing.

The tailings and coarse reject samples from the washability testwork were representative of five of the main plies/ply composites from the working section of the Ulan Seam at Wilpinjong. Following consultation with WCPL's Project geologist, the individual product coal samples were composited into one sample for geochemical testing. Some compositing of the raw coal samples was also carried out, resulting in a total of 14 samples as follows:

Raw coal samples representing:

- Plies A12+B1+B2+B3
- Plies D0+D1+D2
- Composite of Plies E12+E21+E22 and Ply E32

Product coal representing:

- Composite of Plies A12+B1+B2+B3, D0+D1+D2, E12+E21+E22, E32 and G1

Tailings and coarse rejects from raw coal samples representing:

- Plies A12+B1+B2+B3
- Plies D0+D1+D2
- Plies E12+E21+E22
- Ply E32
- Ply G1

2.3 Analytical Program and Methods

The analytical program included analysis or determination of the following parameters:

Existing pH and Salinity

The existing pH and salinity of each sample were determined by equilibrating a 30 gram sub-sample of crushed material with deionised water at a solids:liquor ratio of 1:2 (w/w) for 24 hours. The pH was determined with a glass electrode and salinity was determined by measurement of electrical conductivity.

Total Sulphur Content

The total sulphur content of each sample was determined by the Leco furnace method. Sulphur assays were carried out by Sydney Environmental and Soil Laboratory Pty Ltd under a quality assurance system certified as complying with ISO 9002.

Maximum Potential Acidity (MPA)

The MPA is the maximum amount of acid that could be generated by the sulphur contained within a sample assuming that all the sulphur occurs as reactive pyrite. The MPA of each sample was calculated from the total sulphur content as follows: MPA (kg H_2SO_4/t) = (Total %S) x 30.6.

Acid Neutralising Capacity (ANC)

The acid produced by pyrite oxidation will to some extent react with other minerals contained within a sample. This inherent acid buffering is referred to as ANC, and has the same units as MPA. ANC was determined using the Sobek Method. This involved reacting a sample with a known amount of acid at pH less than 1 for 1 to 2 hours, then back-titrating the residual acidity to determine the amount of acid consumed by the sample.

Net Acid Producing Potential (NAPP)

The NAPP is the amount of acid that potentially can be produced by a sample after allowing for ANC. It is calculated by subtracting the ANC value from the MPA value. If the NAPP is negative then it is likely that the material has sufficient inherent buffer capacity to prevent acid generation. Conversely, if the NAPP is positive then the material may be acid generating.

ANC/MPA Ratio

The ANC/MPA ratio is another way of evaluating the balance between ANC and MPA, and provides an indication of the relative margin of safety with respect to the acid forming potential of a sample. A ratio less than 1 corresponds to a positive NAPP and indicates a material may be acid generating. Conversely, an ANC/MPA ratio of 2 or more generally signifies that there is a high probability that the material will remain circum-neutral in pH (*i.e.* the material should not be problematic with respect to ARD).

Net Acid Generation (NAG)

NAG is a direct oxidation method for estimating the acid forming potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals present. Both acid generation and acid neutralisation occur simultaneously during the NAG test, hence the end result represents a direct measurement of the net amount of acid that a sample can generate. If the sample after reaction has a pH less than 4.5 (*i.e.* NAGpH < 4.5) then it is considered to be acid forming. The actual amount of acidity generated can be determined by titration of the mixture.

When testing tailings and coarse reject samples, the NAG test was modified to account for oxidation of carbonaceous matter in such materials. Following the standard reaction step described above, the NAG liquor was filtered and the filtrate then divided into two equal aliquots. One aliquot was titrated as described above. The other aliquot was treated with additional hydrogen peroxide then boiled for several hours. The purpose of the additional step was to fully decompose any organic acids that may have been produced in the initial treatment of the sample. Following the extended boiling, the pH of the liquor was recorded and the acidity of the liquor determined by titration.

2.4 ARD Classification Scheme

The acid forming potential of each sample was classified on the basis of the sulphur, NAPP and NAG test results into one of the following five categories:

- PAF Potentially acid forming
- PAF-lc PAF-lower capacity
- NAF Non-acid forming
- NAF(org) Non-acid forming but contains reactive organic carbon
- UC Uncertain

The classification criteria for each material type are described below.

Potentially Acid Forming (PAF) Material

A sample was classified as PAF if it had a NAPP greater than 10 kg H_2SO_4/t and the NAGpH was less than, or equal to 4.5. PAF material typically has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a risk that such a material, even if pH circum-neutral when freshly mined, could oxidise and generate acidic drainage if exposed to atmospheric conditions.

PAF-lower capacity Material

A sample was classified as PAF-lower capacity if it had a NAPP of 0 to 10 kg H_2SO_4/t and the NAGpH was less than, or equal to 4.5. There is a possibility that such material could acidify if exposed to atmospheric conditions and produced mildly acidic drainage but the total amount of acidity generated would be relatively low. Acidification of such material can often be prevented by application of lime.

Non-Acid Forming (NAF) Material

NAF material may, or may not, have a significant sulphur content but the availability of carbonate minerals and ANC within the material is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals. As such, material classified as NAF is considered unlikely to be a source of acidic drainage. The criteria used to define NAF material were a negative NAPP and a NAGpH greater than 4.5.

NAF (org) Material

Overburden samples from coal deposits sometimes acidify under NAG test conditions to less than pH 4.5 even though they contain little, if any, sulphide mineralisation. In such cases, the acidity is due to partial oxidation of organic (carbonaceous) matter within the sample by the hydrogen peroxide used in the NAG test. The acidification process is an artifact of the NAG test procedure and does not signify that the sample has the potential to generate ARD. A sample was classified as NAF(org) if the NAGpH was less than, or equal to 4.5, the total sulphur content was less than, or equal to 0.1 %S, and the NAPP was less than, or equal to 0 kg H_2SO_4/t.

Uncertain

An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results for samples containing more than 0.1 %S sulphur. A conflict may arise when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH < 4.5. Uncertain samples are generally given a tentative classification based on the available information, which is shown in brackets *e.g.* UC(PAF) or UC(NAF).

2.5 Salinity Classification Scheme

The salinity of each sample was classified on the basis of the electrical conductivity (EC) of an extract comprising one part by weight of air dried sample and two parts by weight of deionised water into one of the following classes:

Non-saline	EC less than 500 µS/cm
Slightly saline	EC 500 to 1000 µS/cm
Saline	EC 1000 to 2500 µS/cm
Highly saline	EC greater than 2500 µS/cm

3.0 Geochemistry of Overburden Samples

3.1 Acid Forming Potential

The acid forming characteristics of the 50 samples are given in Table 1. Overall, the overburden materials represented by the samples are typically characterised by circum-neutral pH, low total sulphur content (and hence low MPA) and low ANC. The distribution of samples between the various ARD classifications was as follows:

- PAF-lc 2 samples
- NAF 37 samples
- NAF (org) 10 samples
- UC (NAF) 1 sample

Graph 1 shows an acid-base account plot for the overburden samples. The acid-base account plot shows the relationship between sulphur and ANC contents within samples, and illustrates graphically the acid forming potentials of samples relative to the NAPP=0 line. Samples that lie above the NAPP=0 line have negative NAPPs. Most samples lie well above the NAPP=0 line, and indeed most samples lie above a line corresponding to an ANC/MPA ratio of 2. As a general rule, when the ANC/MPA ratio is 2 or more there is a high probability that the material will remain circum-neutral in pH and will not be problematic with respect to ARD.

Table 1: Acid forming characteristics of overburden samples, Wilpinjong Coal Project.

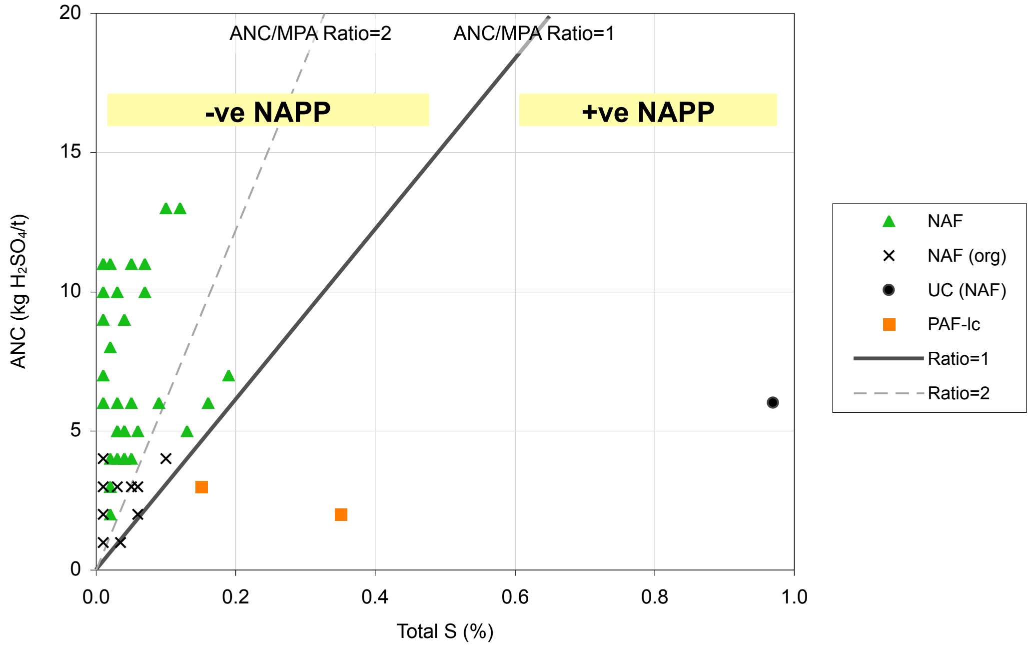
EGi Code	Client Code	Hole Number	Interval (m)	Lithology	Seam	pH	EC µS/cm	Sulphur (%S)	MPA	ANC	ANC/MPA Ratio	NAPP	NAG	NAGpH	ARD Classification
27242	16035	EW 1002	7.98-8.49	claystone		7.9	176	0.05	2	11	7.2	-9	0	7.8	NAF
27243	16036	EW 1002	18.05-18.48	carbonaceous claystone		7.8	112	0.06	2	5	2.7	-3	0	6.3	NAF
27244	16037	EW 1002	20.88-21.26	siltstone / sandstone		7.7	117	<0.01	0	11	> 37	-11	0	7.8	NAF
27245	16038	EW 1002	25.43-25.85	siltstone		7.9	129	0.01	0	10	33	-10	0	7.9	NAF
27246	16039	EW 1002	32.80-33.14	claystone	F	8.3	72	0.04	1	9	7.4	-8	0	7.8	NAF
27247	16040	EW 1002	34.67-35.00	siltstone / carbonaceous claystone		8.1	92	0.06	2	3	1.6	-1	7	4.4	NAF (org)
27248	16006	EW 1003	5.07-5.44	sandstone	XC	8.1	88	<0.01	0	1	> 3	-1	12	3.9	NAF (org)
27249	16007	EW 1005	5.89-6.62	siltstone		8.2	99	0.01	0	7	23	-7	0	7.8	NAF
27291	16008	EW 1005	25.36-25.83	claystone	A2	6.9	172	0.04	1	4	3.3	-3	0	7.1	NAF
27250	16009	EW 1005	32.68-32.93	claystone/carbonaceous	CMK	7.7	107	0.05	2	6	3.9	-4	0	7.3	NAF
27251	16010	EW 1005	39.68-40.08	claystone	F	7.5	116	0.12	4	13	3.5	-9	0	7.7	NAF
27252	16011	EW 1005	40.83-41.14	siltstone/sandstone		7.3	111	<0.01	0	3	> 10	-3	20	3.2	NAF (org)
27253	16005	EW 1007	12.48-12.91	siltstone		6.9	114	0.35	11	2	0.2	9	4	3.4	PAF-lc
27254	16012	EW 1008	15.12-15.43	claystone	CMK	7.4	124	0.04	1	9	7.4	-8	0	7.9	NAF
27255	16013	EW 1008	22.71-22.98	claystone	F	6.9	132	0.19	6	7	1.2	-1	0	6.6	NAF
27256	16014	EW 1008	22.87-23.21	claystone/siltstone		7.7	136	0.05	2	3	2.0	-1	14	3.1	NAF (org)
27257	16003	EW 1010	5.96-7.49	carbonaceous claystone/claysone		7.9	144	0.04	1	4	3.3	-3	0	6.3	NAF
27258	16004	EW 1010	16.15-16.49	siltstone		7.9	107	0.02	1	3	4.9	-2	0	5.8	NAF
27259	54748	EW 1013	11.12-11.48	siltstone		7.9	121	0.13	4	5	1.3	-1	0	5.0	NAF
27260	54749	EW 1013	14.63-15.04	siltstone/claystone (some carbonaceous)		8.0	98	0.03	1	10	11	-9	0	7.3	NAF
27261	54750	EW 1013	17.56-19.33	siltstone / sandstone/sandstone coarse		7.9	32	0.02	1	3	4.9	-2	0	5.1	NAF
27262	16001	EW 1013	27.31-27.96	siltstone		7.9	102	0.03	1	4	4.4	-3	0	7.1	NAF
27263	16019	EW 1015	12.06-12.90	siltstone	A11	7.9	107	0.16	5	6	1.2	-1	0	5.2	NAF
27264	16018	EW 1015	15.89-16.24	siltstone / claystone		7.4	87	0.02	1	8	13	-7	0	7.4	NAF
27265	16017	EW 1015	20.36-21.48	siltstone	CMK	7.3	62	0.04	1	5	4.1	-4	0	7.5	NAF
27266	16016	EW 1015	28.01-28.31	claystone/carbonaceous	F	7.3	79	0.09	3	6	2.2	-3	0	7.2	NAF
27267	16015	EW 1015	29.84-30.16	siltstone		7.2	88	0.15	5	3	0.7	2	3	4.0	PAF-lc

Table 1: continued

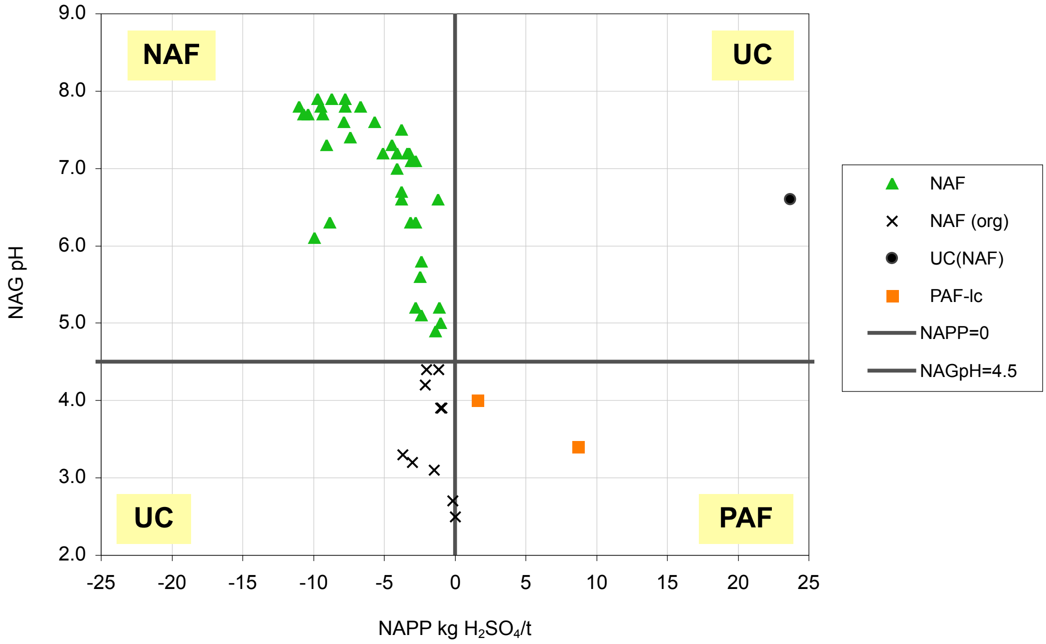
EGi Code	Client Code	Hole Number	Interval (m)	Lithology	Seam	pH	EC µS/cm	Sulphur (%S)	MPA	ANC	ANC/MPA Ratio	NAPP	NAG	NAGpH	ARD Classification
27268	16041	EW 1016	22.38-22.85	claystone / carbonaceous		6.9	211	0.97	30	6	0.2	24	0	6.6	UC (NAF)
27269	16042	EW 1016	26.81-27.20	claystone/carbonaceous		6.9	216	0.01	0	9	29	-9	0	7.9	NAF
27270	16043	EW 1016	30.84-31.74	siltstone	XC	7.2	207	0.07	2	11	5.1	-9	0	6.3	NAF
27271	16020	EW 1017	13.08-13.57	carbonaceous claystone		7.3	214	0.01	0	11	36	-11	0	7.7	NAF
27272	16021	EW 1017	20.23-20.53	siltstone		7.4	311	0.02	1	11	18	-10	0	7.7	NAF
27273	16022	EW 1017	23.18-23.71	siltstone	B2P	7.9	111	0.01	0	6	20	-6	0	7.6	NAF
27274	16023	EW 1017	26.28-26.57	claysone		7.8	92	0.03	1	5	5.4	-4	0	7.2	NAF
27275	16024	EW 1017	27.48-27.74	carbonaceous claystone		7.9	99	0.10	3	13	4.2	-10	0	6.1	NAF
27276	16025	EW 1017	29.95-30.33	siltstone		8.0	89	0.04	1	5	4.1	-4	0	6.6	NAF
27277	16026	EW 1017	35.32-35.67	claystone	F	7.7	102	0.04	1	4	3.3	-3	0	5.2	NAF
27278	16027	EW 1017	37.04-37.55	siltstone / fine sandstone		7.9	114	<0.01	0	2	> 7	-2	4	4.4	NAF (org)
27279	54743	EW 1018	7.66-11.47	siltstone		7.1	107	0.03	1	6	6.5	-5	0	7.2	NAF
27280	54744	EW 1018	13.01-13.43	claystone / carbonaceous		7.2	114	0.07	2	10	4.7	-8	0	7.6	NAF
27281	54745	EW 1018	15.09-15.59	claystone (some carbonaceous)		7.3	92	0.02	1	4	6.5	-3	0	7.2	NAF
27282	54746	EW 1018	18.50-19.00	claystone / carbonaceous		7.3	88	0.04	1	5	4.1	-4	0	6.7	NAF
27283	54747	EW 1018	27.54-27.85	carbonaceous claystone		7.2	89	0.03	1	3	3.3	-2	6	4.2	NAF (org)
27284	16028	EW 1019	7.23-7.63	siltstone		7.1	72	0.04	1	1	0.8	0	53	2.5	NAF (org)
27285	16029	EW 1019	8.83-9.12	siltstone / claystone		6.9	69	0.01	0	4	13	-4	19	3.3	NAF (org)
27286	16030	EW 1019	11.95-12.57	claystone / carbonaceous		5.8	67	0.03	1	5	5.4	-4	0	7.0	NAF
27287	16031	EW 1019	15.22-15.60	siltstone		6.9	114	0.05	2	4	2.6	-2	0	5.6	NAF
27288	16032	EW 1019	16.46-16.82	claystone / carbonaceous	CMK	6.9	155	0.02	1	2	3.3	-1	0	4.9	NAF
27289	16033	EW 1019	22.00-22.19	carb claystone / stoney coal / claystone	F	5.9	145	0.10	3	4	1.3	-1	2	3.9	NAF (org)
27290	16034	EW 1019	23.64-23.93	siltstone		6.8	162	0.06	2	2	1.1	0	34	2.7	NAF (org)

KEY

pH	pH of 1:2 extract	NAPP	Net Acid Producing Potential (kgH_2SO_4/t)	NAF	Non-Acid Forming
EC	Electrical Conductivity of 1:2 extract (µS/cm)	NAG	Net Acid Generation capacity (kgH_2SO_4/t)	NAF(org)	NAF with organic matter
MPA	Maximum Potential Acidity (kgH_2SO_4/t)	NAGpH	pH of NAG liquor	UC (NAF)	Uncertain but probably NAF
ANC	Acid Neutralising Capacity (kgH_2SO_4/t)			PAF-lc	Potentially Acid Forming - lower capacity



Graph 1: Acid-base account plot for overburden samples, Wilpinjong Coal Project



Graph 2: ARD classification plot for overburden samples, Wilpinjong Coal Project

Graph 2 shows an ARD classification plot for the overburden samples. The ARD classification plot graphically compartmentalises the acid forming potential using the NAPP value and the actual extent of acidification when reacted in the NAG test. It can be seen that the majority of samples clearly fall within the "NAF" quadrate and that only two samples clearly fall within the "PAF" quadrate. Both these samples had NAPPs less than 10 kg H_2SO_4/t and therefore were classified as PAF-lower capacity.

NAF Samples

The NAF samples had low sulphur contents, with all but five of the 37 NAF samples tested containing less than 0.1 %S. The average total sulphur content of the NAF samples was only 0.05 %S. This average sulphur content corresponds to a maximum potential acidity of less than 2 kg H_2SO_4/t. The ANCs were also low (average of 7 kg H_2SO_4/t) but adequate to buffer the acid potentials of the minor sulphur present. The NAG test results confirm the absence of acid generation.*NAF(org) Samples*

Overall, there is little difference between NAF and NAF(org) samples in respect of total sulphur content, and the distinction of NAF(org) in the database is only intended to highlight the difference in behaviour exhibited by these samples under NAG test conditions. In most cases, the NAF(org) samples had NAG values that were an order-of-magnitude greater than MPAs based on total sulphur contents. As noted in Section 2.4, it is not uncommon for samples with significant organic (carbonaceous) content to acidify to less than pH 4.5 in the standard NAG test. The decrease in pH is not due to sulphide oxidation but rather formation of organic acids that are released when organic matter is partially oxidised by the hydrogen peroxide used in the NAG test.

PAF-lower capacity Samples

The two samples classified as PAF-lower capacity were both siltstone and were representative of floor rock immediately below coal seam G. The drill core numbers and interval depths were EW1007 (12.48-12.91m) and EW1015 (29.84-30.16m), respectively. Although the total sulphur contents of both samples were only slightly elevated (0.35 and 0.15 %S), the NAPP values were positive (9 and 2 kg H_2SO_4/t) and both samples acidified to less than pH 4.5 when reacted in the NAG test. Some of the acidity generated in the NAG test may have resulted from organic matter oxidation. However, the higher sulphur contents reported for these two samples and the consistency of the NAPP and NAG test are indicative of some ARD potential, albeit relatively small.

UC(NAF) Sample

There was one sample of carbonaceous claystone that could not be definitively classified. The sample was from EW1016 (22.38-22.85m) and had a sulphur content of 0.97 %S, which was higher than for all other samples. The NAPP for this sample was strongly positive at 24 kg H_2SO_4/t, but the sample did not acidify when reacted in the NAG test. The absence of any acid generation under NAG test conditions suggests that the sulphur does not occur as inorganic sulphides but rather in sulphate or organic forms that have no acid generation potential. The sample was classified as UC(NAF) based on the NAG test result.

3.2 Salinity

An indication of the likely salinity of overburden was obtained from measurements of electrical conductivity (EC) of water extracts. Extracts were prepared by equilibrating samples in deionised water at a solid:water ratio of 1:2 w/w. The EC results are included in Table 1. An EC measurement is directly related to the amount of soluble salts present within a sample.

The EC values ranged from 32 to 311 µS/cm and the average for the 50 samples was 119 µS/cm. These values are indicative of very low soluble salts contents. Based on these results, it is expected that overburden at Wilpinjong will be non-saline.

4.0 Geochemistry of Coal and Coal Washery Waste Samples

4.1 Acid Forming Potential

The acid forming characteristics of samples representing raw coal, product coal, and coal washery waste materials (tailings and coarse rejects) are given in Table 2. A summary of the classifications applied to the various samples is also given in Table 3.

Raw and Product Coal

There was little difference in the acid forming characteristics of the three raw coal samples and the product coal sample. All four samples contained some sulphur (0.26 to 0.39 %S) but almost no ANC (1 to 2 kg H_2SO_4/t). The NAPPs of the coal samples were positive (6 to 10 kg H_2SO_4/t) and on the basis of the NAPP results all four samples were classified as PAF-lower capacity. The similarity in the sulphur content of the product coal sample with the contents found in the raw coal samples suggests no significant loss of sulphur from the raw coal during the coal washing process.

Coarse Rejects

The sulphur contents of the coarse rejects samples were generally consistent, varying between 0.17 and 0.41 %S and averaging 0.3 %S. This average is similar to the sulphur contents reported for the raw coal and product coal samples. Four of the five coarse reject samples had little, if any ANC. The one exception was the coarse rejects from Plies E12+E21+E22, which had an ANC of 16 kg H_2SO_4/t. The NAPP for this sample was negative and it did not acidify in the NAG test. As such, the sample of coarse rejects representing Plies E12+E21+E22 was classified as NAF.

The NAPPs for the other four coarse rejects samples were positive, with values ranging from 6 to 13 kg H_2SO_4/t. The coarse rejects for Ply E32 had the highest NAPP and it reacted strongly in the NAG test generating a pH of 3.9. This sample was therefore classified as PAF. The coarse rejects representing Plies A12+B1+B2+B3, Plies D0+D1+D2, and Ply G1 acidified only slightly under NAG test conditions and were classified as PAF-lower capacity.

Table 2: Acid forming characteristics of coal and coal washery waste samples, Wilpinjong Coal Project.

EGi Code	Material Type	Plies	pH	EC µS/cm	Sulphur (%S)	MPA	ANC	ANC/MPA Ratio	NAPP	NAG	NAGpH	ARD Classification
27712	Tailings	A12+B1+B2+B3	3.8	3740	0.99	30	0	0.0	30	26	2.9	**PAF**
27693	Tailings	D0+D1+D2	6.9	524	0.30	9	4	0.4	5	4	5.4	PAF-lc
27698	Tailings	E12+E21+E22	6.9	1210	0.37	11	4	0.4	7	3	5.9	PAF-lc
27703	Tailings	E32	4.3	616	0.60	18	0	0.0	18	21	3.4	**PAF**
27708	Tailings	G1	6.3	1060	0.37	11	1	0.1	10	8	4.5	PAF-lc
27711	Coarse Rejects	A12+B1+B2+B3	4.6	404	0.37	11	2	0.2	9	5	4.9	PAF-lc
27692	Coarse Rejects	D0+D1+D2	5.0	321	0.29	9	3	0.3	6	7	5.0	PAF-lc
27697	Coarse Rejects	E12+E21+E22	6.7	416	0.17	5	16	3.1	-11	0	7.0	NAF
27702	Coarse Rejects	E32	3.9	445	0.41	13	0	0.0	13	8	3.9	**PAF**
27707	Coarse Rejects	G1	4.1	211	0.25	8	1	0.1	7	8	4.8	PAF-lc
27709	Raw Coal	A12+B1+B2+B3	4.4	107	0.39	12	2	0.2	10	-	-	PAF-lc
27690	Raw Coal	D0+D1+D2	6.4	112	0.26	8	2	0.3	6	-	-	PAF-lc
27715	Raw Coal	E12+E21+E22+E32	4.7	102	0.36	11	2	0.2	9	-	-	PAF-lc
27714	Product Coal	A12+B1+B2+B3+D0+D1+D2 +E12+E21+E22+E32+G1	4.4	109	0.32	10	1	0.1	9	-	-	PAF-lc

KEY

pH	pH of 1:2 extract
EC	Electrical Conductivity of 1:2 extract (µS/cm)
MPA	Maximum Potential Acidity (kgH_2SO_4/t)
ANC	Acid Neutralising Capacity (kgH_2SO_4/t)
NAPP	Net Acid Producing Potential (kgH_2SO_4/t)
NAG	Net Acid Generation capacity (kgH_2SO_4/t)
NAGpH	pH of NAG liquor
NAF	Non-Acid Forming
PAF-lc	PAF-lower capacity
PAF	Potentially Acid Forming

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Tailings

The tailings samples (which comprise the slimes and fine rejects) had total sulphur contents ranging from 0.30 to 0.99 %S. The sulphur contents of the tailings were consistently higher than the corresponding coarse rejects from the same Ply. All five tailings samples had positive NAPPs. The tailings for Plies A12+B1+B2+B3 had the highest acid forming potential with a NAPP of 30 kg H_2SO_4/t. This sample also reacted strongly under NAG test conditions and acidified to pH 2.9. The tailings for Ply E32 also reacted strongly and had an NAPP of 18 kg H_2SO_4/t. The results indicate that the tailings from these plies have potential for acid generation and as such these samples were classified as PAF. The other three tailings samples also had positive NAPPs but the values were less than, or equal to 10 kg H_2SO_4/t. As such, the other tailings samples were classified as PAF-lower capacity.

Table 3. Summary of ARD and salinity classifications for coal and coal washery waste samples

<table>
<tr><th>Plies</th><th>TAILINGS</th><th>COARSE REJECTS</th><th>RAW COAL</th><th>PRODUCT COAL</th></tr>
<tr><td>A12+B1+B2+B3</td><td>PAF
Highly saline</td><td>PAF-lc
Non-saline</td><td>PAF-lc
Non-saline</td><td rowspan="5">PAF-lc
Non-saline</td></tr>
<tr><td>D0+D1+D2</td><td>PAF-lc
Slightly saline</td><td>PAF-lc
Non-saline</td><td>PAF-lc
Non-saline</td></tr>
<tr><td>E12+E21+E22</td><td>PAF-lc
Saline</td><td>NAF
Non-saline</td><td rowspan="2">PAF-lc
Non-saline</td></tr>
<tr><td>E32</td><td>PAF
Slightly saline</td><td>PAF
Non-saline</td></tr>
<tr><td>G1</td><td>PAF-lc
Saline</td><td>PAF-lc
Non-saline</td><td>not tested</td></tr>
</table>

4.2 Salinity

The EC values for the raw and product coal samples ranged from 102 to 112 µS/cm, which suggests very low soluble salts contents. The EC values for the five coarse rejects samples were higher at between 211 and 445 µS/cm, but these values are still indicative of low soluble salt contents. Based on these results, it is expected that raw coal, product coal, and coarse rejects at Wilpinjong will be non-saline.

The EC values for the five tailings samples were higher again, with values ranging from 524 to 3,740 µS/cm, and averaging 1,430 µS/cm. One tailings sample from plies A12+B1+B2+B3 was highly saline, the tailings from plies E12+E21+E22 and ply G1 were saline, and the tailings from plies D0+D1+D2 and ply E32 were slightly saline.

5.0 Summary and Recommendations for Materials Management

5.1 Overburden

Overall, the results indicate a very low likelihood of ARD generation from overburden at Wilpinjong as represented by the drill core samples included in the testing program. Based on the results of geochemical testing carried out by EGi it is expected that most overburden will be non-saline, non-acid forming, and have a circum-neutral pH. Some PAF material was identified in the floor rock immediately below coal seam G, but this was not consistent across all drill holes tested.

Recommendations for Overburden Management

It is recommended that further geochemical testing of overburden is carried out as the project develops to verify the findings of this investigation, including confirmation of the NAF classification of NAF(org) samples, however based on the samples analysed for this report, no special handling requirements for overburden are indicated for ARD control at Wilpinjong.

5.2 Coal Washery Wastes

The results of this geochemical program indicate a total sulphur content of 0.26 to 0.39 %S in most raw coal plies at Wilpinjong. A similar range of sulphur contents was found in the coarse rejects (0.17 to 0.41 %S), whereas concentrations in tailings tend to be higher at between 0.30 to 0.99 %S. The ANC values suggest there will be little acid buffer potential available in most tailings and coarse rejects produced by the CHPP from the various coal plies. Therefore exposure of coal washery waste materials to atmospheric conditions could result in sulphide oxidation and generation of ARD.

The majority of the tailings and coarse rejects samples had NAPP values in the range 5 to 10 kg H_2SO_4/t and were classified as PAF-lower capacity. It is expected that such materials, if exposed to atmospheric conditions could generate drainage that is mildly acidic. The tailings from some plies (*e.g.* Plies A12+B1+B2+B3 and Ply E32) had higher sulphur contents and reacted strongly when oxidised under laboratory conditions. These samples had higher acid forming potentials and were classified as PAF. It is expected that plies that produce tailings of higher sulphur content will be washed in the CHPP at the same time as other coal plies, hence the acid forming potential of the tailings discharge from the CHPP will be an average of the characteristics of the various coal plies being washed at any one time. On a mass weighted basis, it is expected that tailings overall will be PAF-lower capacity and moderately saline, but variations will occur reflecting changes in the proportions of different coal plies passing through the CHPP.

Recommendations for Management of Coarse Rejects

Approximately 47Mt of coarse rejects will be produced over the life of the project. WCPL propose to haul coarse rejects from the CHPP back to the open cut for backfilling or placement with overburden. The results of this study suggest that coarse rejects will contain some sulphur and are likely to have some capacity for acid generation. To reduce the risk of ARD generation, it is recommended that:

- Coarse rejects are dispersed throughout the overburden dumps with the aim of producing a mix that is NAF (*i.e.* the ANC of the overburden exceeds the acid potential of the coarse rejects). For initial planning purposes, it is recommended that overburden and rejects are blended at a ratio[1] of at least 2:1, and that this ratio is re-assessed once mining commences to ensure that actual bulk material has a negative NAPP. The total amount of coarse rejects produced over the life of the project will be approximately 15% of the tonnage of overburden, hence there will be scope to increase the blending ratio, if required. Options for placement of coarse rejects should be assessed to determine the level of blend uniformity that can reasonably be achieved, and whether this is compliant with the design criteria for prevention of ARD (*i.e.* negative NAPP).
- A monitoring program is established to ensure that the geochemical characteristics[2] of the rehabilitated landform containing the coarse rejects complies with the design criteria for ARD prevention (*i.e.* negative NAPP).
- The outer 5 m of overburden stockpiles should be constructed with NAF overburden to protect surface water quality and promote revegetation. Depending on the performance of operational blending of coarse rejects and overburden, a modified cover may be required. A review of the cover design should be carried out as results of the blending performance become available during mining.

Recommendations for Management of Tailings

Approximately 24 Mt of tailings (*i.e.* fine rejects and slimes) will be produced from the CHPP over the life of the project. Tailings will initially be pumped as a slurry to a purpose-built tailings dam/water storage facility located immediately to the south of the rail loop. When open cut operations are sufficiently advanced, tailings will be pumped to a void created within the Pit 1 box cut, then subsequently to voids created in the north and south of Pits 1 and 2, and in the north of Pit 4 (Refer to Figures 2-4 to 2-11 in the EIS). Berms will be used to divide each tailings disposal area into a number of cells to allow excess water to drain from the tailings solids and be re-cycled back to the CHPP. The tailings disposal areas will be filled to within 2 m of the original topography, then capped with waste rock/overburden/soil to create the final rehabilitated landform.

The results of this study suggest that most tailings will be at least moderately saline and have some capacity for acid generation. Since the tailings originate from the Ulan Seam and will be disposed of in-pit, it is expected that the groundwater flux through the tailings disposal areas in the long-term will be of a similar groundwater quality[3] to that which currently exists in the Ulan Seam, provided that the following tailings

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1 A ratio of 2:1 is based on a sulphur content in coarse rejects of 0.3 %S and an ANC for overburden of 6 kg H_2SO_4/t (*i.e.* the average values for the samples tested in this assessment).

2 The calculation of acid potentials in this report assumed that all sulphur occurs as reactive pyrite. It is possible that some sulphur occurs in organic forms, or as inorganic forms that are not acid generating (e.g. sulphate). This would lower the overall acid potential of washery waste materials. Future geochemical testing of coarse rejects should include determination of the sulphur forms so that the pyritic-sulphur contents, and hence acid potentials, of coarse rejects can be quantified more precisely.

3 EC values of 1,020 to 3,390 μS/cm have been reported for groundwater in the Ulan Seam. Reference: Australian Groundwater and Environmental Consultants Pty Ltd (2005).

management recommendations are implemented to minimise the risk of sulphide oxidation and ARD generation:

- Where possible, tailings should remain saturated during the operational phase of each dam by maintaining a water cover. Where this is not possible (*e.g.* for reasons of settling density and/or water recycling), the size of tailings beaches should be kept to a minimum and managed so as the beaches are periodically covered by fresh tailings to maintain saturation levels.
- The acid forming potential of the tailings solids and the composition of the decant water should be routinely monitored to determine if additional mitigation measures[4] are required during the operational phase.
- Closure requirements for tailings dams will also need to be examined. The current plan allows for a 2 m (minimum) capping above the tailings. This cover will act as a revegetation layer, and provide a non-acid forming surface for runoff. However, given the predicted sulphidic nature of tailings, it is likely that the final cover will need to include some form of barrier layer(s) to restrict oxygen and water ingress to the underlying tailings and/or prevent salts rising from the tailings to the soil surface. Effective covers for sulphide oxidation control are typically multi-layered and their construction requires engineering control. Site topography, prevailing climatic conditions, and availability of suitable fine textured material will largely dictate the design of cover layers for tailings dams at Wilpinjong. Cover design criteria can be developed during the mining operations as the geochemical characteristics of tailings within the dams become known.

[4] Additional mitigation measures might include selective use of crushed limestone at rates of approximately 2-3 kg per tonne of tailings to delay by 3 to 6 months the potential onset of acid conditions in PAF tailings exposed to atmospheric conditions.