Appendix E

Flora and fauna

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Kookaburra Gully Graphite Project Flora and Fauna Survey

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Version 8

Prepared by EBS Ecology for Parsons Brinkerhoff.

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Front cover photo: View of the Kookaburra Valley.

GLOSSARY AND ABBREVIATION OF TERMS

BDBSA	Biological Database of South Australia
DEWNR	Department of Environment, Water and Natural Resources
DSEWPaC	Department of Sustainability, Environment, Water, Population and Communities
EBS	EBS Ecology
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EP	Eyre Peninsula
EPNRMB	Eyre Peninsula Natural Resources Management Board
EYB	Eyre Yorke Block (IBRA Bioregion)
IBRA	Interim Biogeographical Regionalisation of Australia
NPW Act	National Parks and Wildlife Act 1972
NRM Act	Natural Resources Management Act 2004
NV Act	Native Vegetation Act 1991
NVC	Native Vegetation Council
SEB	Significant Environmental Benefit
spp.	species (plural)

EXECUTIVE SUMMARY

EBS Ecology was contracted by Parsons Brinkerhoff on behalf of Lincoln Minerals to conduct a flora and fauna survey and a targeted spring orchid survey for the site located at Kookaburra Gully, South Australia. The results of the assessment will inform ecological based procedures related to the potential development of a graphite mine within the site. Further advice was also sought regarding the significance of vegetation growing in association with a number of small creeklines within the site and 'ephemeral springs' in an adjacent property which could not be physically accessed. This advice has been included as an addendum to the report.

Objectives:

- Identify any flora species/communities of national and state conservation significance.
- Identify fauna species of national, state or local conservation significance known or likely to occur in the area and details on possible impacts.
- Determination of areas of high conservation / habitat value which may require specific management or avoidance.
- Species of national, state or local conservation significance known or likely to occur in the area and details on possible impacts
- Undertake mapping of the site's vegetation communities (dominant species and structure) and their condition.
- Identify weed infestations and species of environmental significance.
- Collect vegetation association and land condition data that can be used to inform Significant Environmental Benefit (SEB) calculations and submitted to the Native Vegetation Council if required.
- Highlight potential impacts associated with the proposed project.

Seven baseline flora sites were surveyed across the project area as well as vegetation association and condition mapping where access allowed. Seven bird survey sites were surveyed, with active searching and spotlighting also conducted and all opportune fauna recorded across the project area.

The Protected Matters Search identified 15 nationally threatened flora and fauna species and nine migratory species and protected areas under the EPBC Act that may be relevant to the project area (Table 5.) (DSEWPaC 2013). Two nationally Threatened Ecological Communities (TEC's) could potentially occur in the area. Nine migratory and nine marine species were highlighted in the report. Fifty-four state rated flora and fauna species have the potential to occur within the project area according to the BDBSA search.

Results of the mapping and baseline surveys show the following key findings;

- There are a number of different vegetation communities present within the study area, mostly fragmented which contain a moderate level of species diversity dependent on grazing disturbance;
- Threatened species are common within these communities in general;
- Declared weeds are widespread throughout the project area;
- *Eucalyptus cladocalyx* Woodlands and *Eucalyptus petiolaris* Woodlands in particular, provide high habitat values for a range of species.

Six flora species of conservation significance were observed in close proximity to the proposed mining site. Two of these, *Pultenaea trichophylla* (Tufted Bush Pea) and *Olearia pannosa* subsp*. pannosa* (Silver Daisy Bush) are rated at state and national level while four species, *Acacia imbricata* (Feathery Wattle), *Daviesia pectinata* (Zig-zag Bitter Pea), *Eucalyptus calycogona* ssp*. spaffordii* (Spafford's Square-fruit Mallee) and *Eremophila gibbifolia* (Coccid Emu Bush) are state listed. The timing of the initial survey was not ideal for annual species such as orchids, and therefore a targeted survey was undertaken in spring 2014. No nationally threatened orchid species were found during this survey.

The nationally listed TEC Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland (effective from August 2013) was recorded within the project area. A small patch of the Threatened Ecological Community was mapped along the creekline bordering the Harris and Cullen properties and met the key diagnostic characteristics and condition thresholds for the ecological community. Eyre Peninsula Blue Gum Woodlands occur within the roadside corridor to the north and south of the project area along potential access routes and along the Pillaworta Creek south of the property. A broad assessment was undertaken along the Pillaworta Creek to ascertain whether this community meets the criteria outlined under the Commonwealth Conservation Advice (B - High Quality). Two waterholes along the Pillaworta Creek were also assessed (both qualified as C1 - Medium Quality). No Critically Endangered Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia was detected in the survey area.

Overall, 68 fauna species with 698 individuals were recorded across the project area. 657 birds were observed within 58 species, 15 reptile observations within four species and 25 mammals observed within six species were recorded. No Amphibians were recorded during the survey.

No nationally threatened fauna species were recorded on the December 2013 survey; however four state threatened bird species were recorded within the project area. One state vulnerable bird species (Diamond Firetail (*Stagonopleura guttata*)) and three state rare species were observed within the project area (White-winged Chough (*Corcorax melanorhamphos*), Western Gerygone (*Gerygone fusca*) and the Shy Heathwren (*Calamanthus cautus*).

Key recommendations for this project include:

- Due to the Matters of National Environmental Significance within the proposed development area, a referral under the EPBC Act will be required for the project. Extensive consultation with DSEWPaC will also be necessary.

Table of Contents

1 INTRODUCTION 1

1.1 Objectives 1

1.2 Project area 2

2 COMPLIANCE AND LEGISLATIVE SUMMARY 4

2.1 Environment Protection and Biodiversity Conservation Act 1999 4

2.2 Native Vegetation Act 1991 5

2.3 National Parks and Wildlife Act 1972 6

2.4 Natural Resources Management Act 2004 6

3 BACKGROUND INFORMATION 8

3.1 Project details 8

3.2 Environmental setting 8

3.2.1 IBRA 9

3.2.2 Administrative boundaries 10

3.2.3 Previous surveys conducted 10

4 METHODS 11

4.1 Desktop assessment 11

4.1.1 Database searches 11

4.2 Field survey 12

4.2.1 Vegetation associations and condition 12

4.2.2 Flora 12

4.2.3 Scattered Trees 13

4.2.4 Fauna 13

4.3 Limitations 17

5 RESULTS 20

5.1 Desktop assessment 20

5.1.1 Matters of national environmental significance 20

5.1.2 Threatened ecological communities 21

5.1.3 Threatened flora 24

5.1.4 Threatened fauna 26

5.1.5 Wetland of international significance (RAMSAR) 27

5.2 Field survey 30

5.3 Vegetation communities 30

5.3.1 Association 1- Exotic dominated 44

5.3.2 Association 2 - Eucalyptus cladocalyx (Sugar Gum) Woodland 44
5.3.3 Association 3 – Eucalyptus cladocalyx +/- Eucalyptus calycogona ssp. spaffordii Woodland 45
5.3.4 Association 4 – Eucalyptus cladocalyx +/- Eucalyptus calycogona ssp. spaffordii +/- Eucalyptus peninsularis Woodland 46
5.3.5 Association 5 - Melaleuca uncinata shrubland 47
5.3.6 Association 6 - Eucalyptus peninsularis low woodland 48
5.3.7 Association 7 - Xanthorrhoea semiplana ssp. +/- Allocasuarina verticillata Grassland 48
5.3.8 Association 8 - Allocasuarina verticillata +/- emergent Acacia pycnantha Low Open Forest 49
5.3.9 Association 9 - Eucalyptus spp. Mixed Mallee 50
5.3.10 Association 10 - Eucalyptus spp. +/- Callistemon rugulosa Mallee 51
5.3.11 Association 11 - Eucalyptus petiolaris Woodlands +/- Allocasuarina verticillata +/- Acacia pycnantha 52
5.3.12 Association 12 - Eucalyptus petiolaris Woodland over Acacia pycnantha and Acacia rupicola 54
5.3.13 Association 13 - Acacia pycnantha / Acacia imbricata Shrubland 55
5.3.14 Association 14 - Gahnia filum Sedgeland 56
5.3.15 Association 15 – Gahnia filum / Juncus kraussii Sedgeland 57
5.3.16 Association 16, 17, 18 and 19 – Juncus kraussii Sedgeland 58
5.3.17 Association 20 – Cyperus gymnocaulos / Juncus kraussii Sedgeland 60
5.3.18 Association 21 – Acacia imbricata / Lissanthe strigosa / Acacia rupicola open shrubland+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona ssp. spaffordii 60
5.3.19 Association 22 – Acacia pycnantha +/- Allocasuarina verticillata Low Open Forest 61
5.3.20 Association 23 – Eucalyptus petiolaris Woodland 62
5.3.21 Scattered Trees 65
5.4 Targeted vegetation structures 68
5.5 Threatened flora surveys 68
5.6 Fauna 72
5.6.1 Birds 72
5.6.2 Bats 78
5.6.3 Active searching / Opportune 78
5.6.4 Spotlighting 78
5.7 Fauna Habitat 78

6 DISCUSSION 80

6.1 General flora observations 80
6.1.1 Weed species and soil pathogen management 81
6.2 Matters of national significance 81
6.2.1 Threatened Ecological Communities 81

6.2.2 Nationally threatened flora 83
6.3 FAUNA 84
Diamond Firetail (Stagonopleura guttata) State Vulnerable 84
White-winged Choughs (Corcorax melanorhamphos) State Rare 85
6.4 Potential impact of the mine on flora and fauna 85

7 RECOMMENDATIONS 86
7.1 Legislative approvals 86
7.2 General recommendations 86

8 REFERENCES 87

9 APPENDICES 89

10 ADDENDUM 106

List of Tables

Table 1. IBRA bioregion, subregion, and environmental association environmental landscape summary 9
Table 2. Assessment of the likelihood of each threatened species occurring. 12
Table 3. Condition thresholds for the Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland 16
Table 4. Assessment criteria for the condition of vegetation communities. 19
Table 5. EPBC Matters of national significance 20
Table 6. Condition thresholds results for the Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland 23
Table 7. Threatened flora species potentially occurring within the project area. 24
Table 8. Threatened fauna species potentially occurring within the project area. 26
Table 9. Weather during the field survey 3-5 December 2013 30
Table 10. Overall summary of vegetation associations. 30
Table 11. Overall summary of vegetation associations undertaken by Bebbington in 2015 32
Table 11. Summary of vegetation association 2. *Eucalyptus cladocalyx* Woodland. 44
Table 12. Summary of vegetation association 3. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* Woodland 45
Table 13. Summary of vegetation association 4. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland. 46
Table 14. Summary of vegetation association 5. *Melaleuca uncinata* +/- *Allocasuarina verticillata* Shrubland 47
Table 15. Summary of vegetation association 6 *Eucalyptus peninsularis* Low Woodland. 48

Table 16. Summary of vegetation association 7. *Xanthorrhoea semiplana* ssp. +/- *Allocasuarina verticillata* Grassland. 48
Table 17. Summary of vegetation association 8. *Allocasuarina verticillata* + emergent *Acacia pycnantha* Low Open Forest....49
Table 18. Summary of vegetation association 9 *Eucalyptus* spp. Mixed Mallee....50
Table 19. Summary of vegetation association 10 *Eucalyptus* spp. +/- *Callistemon rugulosus* Mallee. 51
Table 20. Summary of vegetation association 11 *Eucalyptus petiolaris* +/- *Allocasuarina verticillata*. 52
Table 21. Summary of vegetation association 12 *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola* 54
Table 22. Summary of vegetation association 13 Acacia pycnantha / Acacia imbricata *Shrubland* 55
Table 23.Summary of vegetation association 14 Gahnia filum Sedgeland 56
Table 24. Summary of vegetation association 15 *Gahnia filum / Juncus kraussii* Sedgeland....57
Table 25. Summary of vegetation association 16, 17, 18 and 19 *Gahnia filum* Sedgeland 58
Table 26. Summary of vegetation association Cypress gymnocaulos / Juncus kraussii Sedgeland....60
Table 27. Summary of vegetation association *Acacia imbricata / Lissanthe strigosa / Acacia rupicola open shrubland+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii* 60
Table 28. Summary of vegetation association 22, *Acacia imbricata / Lissanthe strigosa / Acacia rupicola open shrubland+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii* 61
Table 29. Summary of vegetation association 23, *Eucalyptus petiolaris* Woodland 62
Table 30. Summary of vegetation association 23, *Eucalyptus petiolaris* Woodland at Waterhole1....64
Table 31. Summary of vegetation association 23, *Eucalyptus petiolaris* Woodland at Waterhole2....64
Table 32. Species list for Waterholes 1 and 2 along the Pillaworta Creek Waterhole2....65
Table 33. Scattered Tree details....66
Table 34. Baseline quadrat summary. 68
Table 35. Threatened species recorded in baseline plots. 69
Table 36. All fauna observations recorded in the project area....74

List of Figures

Figure 1. Kookaburra Gully proposed Mine location....3
Figure 2. Climate data from Tod River (closed) weather station. 8
Figure 3. Example of AnaBat set-up in the Kookaburra Gully project area. 14
Figure 4. Vegetation/ bird and bat sites in the project area....18
Figure 5. Threatened Flora Records (EPBC and BDBSA) 28
Figure 6. Threatened Fauna records (BDBSA) 29

Figure 7. Vegetation Association mapping within the project area.....34
Figure 8. Vegetation Association mapping within project area. (Focussing on proposed pit area).....35
Figure 9. Vegetation Association mapping within project area. (Focussing on proposed waste rock storage facility). 36
Figure 10. Vegetation Association mapping within project area. (Focussing on proposed southern areas). 37
Figure 11. Vegetation Association mapping within project area. (Focussing on creek areas).....38
Figure 12. L. Bebbington vegetation mapping on Borthwick property (Bebbington, 2015).....39
Figure 13. L Condition (SEB) mapping within Cullen Creek area. 40
Figure 14. Vegetation Condition (SEB) mapping within Harris-Cullen Creek area. 41
Figure 15. Vegetation Condition (SEB) mapping within southern area of property.....42
Figure 16. Vegetation Condition (SEB) mapping (Focussing on Pillaworta creek areas).....43
Figure 17. *Eucalyptus cladocalyx* (Sugar Gum) Woodland.....44
Figure 18. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* Woodland on Harris property. 45
Figure 19. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland on Harris property. 46
Figure 20. *Melaleuca uncinata* shrubland with diverse understorey.....47
Figure 21. Hill crest with dominant *Xanthorrhoea semiplana ssp.* grassland.....49
Figure 22. Roadside reserve with dominant regrowth of *Allocasuarina* and *Acacia pycnantha*. 50
Figure 23. *Eucalyptus leptophylla* +/- *Eucalyptus phenax* Low Mallee.....51
Figure 24. *Eucalyptus petiolaris* open woodland with high density of exotic grass. 53
Figure 25. *Senecio pterophorus* (African daisy) high cover in *E. leucoxylon* ssp. *petiolaris* Woodland 53
Figure 26. *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*.....54
Figure 27. *Acacia pycnantha* / *Acacia imbricata* shrubland. 55
Figure 28. *Gahnia filum* Sedgeland 56
Figure 29. *Gahnia filum* / *Juncus kraussii* Sedgeland along the creekline between Cullen and Harris properties 57
Figure 30. *Juncus kraussii* Sedgeland with scattered *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) along the Pillaworta Creek.....58
Figure 31. *Juncus kraussii* Sedgeland along the Pillaworta Creek.....59
Figure 32. *Juncus kraussii* Sedgeland along the creekline on Cullen property.....59
Figure 33. Typical view of Association 21. 61
Figure 34. Typical view of Association 22. 62
Figure 30. Typical view of Association 23, Pillaworta Creek. 63
Figure 36. Waterhole 1.....63
Figure 37. Waterhole 2.....64
Figure 38. Scattered Tree locations.....67
Figure 39. *Olearia pannosa* ssp. *pannosa* (Silver Daisy Bush). 69

Figure 40. *Pultenaea trichophylla* (Tufted Bush Pea). 70
Figure 41. Threatened flora observations within the project area. 71
Figure 42. Diamond Firetail (*Stagonopleura guttata*) 72
Figure 43. Threatened Fauna observations within the Kookaburra Gully project area. 73

1 INTRODUCTION

EBS Ecology was contracted by Parsons Brinkerhoff on behalf of Lincoln Minerals to conduct a flora and fauna survey and targeted threatened species survey for the site located at Kookaburra Gully, South Australia. The results of the assessments will inform ecological based procedures related to the potential development of a graphite mine within the site.

1.1 Objectives

- Identify any flora species/communities of national and state conservation significance.
- Identify fauna species of national, state or local conservation significance known or likely to occur in the area and details on possible impacts.
- Determination of areas of high conservation / habitat value which may require specific management or avoidance.
- Undertake mapping of the site's vegetation communities (dominant species and structure) and their condition.
- Identify weed infestations and species of environmental significance.
- Collect vegetation association and land condition data that can be used to inform Significant Environmental Benefit (SEB) calculations and submitted to the Native Vegetation Council if required.
- Highlight potential impacts associated with the proposed project.

1.2 Project area

The Kookaburra Gully project area is located on Eyre Peninsula, South Australia, approximately 20 km west to south-west of Tumby Bay and 35 km north of Port Lincoln (Figure 1). The current land use in this area is primarily cereal cropping supplemented by stock grazing. Large areas have been subsequently cleared, however due to the undulating landscape; patches of remnant native vegetation occur where shallow soils and steep terrain are present and provide unsuitable land for cropping. In Kookaburra Gully this largely comprises *Eucalyptus cladocalyx* (Sugar Gum) Woodlands with *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) over Sedgelands communities dominating the creeks and drainage lines.

The area has been identified as a Threatened Habitat Area (DEH 2002). Five Threatened Habitat Areas across the Eyre Peninsula were identified based on a number of factors including regionally threatened ecosystems, low remnancy and highly fragmented and isolated vegetation blocks, low representation within the reserve system and large numbers of threatened species, many at a national level (DEH 2002).

Figure 1. Kookaburra Gully proposed Mine location

2 COMPLIANCE AND LEGISLATIVE SUMMARY

2.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places – defined in the Act as 'matters of national environmental significance'. The eight matters of national environmental significance protected under the Act are:

- World Heritage properties
- National Heritage places
- wetlands of international importance (listed under the Ramsar Convention)
- listed threatened species and ecological communities
- migratory species protected under international agreements
- Commonwealth marine areas
- the Great Barrier Reef Marine Park
- nuclear actions (including uranium mines)
- a water resource, in relation to coal seam gas development and large coal mining development

Any action that has, will have, or is likely to have a significant impact on matters of national environmental significance requires referral under the EPBC Act. Substantial penalties apply for undertaking an action that has, will have or is likely to have significant impact on a matter of national environmental significance without approval.

The EPBC Act Significant Impact Guidelines provide overarching guidance on determining whether an action is likely to have a significant impact on a matter of national environmental significance. In terms of nationally threatened species, the guidelines define an action as likely to have a significant impact if there is a real chance or possibility that it will:

- lead to a long term decrease in the population
- reduce the area of occupancy of the species
- fragment an existing population
- adversely affect critical habitat
- disrupt breeding cycles
- modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
- result in the establishment of invasive species that are harmful to the species
- introduce disease that may cause the species to decline
- interfere with the recovery of the species.

2.2 Native Vegetation Act 1991

All native vegetation in South Australia is protected under the provisions of the *Native Vegetation Act 1991*. Clearance of vegetation is prohibited unless approved by the Native Vegetation Council (NVC) or the activity requiring the clearance is exempt by the regulations under the Act. In most circumstances, including exemptions, approval to clear vegetation is contingent upon the proponent providing a management plan that creates a Significant Environmental Benefit (SEB) (set aside of land for the management of native vegetation that results in a net gain for the environment).

If areas of native vegetation are to be restored or managed a Native Vegetation Management Plan (NVMP) is required. The plan must describe the benefits of the proposal and the activities that will be implemented to achieve the SEB and include details on the existing condition of the vegetation, the management actions, the timing of actions and any monitoring requirements.

The project site is situated in the District Council of Tumby Bay which is subject to the *Native Vegetation Act 1991* and *Regulations 2003*. An assessment against the Native Vegetation Clearance Principles is not required as the clearance is considered to comply with *Exemption 5 (1)(zd) Mining Activities (Operations).* However, for this exemption to apply, the criteria within the regulation (detailed below) must be satisfied.

Regulation
5(1)(zd) Mining Activities (Operations)
Pursuant to Section 27(1)(b) of the Act, native vegetation may, subject to any other Act or law to the contrary, be cleared if—

(i) the clearance is incidental to operations authorised under the Mining Act 1971 *or the* Petroleum Act 2000; *and*

(ii) —

(A) in the case of operations authorised under the Mining Act 1971, the clearance is undertaken in accordance with a management plan under that Act and the Council has signified that, as a result of work undertaken in accordance with that plan, there will be a significant environmental benefit on the site of the operations or within the same region of the State, or the person undertaking the operations has, on application to the Council to proceed with clearing the vegetation in accordance with this provision, made a payment into the Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit in the manner contemplated by section 21(6) of the Act; and

(B) in the case of operations authorised under the Petroleum Act 2000, the clearance is undertaken in accordance with a statement of environmental objectives under that Act and the Council has signified that, as a result of work undertaken in accordance with that statement, there will be a significant environmental benefit at the site of the operations or within the same region of the State, or the person undertaking the operations has, on application to the Council to proceed with clearing the vegetation in accordance with this provision, made a payment into the Fund of an amount considered by the Council to be sufficient to achieve a significant environmental benefit in the manner contemplated by section 21(6) of the Act.

2.3 National Parks and Wildlife Act 1972

The South Australian *National Parks and Wildlife Act 1972* covers the protection of native plants within reserves and native animals throughout the State. Threatened plant and animal species are listed in Schedules 7 (endangered species), 8 (vulnerable species) and 9 (rare species). Persons must not:

- take a native plant on a reserve, wilderness protection area, wilderness protection zone, land reserved for public purposes, a forest reserve or any other Crown land.
- take a native plant of a prescribed species on private land.
- take a native plant on private land without the consent of the owner (such plants may also be covered by the *Native Vegetation Act 1991*).
- take a protected animal or the eggs of a protected animal without approval.
- keep protected animals unless authorised to do so.
- use poison to kill a protected animal without approval.

Persons must comply with the conditions imposed upon permits and approvals.

2.4 Natural Resources Management Act 2004

To promote and facilitate integrated and sustainable management of all natural resources (water, soil, biodiversity etc); and to provide for arrangements to involve the community in the development and implementation of regional initiatives to improve the management of the natural resources.

Key components include the establishment of regional Natural Resource Management (NRM) Boards and development of regional NRM Plans; the ability to control water use through prescription, allocations and restrictions; requirement to control pest plants and animals, and activities that might result in land degradation.

A 'duty of care' is a fundamental component of this Act, i.e. ensuring one's environmental and civil obligation by taking reasonable steps to prevent land and water degradation. Persons can be prosecuted if they are considered negligent in meeting their obligations.

Section 188(5) of the Act requires that the NRM Board must take into account any relevant provision of the regional NRM plan.

The NRM Board may appoint authorised officers to administer and enforce the Act. Authorised officers possess powers of entry, powers to give directions, powers to collect evidence and seize and remove animals and plants. An authorised officer may issue a protection order for the purpose of securing compliance with specified provisions of the Act:

- breach of the general statutory duty;
- breach of the duty not to damage watercourses or lakes;
- failure to take action to destroy or control certain animals or plants;

- failure to comply with the terms of a management agreement entered into under the Act;
- and any other requirement imposed by the NRM Act or a repealed Act and which has been specified in the NRM Regulations.

An owner of land who is, or is likely to be, in breach of the general statutory duty under the Act resulting or likely to result in land degradation may be required to prepare an action plan. Failure to comply with a notice requiring preparation of an action plan is an offence. An NRM authority or a State authorised officer may issue a reparation order in certain circumstances where a person has caused harm to a natural resource and repair is necessary. Enforcement action in the ERD Court can be taken if necessary.

Note: this summary is not intended to be a substitute for particular legal advice and does not address the legal implications of every set of circumstances.

3 BACKGROUND INFORMATION

3.1 Project details

Lincoln Minerals (on behalf of Australian Graphite Limited) intends to mine Graphite at the Kookaburra Gully site. All material will be processed onsite which requires areas for tailings and waste rock storage.

3.2 Environmental setting

The climate present onsite is that typical of a Mediterranean zone with most rainfall occurring in the winter months. This level of rainfall would be expected to cause moderate levels of run-off into the wider area. This site forms part of the Tod River catchment.

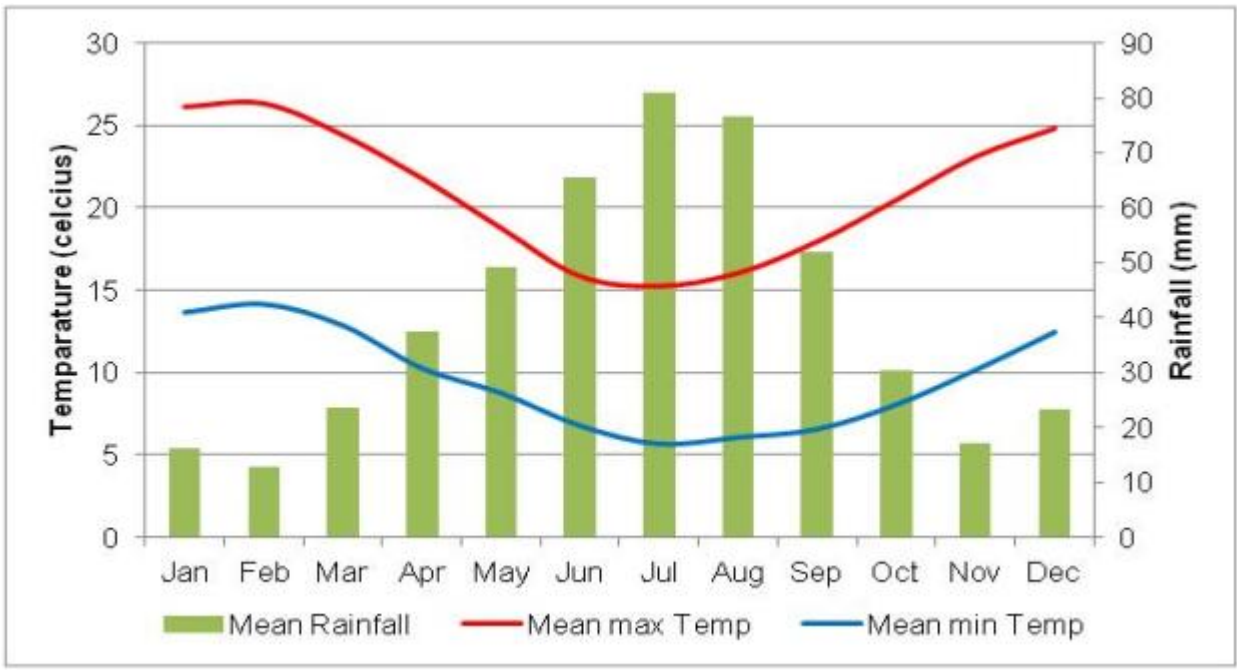

Figure 2. Climate data from Tod River (closed) weather station.

The project area was widely burnt during the Wangary fires in January 2005. This fire burnt more than 78,000 hectares of land including a large part of the Koppio area. As a result the vegetation communities are still in a state of transition following major regrowth of *Acacia* and other fire responsive species. Many areas containing Sugar Gum Woodlands have not regenerated to pre-burn levels.

3.2.1 IBRA

Interim Biogeographic Regionalisation for Australia (IBRA) represents a landscape based approach to classifying the land surface of South Australia. Bioregions describe the larger scale regional classification of homogenous ecosystems. Subregions provide a more localized and finer scale classification of ecosystems within the bioregion boundaries. Environmental associations reflect a unifying set of major environmental influences (such as geology, landform patterns, climate & ecological features) which shape the occurrence of flora and fauna associations and their interaction with the physical environment at a more localised scale (DEWNR 2013).

Kookaburra Gully is situated within the Eyre Yorke Block IBRA bioregion, the Eyre Hills subregion and the Yallunda environmental association (Table 1). The Yallunda environmental association contains one of the highest proportions of remnant vegetation cover within the Eyre Hills subregion, with 20% remnant vegetation cover (Brandle 2010).

Table 1. IBRA bioregion, subregion, and environmental association environmental landscape summary

Eyre Yorke Block IBRA bioregion	
Archaean basement rocks and Proterozoic sandstones overlain by undulating to occasionally hilly calcarenite and calcrete plains and areas of aeolian quartz sands, with mallee woodlands, shrublands and heaths on calcareous earths, duplex soils and calcareous to shallow sands, now largely cleared for agriculture.	
Eyre Hills IBRA subregion	
This subregion consists of the southern section of the uplands along the east coast of the Eyre Peninsula, and the undulating to low hilly plains to the west. The uplands rise abruptly from a narrow coastal foreland to altitudes of between 200m and 400m then slope gradually to the west where they merge into the undulating plain. The eastern and highest section of the uplands is formed of metasediments, predominantly quartzite, and is mainly hilly while the slightly lower-lying western part constitutes a dissected laterite plateau. Moderately deep yellow duplex soils with lateritic concretions occur on the uplands and support low open woodland of Eucalyptus cladocalyx, E. odorata and E. leucoxylon. The plains to the south and west are formed predominantly on old alluvium, or on calcarenite near the coastal fringe where some dunes and cliffs occur. Shallow reddish loams with rock outcrops support E. incrassata / Melaleuca uncinata mallee on the plains or Melaleuca lanceolata woodland along the coastal fringe. Lincoln National Park occupies the south eastern tip of the subregion and consists of 15 971ha of coastal mallee. The majority of this subregion is cleared for winter cereal cultivation and grazing livestock.	
Remnant vegetation	Approximately 30% (350795 ha) of the subregion is mapped as remnant native vegetation, of which 36% (124693ha) is formally conserved
Landform	Low limestone dune ridges: small granitic islands with dunes.
Geology	Ripon Calcrete; Loveday Soil in aeolian sand sheets, dune sand, red soils (terra rossa).
Soil	Sands soils of minimal pedologic development, brown calcareous earths, brown sand soils, shallow red brown sandy soils, sandy soils with yellow clayey mottled subsoil.
Vegetation	E2: "Mediterranean" climate, but with drier cooler winters and less growth than E1.
Conservation significance	34 species of threatened fauna, 88 species of threatened flora. 4 wetlands of national significance.
Yallunda IBRA environmental association	
Remnant vegetation	Approximately 20% (21661 ha) of the association is mapped as remnant native vegetation, of which 9% (1984ha) is formally conserved
Landform	Low hills derived from the dissection of a former lateritic plateau.
Geology	Laterite and alluvium.
Soil	Hard pedal mottled-yellow duplex soils and grey calcareous loams.
Vegetation	E1: Classic, "Mediterranean" climate with peaks of growth in autumn and spring and moderate growth in winter.
Conservation significance	5 species of threatened fauna, 23 species of threatened flora. 1 wetlands of national significance.

3.2.2 Administrative boundaries

Kookaburra Gully is under the jurisdiction of the District Council of Tumby Bay. It is located within County Flinders and the Hundred of Koppio. The Eyre Peninsula Natural Resources Management Board (NRM Board) is responsible for managing the region's natural resources (EPNRMB 2010).

3.2.3 Previous surveys conducted

The South Australian Department for Environment and Heritage has previously conducted a biological survey within this region. 'The Biological Survey of Eyre Peninsula South Australia' reports on the results of 22 surveys conducted within the region from 1978-2008. This survey includes a range of information on flora and fauna species, vegetation communities, habitat etc (Brandle 2010).

EBS Ecology has previously undertaken recent fauna and flora surveys and threatened species assessments within close proximity to Kookaburra Gully. An additional survey was also undertaken on the 7 May 2015.

Donato Environmental Services undertook a baseline flora and fauna study and an associated risk assessment in preparation for a potential open-cut mining development for the Fusion (Koppio) Project, Eyre Peninsula (2012) located approximately 15 km west of Tumby Bay in the Koppio Hills.

4 METHODS

4.1 Desktop assessment

4.1.1 Database searches

The online Protected Matters Search Tool was used to determine matters of national environmental significance within a 10 km buffer area in December 2013, under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) that may occur within the project area.

A Biological Database of South Australian (BDBSA) search was obtained from DENR in November 2013, to identify flora and fauna species previously recorded within a 10 km buffer around the project area (DENR 2011a). The BDBSA is comprised of an integrated collection of corporate databases which meet DENR standards for data quality, integrity and maintenance. In addition to DENR biological data the BDBSA also includes data from partner organisations (Birds Australia, Birds SA, Australasian Wader Study Group, SA Museum, and other State Government Agencies). This data is included under agreement with the partner organisation for ease of distribution, but they remain owners of the data and should be contacted directly for further information.

An assessment of the likelihood (Table 2) of each threatened species occurring was undertaken. A likelihood of occurrence rating was assigned to each threatened species identified in the Protected Matters Search and BDBSA database searches. This rating, 'Highly Likely', 'Likely', 'Possible' and 'Unlikely' takes the following criteria into consideration:

- date of the most recent record (taking into consideration the date of the last surveys conducted in the area)
- proximity of the records (distance to the project area)
- landscape location of the records, vegetation remnancy and vegetation type of the record location (taking into consideration the landscape, remnancy and vegetation type of the project area, with higher likelihood assigned to species that were found in similar locations/condition/vegetation associations)
- knowledge of the species habitat preferences, causes of its decline, and local population trends.

Table 2. Assessment of the likelihood of each threatened species occurring.

Likelihood category	Criteria
Unlikely	No BDBSA records despite survey effort considered adequate, or No BDBSA records and survey effort is considered not adequate, and no suitable habitat is known to occur in the area, or No BDBSA records and survey effort is not considered adequate, and no suitable is known to occur in the area, and species of similar habitat needs have no records either.
Possible	No BDBSA records, survey effort is considered not adequate, suitable habitat does occur (or isn't known if it does occur) and species of similar habitat needs have been recorded in the area, or BDBSA records within the last 40 years, and the area is not largely intact, or BDBSA records in the last 10 years, the species does not have highly specific needs, and habitat is largely intact.
Likely	BDBSA records in the last 10 years, the species does not have highly specific habitat needs and the habitat is largely intact, or BDBSA records in the last 10 years, the species does have highly specific habitat needs and these needs occur in the area.
Highly likely	BDBSA records in the last 10 years, the species does not have highly specific needs, and the habitat is largely intact.

4.2 Field survey

4.2.1 Vegetation associations and condition

The vegetation associations and vegetation condition were mapped across the project site where accessible. A flora species list was compiled for each of the associations and weeds were recorded where observed. Data was recorded to the required standards under the *Native Vegetation Act 1991*.

In addition to established sites, flora species were recorded across each vegetation community with a particular focus on threatened species. Each vegetation community was traversed on foot to record individual species, known as a ramble survey. Each vegetation community was assigned an SEB condition rating. The SEB condition scores are based on assessment criteria for the condition of vegetation communities in Table 4.

4.2.2 Flora

Seven baseline flora surveys sites were conducted across the project area, sites one to seven (Figure 4). Each flora site consisted of:

- 30 x 30 metre quadrat sampling for species diversity (both annual and perennial species) and broad-scale species cover abundance.

The 30 x 30 metre quadrats are a modified approach of the South Australian Biological Survey Method (used by the Department of Environment, Water and Natural Resources) as a standard, repeatable method. The presence of all vascular plant species is recorded (vouchers are taken for later identification when necessary) with one or two surveyors scanning the entire area until the species list is exhausted.

For each flora species (both annuals and perennials), the average cover abundance for the site is recorded using the modified Cover/Abundance Scale adapted from Braun-Blanquet (1965).

Sites were selected to represent the different vegetation associations within the project area. Through discussions with the client, the majority of the sites were focussed around the proposed mine and associated infrastructure areas. Potential access roads were also assessed to record vegetation associations and condition.

4.2.3 Scattered Trees

Individual trees were identified to species level, photographed and marked with a GPS coordinate. Detailed tree assessments were undertaken to satisfy the requirements under the *Native Vegetation Act, 1991*. The current NVC endorsed scoring system for scattered trees was utilised to determine the wildlife habitat value of individual trees to meet the requirements of Principles of Clearance 1(b) *Wildlife Habitat*.

Data was collected to reflect a number of key attributes of each of the trees to be potentially impacted:

- species;
- height;
- canopy health (also known as percentage dieback);
- proximity to other areas of intact native vegetation (>1ha);
- number and size of hollows;
- density and
- habitat potential for threatened fauna species.

The data is then entered into the NVC's Point Scoring System (PSS) to calculate a wildlife habitat value for each tree and determine the Significant Environmental Benefit (SEB) contribution.

4.2.4 Fauna

The survey consisted of targeted survey effort for birds and bats and active searching for reptiles and mammals. This approach is based on the known threatened species in the area and the most appropriate methods to target those species. Sites were selected to represent the variation in habitat within the project area. Following discussions with the client the majority of the sites were focussed around the proposed mine and associated infrastructure areas. Potential access roads were also assessed for fauna species.

Bird

Bird surveys were undertaken across the project area within seven established sites one to four and sites six to eight (Figure 4), with each site surveyed for half an hour in the morning (before 11 am) and afternoon (after 3 pm) using a point-count technique. The surveyor records all birds that can be positively identified by sight on the grid or within 100 m of the grid in similar habitat of the site. Call play-backs were

incorporated where it was deemed appropriate. In addition, targeted bird sites were also surveyed to focus on key habitats for threatened bird species known to occur within the area.

Bat

Bat surveys were undertaken at two sites (Figure 4) utilising AnaBat detectors (recording device which records bat ultrasonic echolocation calls) (Figure 3). AnaBat recordings were analysed by viewing the unique pulse rates and frequency characteristics to identify the calls to species level where possible or species complex.

Figure 3. Example of AnaBat set-up in the Kookaburra Gully project area.

Spotlighting

Spotlight surveys were conducted within targeted key habitat areas, focusing on maximizing the types of habitats surveyed. Spotlighting was undertaken via vehicle in open areas and on foot in woodland areas.

Active Searching/ Opportune sightings

A common technique for capturing amphibian, reptilian and some mammalian species is by active search and hand-capture. This involved a search for the sites that animals roost or shelter in and their removal from under logs or rocks, behind loose bark, in old bird nests, or in holes and burrows. Searches were conducted across the project area. In addition, all fauna observed opportunistically within the project area were noted and a GPS location obtained.

Targeted threatened species survey – spring 2014

All areas of vegetation previously surveyed, including those additional areas subject to the latest changes to the project layout plan, were traversed during the spring to detect the presence of threatened annual species such as orchids. Additional records of other threatened species were also recorded and included in the dataset.

Threatened Ecological Communities

The field survey involved undertaking the following steps to determine the presence of the nationally threatened ecological community, Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland:

Step 1

Using the *Key Diagnostic Characteristics,* to determine whether the community qualifies as Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland.

The key diagnostic characteristics are:

1. Distribution occurs within the Eyre York Block bioregion – in the Eyre Hills subregion EYB03 with outliers possibly occurring within the Talia subregion EYB04 (IBRA Version 7) of the Eyre Peninsula.
2. Vegetation structure is typically woodland to open forest.
3. The upper layer is dominated or co-dominated by *Eucalyptus petiolaris* (Blue Gum) and the tree canopy cover is 10% or more.
4. The mid layer varies from open to dense in response to soil moisture and disturbance and/or management history and consists of native sclerophyllous shrubs and small trees.
5. The ground layer is variable in development and composition, ranging from sparse to a thick layer of native grasses and other herbs. Ground layer flora typically is dominated by one or more of the graminoid genera: *Austrostipa*, *Carex*, *Chorizandra*, *Gahnia*, *Juncus*, *Lepidosperma, Lomandra* and *Rytidosperma*; but also often contains other herbs and small shrubs.
6. The ecological community is mainly restricted to well-drained, moderate to high fertility soils and is typically associated with sheltered valleys, lower hill slopes and watercourses in the higher rainfall districts of the Eyre Peninsula.

Step 2

Using the *Condition Thresholds* to determine whether the patch qualifies as a Nationally Threatened Ecological Community. See Table 3 for Condition Thresholds from EPBC Listing Advice.

The assessment process involved selection of a sampling site for the patch. According to the EPBC Listing Advice, “The area with the most apparent ‘richness’ of native species in the understorey should

be selected to determine estimates of native species richness and cover." The sampling quadrat should be at least 20m x 20m (400m²).

Table 3. Condition thresholds for the Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland

Category and rationale	Thresholds
A. Exceptional quality – larger patches with very high native species vegetation cover and very diverse understorey.	Patch size is ≥ 1ha; **AND** ≥70% of total vegetative cover[2] in the mid and ground layers are comprised of native species[3]; **AND** 18 or more native species from Appendix B, Table B1 are present in the mid and ground layers.
B. High quality – good native vegetation cover and good native species diversity in the understorey.	Patch size is ≥ 0.2 ha; **AND** ≥50% of total vegetative cover in the mid and ground layers are comprised of native species; **AND** 12 or more native species from Appendix B, Table B1 are present in the mid and ground layers.
C1. Medium quality – good native vegetation cover and diverse native species in the understorey.	Patch size is ≥ 0.2 ha; **AND** ≥50% of total vegetative cover in the mid and ground layers are comprised of native species; **AND** 4 or more native species from Appendix B, Table B1 are present in the mid and ground layers;
OR	
C2. Medium quality – patches with connectivity to other native vegetation remnants in the landscape.	Patch size is ≥ 0.2 ha; **AND** ≥30% of total vegetative cover in the mid and ground layers are comprised of native species; **AND** 4 or more native species from Appendix B, Table B1 are present in the mid and ground layers; **AND** The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥1ha in area.
OR	
C3. Medium quality – patches that have large mature trees or trees with hollows (habitat)	Patch size is ≥ 0.2 ha; **AND** ≥30% of total vegetative cover in the mid and ground layers are comprised of native species; **AND** 4 or more native species from Appendix B, Table B1 are present in the mid and ground layers; **AND** The patch has at least one tree with hollows or at least one large tree (≥80cm dbh[4]) from the upper layer species list in Table B1. Where patches are ≥1 ha, a density of at least one mature tree or tree with hollows per hectare is required.

[2] Vegetative cover excludes mosses and lichens, patches of bare ground, plant litter.

[3] Mid and ground layers exclude juvenile canopy species. This applies to categories A, B, C1, C2 and C3.

[4] dbh is diameter at breast height.

4.3 Limitations

Biological Database of SA (BDBSA) flora and fauna records were limited to a 10 km buffer around the survey area. The reliability of the BDBSA data ranges from 100 m to over 100 km. Fauna species, in particular birds, also have the ability to traverse distances in excess of 10 km. Hence the BDBSA records provided may not adequately highlight all threatened flora and fauna species that may occur in the area.

The findings and conclusions expressed by EBS Ecology are based solely upon information in existence at the time of the assessment. Field data collected during the December 2013 combined with database records and background research is considered to provide an adequately detailed assessment of the flora and fauna that occur and are likely to occur within the project area.

The use of AnaBat detectors provides a good measure of species presence and levels of bat activity, it does however have some limitations. Multiple calls from a single bat are indistinguishable from single calls from multiple bats (Law et. al., 1998). In addition, the calls from some species are difficult to distinguish and can only be identified to genus level. The unit's recording range varies with temperature and humidity, therefore the range being sampled is not equal across the night. Different species are active at different times during the night, this means that depending on weather conditions, not all species will be recorded equally (D. Matthews, pers. com.).

The entire project area was not surveyed in detail by EBS Ecology due to access issues. This includes the Borthwick property to the north, however it was surveyed by L. Bebbington in April 2015. Bebbington mapped the vegetation associations and reported on the overall condition of the remnant, however no SEB ratios were assigned in the report or associated map, or specific threatened flora location data accessible. Therefore no reliance on this information has been made from this report. Additional assessment will need to be undertaken when access is obtained, to provide a complete and consistent assessment of the native vegetation to the standard of the Native Vegetation Council.

Other areas were accessed from the roadside with use of mapping, including a section of the Pillaworta Creek. Adequate information was collected from this area to assist with assessment against EPBC criteria in the Commonwealth Listing Advice. The Cullen and Harris properties, where the potential mine area will be potentially located, was a primary focus for thorough assessment, with access roadside corridors mapped as well. Two waterholes associated with the Pillaworta Creek were also thoroughly surveyed.

Weather conditions on the initial three day survey period were not ideal for sampling bat calls, active searching and spotlighting due to the cool and windy conditions.

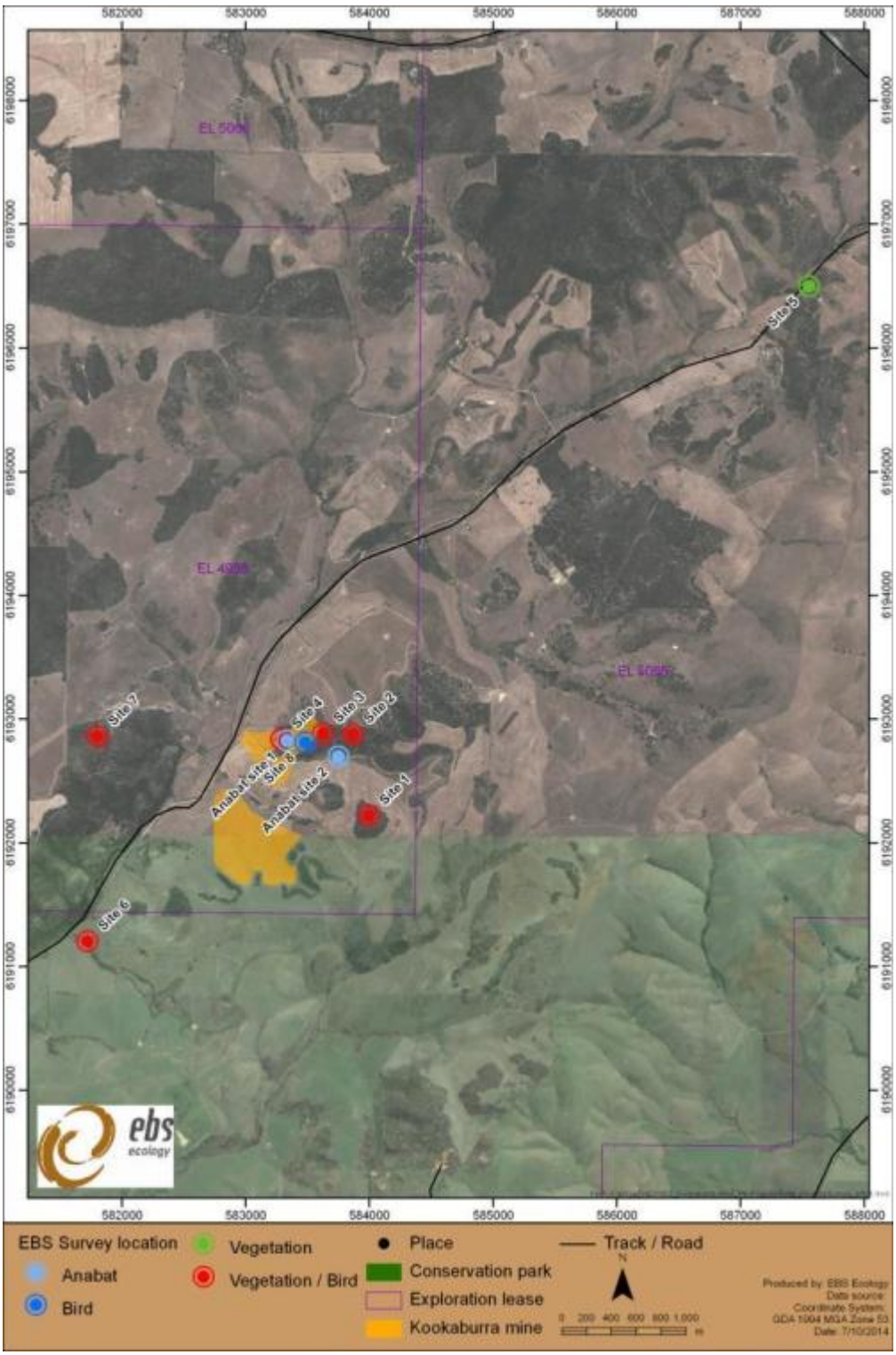

Figure 4. Vegetation/ bird and bat sites in the project area.

Table 4. Assessment criteria for the condition of vegetation communities.

Condition	SEB ratio	% indigenous cover	Overstorey condition description	Understorey condition description	Indicators	NVC Interim Policy (1.2.11)
Very Poor	**0:1**	<10%	No overstorey stratum remaining.	Complete destruction of indigenous understorey* (by grazing &/or introduced plants).	Vegetation structure no longer intact (e.g. removal of one or more vegetation strata). Scope for regeneration, but not to a state approaching good condition without intensive management. Dominated by very aggressive weeds. Partial or extensive clearing (> 50% of area). Evidence of heavy grazing (tracks, browse lines, species changes, complete depletion of soil surface crust).	Where proposed clearance is considered to be minor and of limited biodiversity impact, e.g. lopping of overhanging limbs only or minor clearance of shrubs in areas otherwise considered as highly disturbed.
	1:1	10-19%	Scattered trees in poor health and/or representing an immature stand.	Almost complete destruction of indigenous understorey* (by grazing &/or introduced plants) - reduced to scattered clumps and individual plants.		Where proposed clearance is in areas dominated by introduced species, the area of native vegetation is largely reduced to scattered trees, indigenous understorey reduced to scattered clumps and individual plants.
	2:1	20-29%	Scattered trees either immature in good health or mature in poor/moderate health. Alternatively, the dominant overstorey stratum is largely intact and is an immature stand (or regrowth), and is generally in poor health.			
Poor	**3:1**	30-39%	Dominant overstorey stratum is largely intact and is a moderately healthy mature stand.	Heavy loss of native plant species (by grazing &/or introduced plants). The understorey* consists predominately of alien species, although a small number of natives persist.	Vegetation structure substantially altered (e.g. one or more vegetation strata depleted). Retains basic vegetation structure or the ability to regenerate it. Very obvious signs of long-term or severe disturbance. Weed dominated with some very aggressive weeds. Partial clearing (10 – 50% of area). Evidence of moderate grazing (tracks, browse lines, soil surface crust extensively broken).	Where the proposed clearance is of mostly intact overstorey vegetation but there is still considerable weed infestation amongst the understorey flora.
	4:1	40-49%	Dominant overstorey stratum is largely intact and is a healthy mature stand with high wildlife habitat value (e.g. hollows).			
Moderate	**5:1**	50-59%	Dominant overstorey stratum is largely intact – any condition+	Moderate loss of native understorey diversity. Weed-free areas small. Substantial invasion of aliens resulting in significant competition, but native understorey* persists; for example, may be a low proportion of native species and a high native cover, or a high proportion of native species and low native cover.	Vegetation structure altered (e.g. one or more vegetation strata depleted). Most seed sources available to regenerate original structure. Obvious signs of disturbance (e.g. tracks, bare ground). Minor clearing (<10% of area). Considerable weed infestation with some aggressive weeds. Evidence of some grazing (tracks, soil surface crust patchy).	Where the proposed clearance is of mostly intact overstorey vegetation with moderate but not severe weed infestation amongst the understorey flora. Clearance is not seriously at variance with the Principles.
	6:1	60-69%	Dominant overstorey stratum is largely intact – any condition+	Moderate but not severe weed infestation amongst the understorey flora.		
Good	**7:1**	70-79%	Original overstorey stratum is still dominant and intact – any condition+	Understorey only slightly modified. High proportion of native species and native cover in the understorey*; reasonable representation of probable pre-European vegetation.	Vegetation structure intact (e.g. all strata intact). Disturbance minor, only affecting individual species. Only non-aggressive weeds present. Some litter build-up.	Where the proposed clearance is of mostly intact overstorey and understorey vegetation, weed infestation is moderate to low, but the original vegetation is still dominant. Clearance is assessed by the NVC to be at variance with the Principles.
	8:1	80-89%	Original overstorey stratum is still dominant and intact – any condition+	Understorey only slightly modified. High proportion of native species and native cover in the understorey*; reasonable representation of probable pre-European vegetation.		
Excellent	**9:1**	> 89%	Original vegetation is still dominant and intact. Overstorey individuals in good condition and represent a mature stand.	Diverse vegetation with very little weed infestation. Understorey largely undisturbed, minimal loss of plant species diversity. Very little or no sign of alien vegetation in the understorey*; resembles probable pre-European condition.	All strata intact and botanical composition close to original. Little or no signs of disturbance. Little or no weed infestation. Soil surface crust intact. Substantial litter cover.	Where the proposed clearance is of diverse vegetation with very little weed infestation. Clearance is assessed by the NVC to be seriously at variance with the Principles.
	10:1		Original vegetation is still dominant and intact. Overstorey individuals in good condition and represent a mature stand, with high habitat value (e.g. hollows).			

* Or all strata if the upper and lower strata are difficult to distinguish.
+ Ratio assessment will largely depend upon condition of understorey associated with an intact overstorey stratum.

Adapted from *Guide to Roadside Vegetation Survey Methodology for South Australia* (Stokes et al. 1998) and *Guidelines for a Native Vegetation Significant Environmental Benefit Policy* (DWLBC 2005)

5 RESULTS

5.1 Desktop assessment

5.1.1 Matters of national environmental significance

The Protected Matters Search identified 15 nationally threatened flora and fauna species and nine migratory species (Table 5.) (DSEWPaC 2013). Two Nationally Threatened Ecological Communities could potentially occur in the area. Nine migratory and nine marine species were highlighted in the report. These are outlined in the sections below.

Table 5. EPBC Matters of national significance

Search area (5 km buffer)	Matters of National significance under the EPBC Act 1999	Identified within the search area
	World Heritage Properties	None
	National Heritage Properties	None
	Wetlands of International Significance	None
	Nationally Important Wetlands	1
	Commonwealth Marine Areas	None
	Commonwealth Lands	None
	Commonwealth Reserves	None
	Commonwealth Heritage Places	None
	Places on the Register of the National Estate	None
	Listed Marine Species	9
	Whales and other Cetaceans	None
	Critical Habitats	None
	Nationally Threatened Species	15
	Nationally Threatened Ecological Communities	2
	Migratory Species	9
	State and Territory Reserves	2
	Invasive Species	20

5.1.2 Threatened ecological communities

Nationally Critically Endangered Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia potentially occurs within the vicinity of the project area and potentially occurs in small patches on the Borthwick property, but this is unconfirmed and an assessment against the criteria in the *EPBC Act Policy Statement 3.7, Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia* (2007) would need to be undertaken to determine if it represents the Threatened Ecological Community (TEC).

An additional TEC, Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Woodland, was listed under the EPBC Act, 2003 as Endangered, on 13 Aug 2013 and also occurs on site. A small patch of nationally endangered Threatened Ecological Community (TEC) Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland (effective from August 2013) was mapped along the creekline bordering the Harris and Cullen properties and has been subsequently assessed against the condition thresholds within the *Environment Protection and Conservation Act 1999 (EPBC Act) Approved Conservation Advice for the E*yre *Peninsula Blue Gum* (*Eucalyptus petiolaris*) *Woodland*. See mapped *orange* patch (Association 12) in Figure 9. Vegetation Association mapping within project area. (Focussing on proposed waste rock storage facility).

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The total patch was measured at approximately 0.73ha. The overstorey individuals are large and mature, but no evidence of recruitment in the population, however there is a high proportion of weeds in the understorey, which is likely to be inhibiting seedling germination to some degree. The understorey contained scattered native species persisting as individuals and in small patches with native and exotic grasses and herbs dominating the ground cover. See Appendix 2 for total plant list collected during field survey.

Table 6 show the results of the sample quadrat. The patch met the condition thresholds for listing as the nationally endangered Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland ecological community (C1 - Medium Quality). See

Figure 26 for typical photo taken of the community.

The community also occurs within the roadside corridor to the north and south of the project area along potential access routes, and along the Pillaworta Creek south of the property. A broad assessment was undertaken along the Pillaworta Creek to ascertain whether this community meets the criteria outlined under the Commonwealth Conservation Advice (B - High Quality). Two waterholes along the Pillaworta Creek were also assessed (both qualified as C1 - Medium Quality). See Table 6.

Table 6. Condition thresholds results for the Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland

Location	Fits Key Diagnostic Characteristics (Y or N)*	A - Exceptional Quality**			B - High Quality**			C1 - Medium Quality**			C2 - Medium Quality**		C3 - Medium Quality**		Potential for Comm. Referral (Yes or No)
		The patch size is ≥ 1ha	≥70% of total vegetative cover[2] in the mid and ground layers are comprised of native species[3]	18 or more native species from Appendix B, Table B1 (Listing Advice) document) in the mid and ground layers	The patch size is ≥ 0.2ha	≥50% of total vegetative cover[2] in the mid and ground layers are comprised of native species[3]	12 or more native species from Appendix B, Table B1 (Listing Advice) document) in the mid and ground layers	The patch size is ≥ 0.2ha	≥50% of total vegetative cover[2] in the mid and ground layers are comprised of native species[3]	4 or more native species from Appendix B, Table B1 (Listing Advice) document) in the mid and ground layers	Same criteria as C1, and	The patch is contiguous with a native vegetation remnant (any native vegetation where cover in each layer present is dominated by native species) that is ≥1ha in area	Same criteria as C1, and	The patch has at least 1 tree with hollows or at least 1 large tree (≥80cm dbh4) from the upper layer species list in Table B1. Where patches are ≥1 ha, a density of at least one mature tree or tree with hollows per hectare is required.	
Patch on Harris Creek (Association 12)	Y	N	N	N	Y	N	N	Y	Y	Y	NA	NA	NA	NA	Yes
Pillaworta Creek	Y	Y	Y	N	Y	Y	Y	NA	NA	NA	NA	NA	NA	NA	Yes
Waterhole 1 along Pillaworta Creek	Y	Y	Y	N	Y	Y	N	Y	Y	Y	NA	NA	NA	NA	Yes
Waterhole 2 along Pillaworta Creek	Y	Y	Y	N	Y	Y	N	Y	Y	Y	NA	NA	NA	NA	Yes

*Must answer Yes in this column to proceed with assessment of other criteria

**Must satisfy ALL components under A, B or C1, C2 or C3

5.1.3 Threatened flora

Nine EPBC listed flora species were identified in the EPBC Protected Matters Search Tool as potentially occurring or having habitat potentially occurring within the vicinity of the project area (Table 7.). Thirty-three state rated species have also been highlighted in the BDBSA search as potentially occurring within the project area. Threatened flora records for the project area are mapped in Figure 5.

Table 7. Threatened flora species potentially occurring within the project area.

Scientific name	Common name	Conservation status		Source of information	Last sighting (year)	Likelihood of occurrence within project area
		Aus	SA			
Acacia dodonaeifolia	Hop-bush Wattle		R	2	1976	Possible
Acacia enterocarpa	Jumping-jack Wattle	EN	E	1,2	1982	Possible
Acacia imbricata	Feathery Wattle		R	2	2007	Likely
Acacia pinguifolia	Fat-leaf Wattle	EN	E	1,2	1985	Possible
Acacia whibleyana	Whibley's Wattle	EN	E	2	1962	Possible
Anogramma leptophylla	Annual Fern		R	2	1882	Unlikely
Caladenia macroclavia	Large-club Spider-orchid	EN	E	1		Possible
Caladenia pusilla	Pigmy Caladenia		R	2	2001	Likely
Caladenia tensa	Inland Green-comb Spider-orchid	EN		1,2	1966	Unlikely
Daviesia pectinata	Zig-zag Bitter-pea		R	2	1988	Possible
Drosera stricticaulis	Erect Sundew		V	2	1995	Possible
Eremophila gibbifolia	Coccid Emubush		R	2	1988	Possible
Frankenia plicata		EN	V	1		Unlikely
Grevillea halmaturina ssp. *laevis*	Prickly Grevillea		R	2	1975	Possible
Haeckeria cassiniiformis	Dogwood Haeckeria		R	2	2006	Likely
Juncus radula	Hoary Rush		V	2	1960	Unlikely
Levenhookia stipitata			R	2	1994	Possible
Olearia pannosa ssp. *cardiophylla*	Velvet Daisy-bush		R	2	1999	Possible
Olearia pannosa ssp. *pannosa*	Silver Daisy-bush	VU	V	1,2	1988	Likely
Philotheca angustifolia ssp. *angustifolia*	Narrow-leaf Wax-flower		R	2	1985	Possible
Prasophyllum fecundum	Self-pollinating Leek-orchid		R	2	1967	Unlikely
Prasophyllum goldsackii	Goldsack's Leek-orchid	EN	E	2		Likely
Ptilotus beckerianus	Ironstone Mulla Mulla	VU	V	1		Possible

Scientific name	Common name	Conservation status		Source of information	Last sighting (year)	Likelihood of occurrence within project area
		Aus	SA			
Pultenaea trichophylla	Tufted Bush-pea	EN	R	1,2	2012	Known
Schoenus sculptus	Gimlet Bog-rush		R	2	1995	Possible
Sphaerolobium minus	Leafless Globe-pea		R	2	1995	Possible
Spyridium leucopogon	Silvery Spyridium		R	2	2004	Likely
Spyridium spathulatum	Spoon-leaf Spyridium		R	2	1995	Possible
Tecticornia flabelliformis	Bead Samphire	VU	V	2	1969	Unlikely
Thelymitra carnea	Small Pink Sun-orchid		R	2	1979	Possible
Thelymitra epipactoides	Metallic Sun-orchid	EN	E	1,2	1974	Possible
Thelymitra flexuosa	Twisted Sun-orchid		R	2	2000	Likely
Wurmbea decumbens	Trailing Nancy		R	2	1995	Possible
Wurmbea latifolia ssp. *vanessae*	Broad-leaf Nancy		R	2	1991	Possible
Xanthorrhoea semiplana ssp. *tateana*	Tate's Grass-tree		R	2	1995	Possible

Conservation status

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation Codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. ssp.: the conservation status applies at the sub-species level. An asterisk denotes ratings that need to be qualified for a variety of reasons, such as changes to taxonomy or nomenclature since listing or because a species assessed as 'presumed extinct' had to be listed under the Endangered category. Further details are available from the Vascular Plant Metadata document on the DEWNR website.

Source of Information

1. **EPBC Act Protected Matters Report DSEWPaC (2013b) – 10 km buffer applied to project area.**
2. **Biological Database of South Australia data extract DENR (2013) – 10 km buffer applied to project area.**

5.1.4 Threatened fauna

Six EPBC listed fauna species were identified in the EPBC Protected Matters Search tool as potentially occurring or having habitat occurring within the vicinity of the project area. Nine state rated species have also been highlighted in the BDBSA search as potentially occurring in the project area. Threatened fauna species are mapped in Figure 6.

Nine nationally listed migratory species and nine marine species were identified in the EPBC Protected Matters Search tool as potentially occurring or having habitat potentially occurring within the vicinity of the project area (Table 8.). Migratory whales and other cetaceans, sharks and marine reptiles have been excluded.

Table 8. Threatened fauna species potentially occurring within the project area.

Scientific name	Common name	Conservation status		Source of information	Last sighting (year)	Likelihood of occurrence within project area
		Aus	SA			
Bird						
Acanthiza iredalei iredalei	Slender-billed Thornbill (western)	VU	R	1		Unlikely
Apus pacificus	Fork-tailed Swift	Mi, Ma		1		Unlikely
Ardea alba	Great Egret, White Egret	Mi, Ma		1		Possible
Ardea ibis	Cattle Egret	Mi, Ma	R	1		Possible
Biziura lobata	Musk Duck		R	2	2004	Possible
Calyptorhynchus funereus	Yellow-tailed Black Cockatoo		V	2	2008	Likely
Charadrius veredus	Oriental Plover, Oriental Dotterel	Mi, Ma		1		Unlikely
Corcorax melanorhamphos	White-winged Chough		R	2	2004	Likely
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	Mi, Ma	R	1		Possible
Gerygone fusca	Western Gerygone		R	2	2008	Likely
Haliaeetus leucogaster	White-bellied Sea-Eagle	Mi, Ma	E	1		Unlikely
Leipoa ocellata	Malleefowl	Mi	V	1		Unlikely
Merops ornatus	Rainbow Bee-eater	Mi, Ma		1		Possible
Oxyura australis	Blue-billed Duck		R	2	1999	Possible
Pandion haliaetus	Osprey	Ma		1		Unlikely
Plegadis falcinellus	Glossy Ibis		R	2	1987	Possible
Podiceps cristatus	Great Crested Grebe		R	2	2004	Possible
Psophodes nigrogularis leucogaster	Western Whipbird (eastern)	VU	E	1		Unlikely

Scientific name	Common name	Conservation status		Source of information	Last sighting (year)	Likelihood of occurrence within project area
		Aus	SA			
Rostratula australis	Australian Painted Snipe	EN	V	1		Unlikely
Rostratula benghalensis (sensu lato)	Painted Snipe	EN, Mi,	V	1		Unlikely
Stagonopleura guttata	Diamond Firetail		V	2	2004	Likely
Sternula nereis nereis	Australian Fairy Tern	VU	E	1		Possible
Stipiturus malachurus parimeda	Southern Emu-wren (Eyre Peninsula)	VU	E	1		Unlikely
Mammal						
Trichosurus vulpecula	Common Brushtail Possum		R	2	1970	Possible

Conservation status

Aus: Australia (Environment Protection and Biodiversity Conservation Act 1999). SA: South Australia (National Parks and Wildlife Act 1972). Conservation Codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. ssp.: the conservation status applies at the sub-species level. Mi: listed as migratory under the EPBC Act. Ma: listed as marine under the EPBC Act.

Source of Information

1. **EPBC Act Protected Matters Report DSEWPaC (2013b) – 5 km buffer applied to project area.**
2. **Biological Database of South Australia data extract DENR (2013) - 10 km buffer applied to project area.**

5.1.5 Wetland of international significance (RAMSAR)

Wetlands are identified as 'special habitats' on Eyre Peninsula in the *Biodiversity Plan for Eyre Peninsula* (DEH 2002), due to such areas having not been cleared or being remnants of the pre-existing vegetation. No wetlands on Eyre Peninsula have been identified as international importance under the Ramsar Convention. One wetland within the Protected Matters Search area that has been identified of national importance by the Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) is the Tod River Wetland System, which is in close proximity to the project area.

The Tod River itself is the only permanent flowing drainage line on Eyre Peninsula, and is therefore an important habitat and refuge for many wetland organisms (Lloyd and Balla 1986, as cited in DEH 2002). The Tod River and Tod Reservoir are the terminal water bodies of the catchment, which is fed by rainfall and water runoff. This reservoir once supplied most of the reticulated water for the whole of the Eyre Peninsula, but since 2002 has been taken offline. Tod Reservoir is under the control of SA Water.

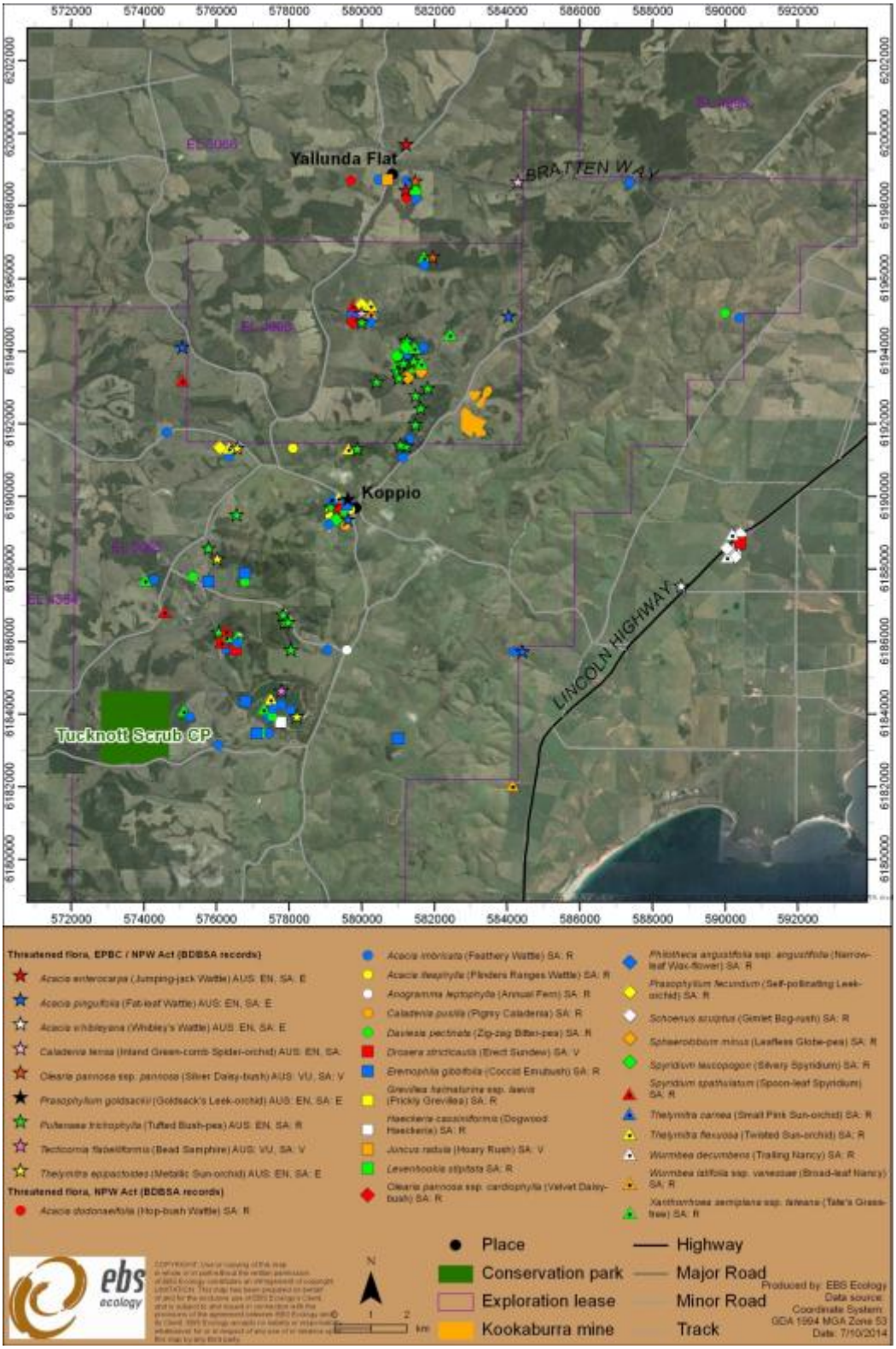


Figure 5. Threatened Flora Records (EPBC and BDBSA)

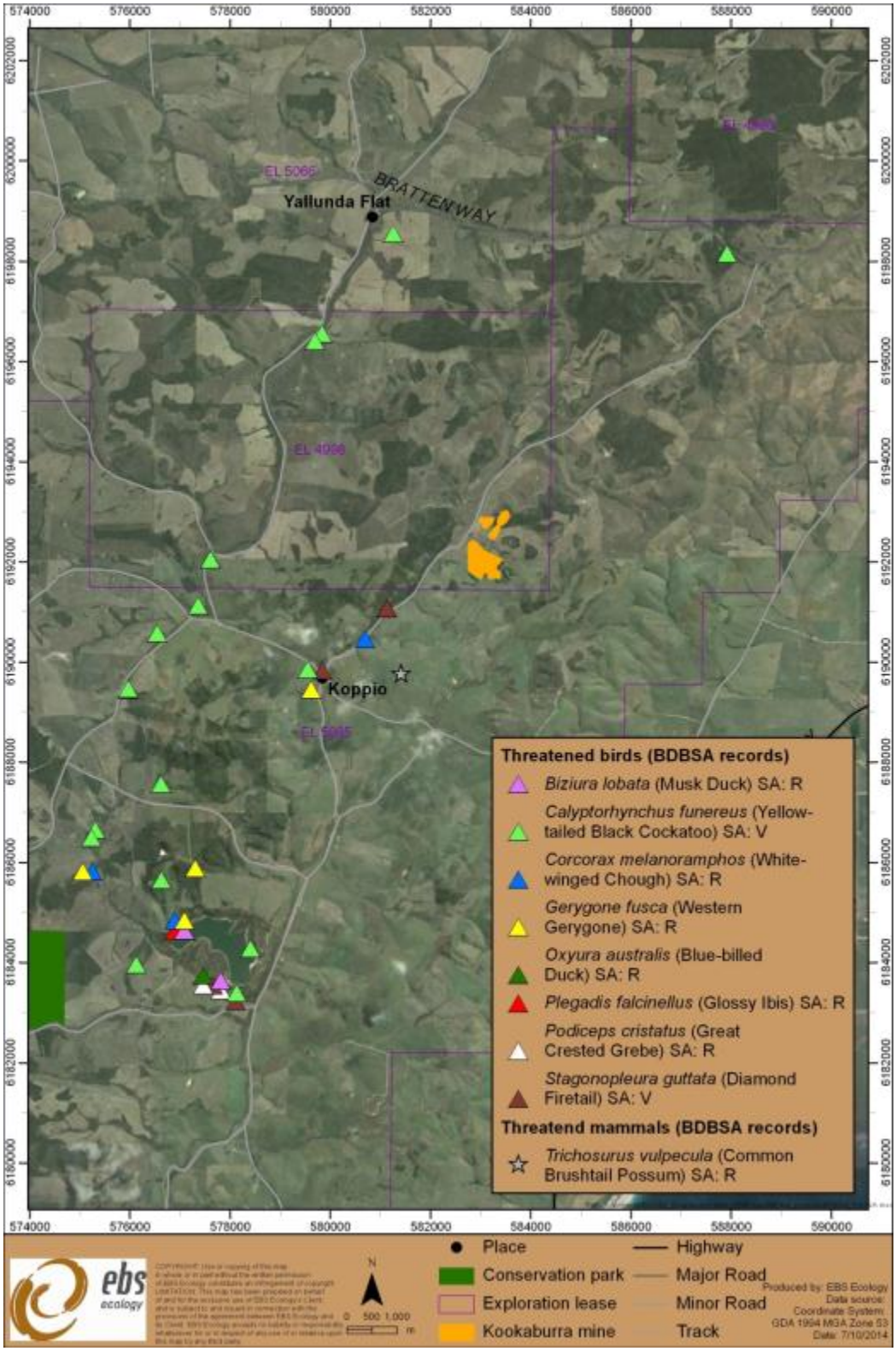


Figure 6. Threatened Fauna records (BDBSA)

5.2 Field survey

EBS conducted the initial field survey on the 3 - 5 December 2013. Weather data was obtained for the period of study from the Port Lincoln airport weather station, an official Bureau of Meteorology site which provided temperature, rainfall, relative humidity, wind direction and wind speed for the duration of the study. Weather data recorded at Port Lincoln during the survey is provided in (Table 9.). Weather conditions over the three day, two night period was cool and windy, with scattered showers.

Table 9. Weather during the field survey 3-5 December 2013

Date	Day	Temps		Rain	Max wind gust			9:00 AM				3:00 PM			
		Min	Max		Dir	Spd	Time	Temp	RH	Dir	Spd	Temp	RH	Dir	Spd
		°C	°C	mm		km/h	local	°C	%		km/h	°C	%		km/h
3	Tue	13	25.7	0	S	41	17:22	18.7	75	ENE	17	23	55	E	19
4	Wed	10.6	20.3	0	W	67	12:59	16.8	54	WSW	28	17.7	50	SW	41
5	Thur	8.1	18.3	6	SW	59	10:55	15	52	SW	30	17.3	52	SSW	31

The targeted survey was undertaken on the 23 – 24 September 2014. Conditions were cool to warm in the low 20s, with scattered light showers in the afternoon.

An additional survey was also undertaken on 7 May 2015. Conditions were cool with a high of 15℃.

5.3 Vegetation communities

The Koppio Hills area is largely defined by Sugar Gum (*Eucalyptus cladocalyx*) and Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Woodlands. However, vegetation communities recorded on site showed significant variation considering the relatively small geographical size of the project area. The vegetation communities were assessed at a finer scale on the Cullen and Harris properties, where the proposed mining area and tailings and waste rock storage facilities are located. Sections of the Pillaworta Creek and the Pillaworta roadside were also thoroughly assessed, whereas areas which are considered to be impacted by the proposal were more broadly mapped. Twenty-three distinct vegetation communities were observed across the project area (Table 10.), however only the native dominated communities are discussed here.

Table 10. Overall summary of vegetation associations.

Vegetation assoc. #	Vegetation association	Condition
1	Exotic dominated	0:1
2	*Eucalyptus cladocalyx* Woodland	4:1 - 8:1
3	*Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* Woodland	5:1 – 6:1
4	*Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland	5:1
5	*Melaleuca uncinata* +/- *Allocasuarina verticillata* Shrubland	4:1 - 7:1
6	*Eucalyptus peninsularis* Low Woodland	5:1 - 6:1
7	*Xanthorrhoea semiplana* ssp. +/- *Allocasuarina verticillata* Grassland	4:1 - 6:1

Vegetation assoc. #	Vegetation association	Condition
8	*Allocasuarina verticillata* +/- emergent *Acacia pycnantha* Low Open Forest	4:1 - 7:1
9	*Eucalyptus* spp. Mixed Mallee	6:1
10	*Eucalyptus* spp. +/- *Callistemon rugulosa* Mallee	6:1
11	*Eucalyptus petiolaris* Woodlands +/- *Allocasuarina verticillata* +/-*Acacia pycnantha*	4:1 - 5:1
12	*Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*	5:1
13	*Acacia pycnantha* / *Acacia imbricata* Shrubland	8:1
14	*Gahnia filum* Sedgeland	4:1
15	*Gahnia filum* / *Juncus kraussii* Sedgeland	6:1
16	*Juncus kraussii* Sedgeland	7:1
17	*Juncus kraussii* Sedgeland +/- scattered *Eucalyptus petiolaris*	4:1 - 5:1
18	*Juncus kraussii* Sedgeland +/- *Ficinia nodosa* +/- scattered *Melaleuca halmaturorum*	3:1
19	*Juncus kraussii* / *Ficinia nodosa* / *Juncus pallidus* Sedgeland +/- scattered *Acacia pycnantha*	4:1
20	*Cypress gymnocaulos* / *Juncus kraussii* Sedgeland	4:1
21	*Acacia imbricata* / *Lissanthe strigosa* / *Acacia rupicola* open shrubland +/- *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii*	8:1
22	*Acacia pycnantha* +/- *Allocasuarina verticillata* Low Open Forest	5:1
23	*Eucalyptus petiolaris* Woodland	8:1

A number of communities have been mapped and recorded by L. Bebbington (2015) who was commissioned by the Borthwick family to undertake a vegetation assessment of the vegetation block located directly north of the Cullen – Borthwick boundary. Some of these communities have not been mapped across the other properties (see Figure 12). Species lists were not listed in the report or the locations of threatened flora species, however both state rare species, *Acacia imbricata* (Feathery Wattle) and *Daviesia pectinata* (Zig-zag Bitter Pea) were recorded throughout the *E. cladocalyx* Low Open Woodland areas and the outwash lower section of the gully, which is reportedly characterised by *Acacia rupicola* / *Acacia imbricata* Low Open Shrubland. These species were also recorded during a surveying expedition by D. Povey, including the state rare *Eremophila gibbifolia* (Coccid Emubush) (D. Povey *pers comm*., 2015).

Bebbington assigned a condition rating of "M" (Moderate) to the remnant, based on condition ratings obtained from Neagle, 1995. This is described as "*Moderate weed invasion and / or moderately grazed in the past resulting in some loss of plant species richness and with significant competition from exotic species in places*."

Other general comments pertaining to the vegetation describe the area as not having been cleared for agriculture due to the rocky nature of the landscape and the vegetation having a long history of sheep grazing which has impacted on seedling recruitment particularly post 2005 wildfire. The author records that at the time of the assessment sheep were grazing Acacia and Eucalypt seedlings throughout the remnant due to the prolonged dry period and that native grasses were heavily grazed throughout by

sheep and kangaroos but were still persisting and setting seed. The *Eucalyptus cladocalyx* Woodland has been recorded as "old growth" based on the size of the mature eucalypts and the presence of large hollows (Bebbington, 2015). Bebbington has rated the habitat potential of the remnant as a "B" category, against the Habitat Significance Rating (HSR) developed under the *Guidelines for a Native Vegetation Significant Environmental Benefit Policy for the clearance of Scattered Trees (DEWNR, 2007).* There are six categories, which are based on the offset's relative habitat, where "B" is considered to fit the following description:

Vegetation community that as compared with the original vegetation has:

- Moderate species diversity
- Tallest layer of vegetation largely intact
- Understorey moderately disturbed (40 - 70% total cover of native species, natural bare ground and native litter, moss etc)
- Exotic species /weeds may be present in high density in some areas but present in low density elsewhere *(DEWNR, 2007).*

Note: Some of the vegetation communities listed and described for the Borthwick property are consistent from observations made by EBS Ecology from the boundary fence during various field surveys and the species recorded in the Bebbington report have been observed also, however it is not possible to confirm the presence of the Nationally Critically Endangered Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia from the mapped area described by Bebbington as a state listed *Eucalyptus odorata* Open Mallee over Native Tussock Grassland. Assessment against the criteria outlines in the Listing Advice would need to be undertaken. An assessment of the condition of the vegetation to properly assign SEB ratios would also need to be undertaken.

Bebbington's recorded communities are listed in Table 11.

Table 11. Overall summary of vegetation associations undertaken by Bebbington in 2015.

Vegetation association
Eucalyptus cladocalyx Low Open Woodland
Melaleuca uncinata Shrubland
Eucalyptus odorata Open Mallee over Native Tussock Grassland
Rytidosperma ssp., Austrostipa ssp. , Themeda triandra Tussock Grasslands
Acacia rupicola / Acacia imbricata Shrubland
Daviesia pectinata +/- *Acacia imbricata* Low Open Shrubland
Lepidosperma concavum Sedgeland
Lissanthe strigosa Heathland +/- *Acacia imbricata*

Vegetation community variation within the project area was driven primarily by elevation and soil depth. Tops of the ranges and exposed buckshot ironstone outcrops consisted of *Melaleuca uncinata* Shrublands, *Xanthorrhoea semiplana* Grasslands, *Acacia* spp. and *Allocasuarina verticillata* Woodlands

with intergrades of some mallee communities such as *Eucalyptus leptophylla* and *Eucalyptus phenax*. The more protected and lower rocky slopes and foothills were dominated by *Eucalyptus cladocalyx* Woodlands, intergrading with patches of *Eucalyptus peninsularis* mallee. Deeper soil profiles and foothills were characterised by *Eucalyptus odorata* and *Eucalyptus porosa* Woodlands of which most have been cleared, due to habitation on the best soil types. Upper drainage lines were often mallee species mixed with *Callistemon rugulosus* shrub patches with high density cover. Lower drainage channels with (assumed) high water tables support the *Eucalyptus petiolaris* Woodlands. A summary of these communities is provided below.

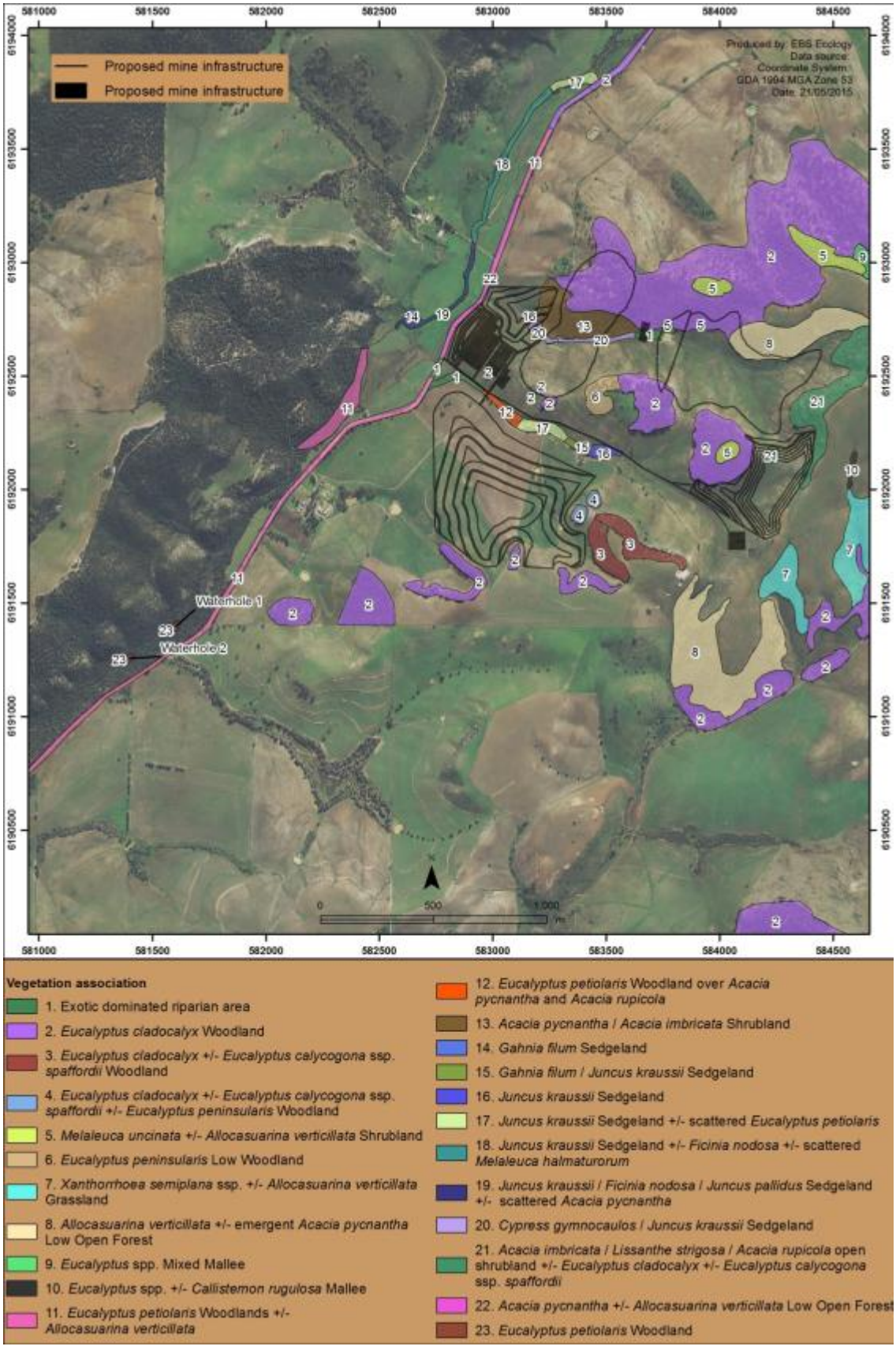


Figure 7. Vegetation Association mapping within the project area.

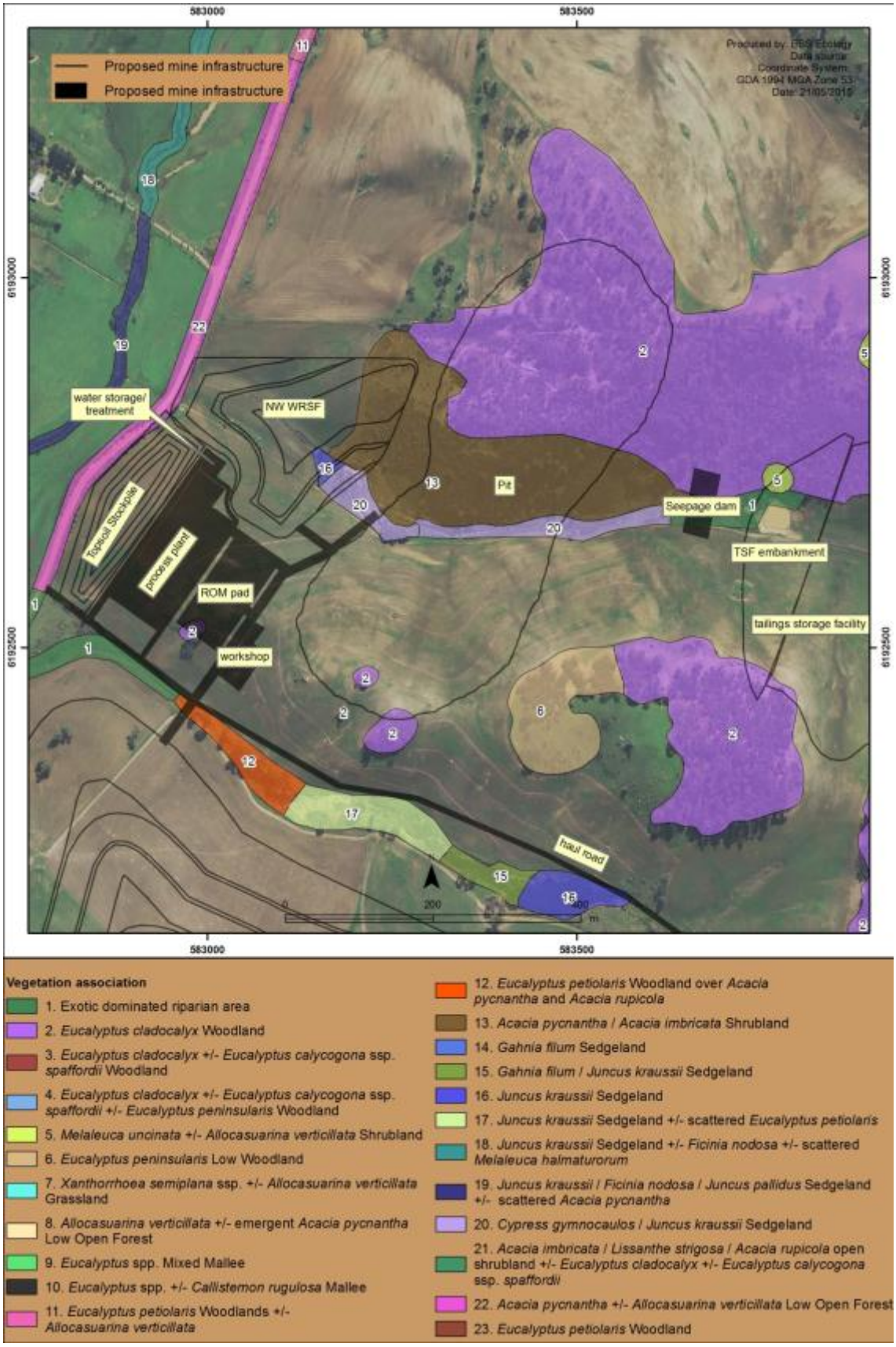
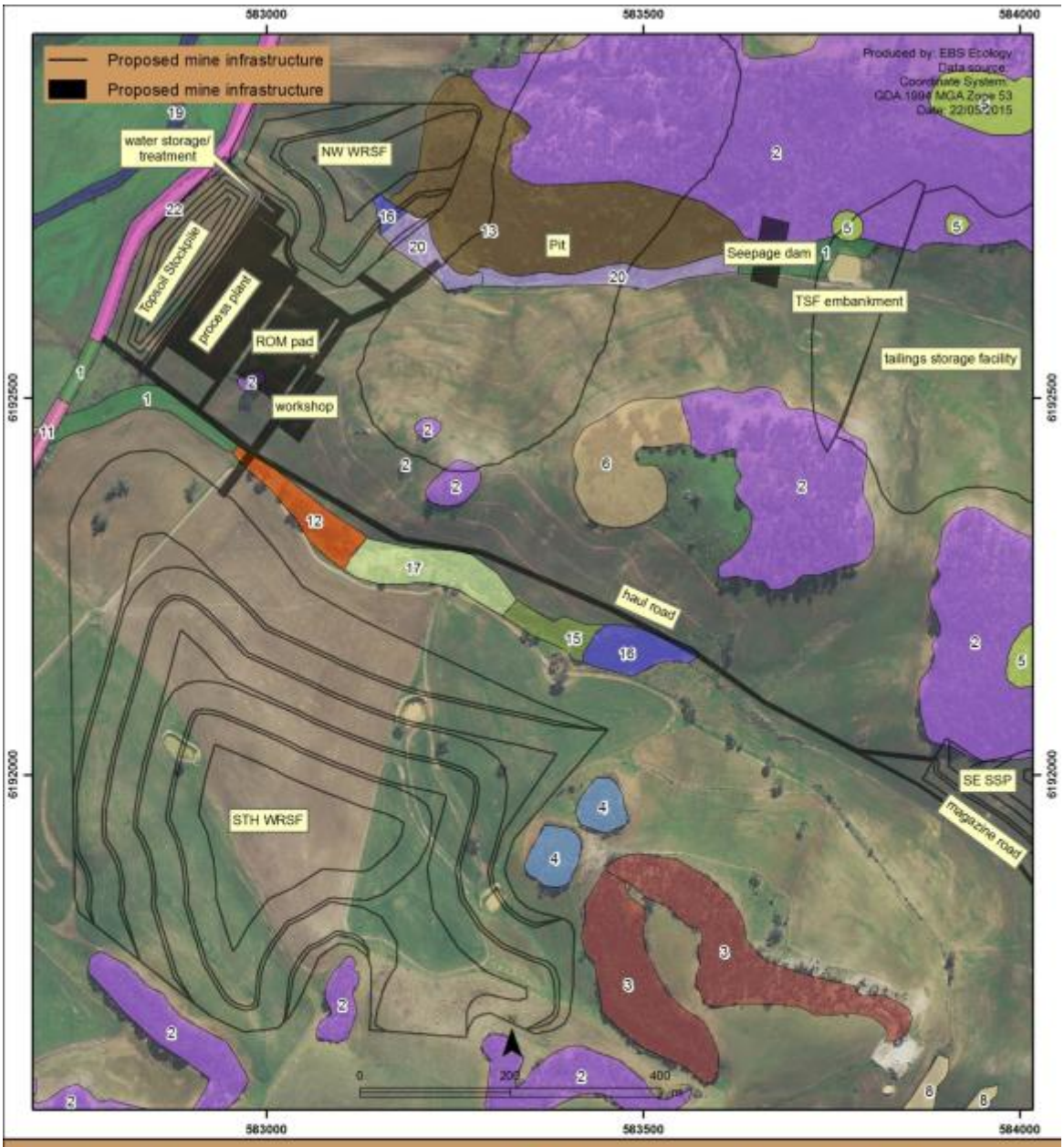


Figure 8. Vegetation Association mapping within project area. (Focussing on proposed pit area).



Vegetation association

1. Exotic dominated riparian area
2. *Eucalyptus cladocalyx* Woodland
3. *Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii* Woodland
4. *Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii +/- Eucalyptus peninsularis* Woodland
5. *Melaleuca uncinata +/- Allocasuarina verticillata* Shrubland
6. *Eucalyptus peninsularis* Low Woodland
7. *Xanthorrhoea semiplana* ssp. *+/- Allocasuarina verticillata* Grassland
8. *Allocasuarina verticillata +/-* emergent *Acacia pycnantha* Low Open Forest
9. *Eucalyptus* spp. Mixed Mallee
10. *Eucalyptus* spp. *+/- Callistemon rugulosa* Mallee
11. *Eucalyptus petiolaris* Woodlands *+/- Allocasuarina verticillata*
12. *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*
13. *Acacia pycnantha / Acacia imbricata* Shrubland
14. *Gahnia filum* Sedgeland
15. *Gahnia filum / Juncus kraussii* Sedgeland
16. *Juncus kraussii* Sedgeland
17. *Juncus kraussii* Sedgeland *+/-* scattered *Eucalyptus petiolaris*
18. *Juncus kraussii* Sedgeland *+/- Ficinia nodosa +/-* scattered *Melaleuca halmaturorum*
19. *Juncus kraussii / Ficinia nodosa / Juncus pallidus* Sedgeland *+/-* scattered *Acacia pycnantha*
20. *Cypress gymnocaulos / Juncus kraussii* Sedgeland
21. *Acacia imbricata / Lissanthe strigosa / Acacia rupicola* open shrubland *+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii*
22. *Acacia pycnantha +/- Allocasuarina verticillata* Low Open Forest
23. *Eucalyptus petiolaris* Woodland

Figure 9. Vegetation Association mapping within project area. (Focussing on proposed waste rock storage facility).

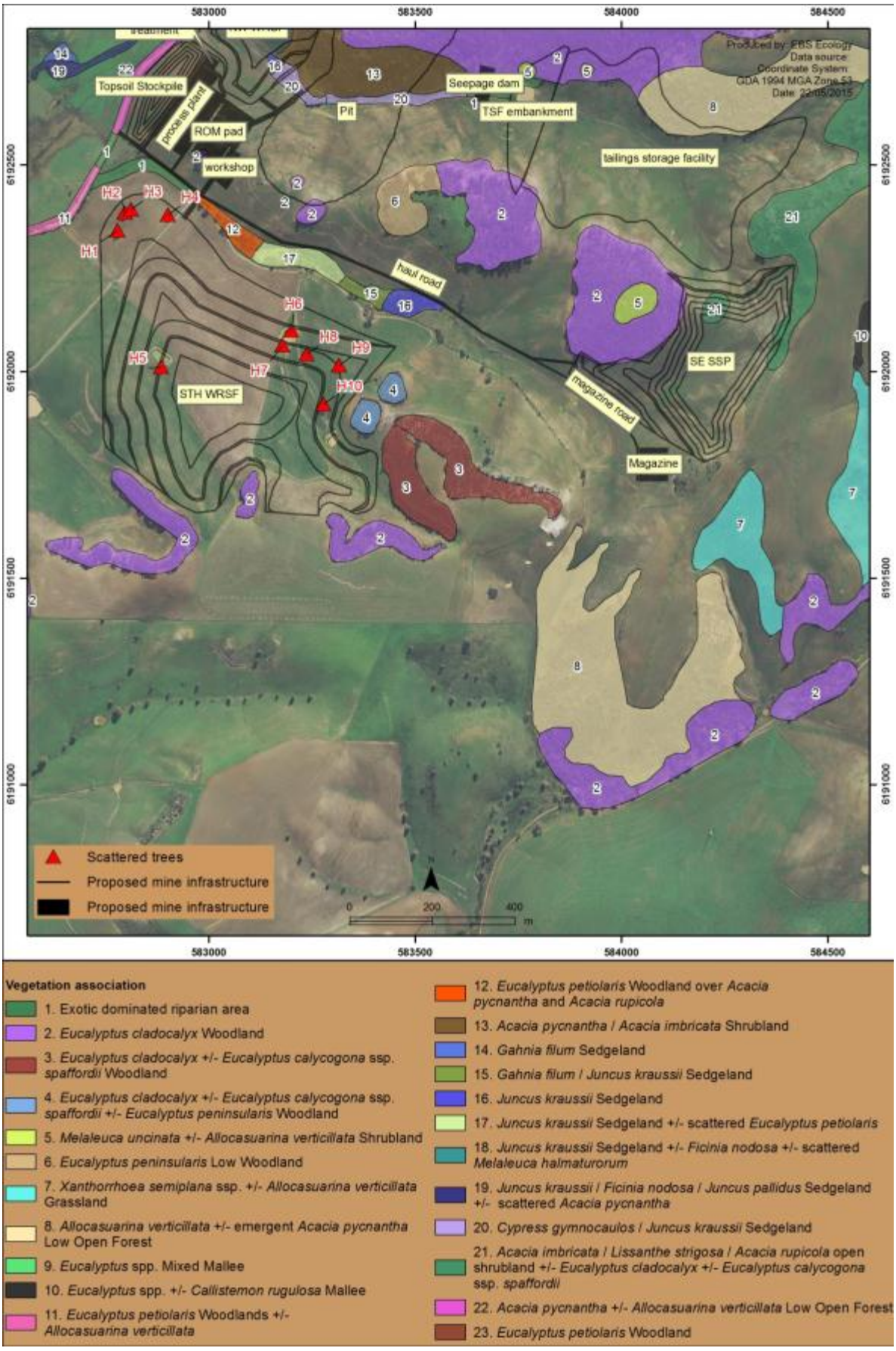


Figure 10. Vegetation Association mapping within project area. (Focussing on proposed southern areas).

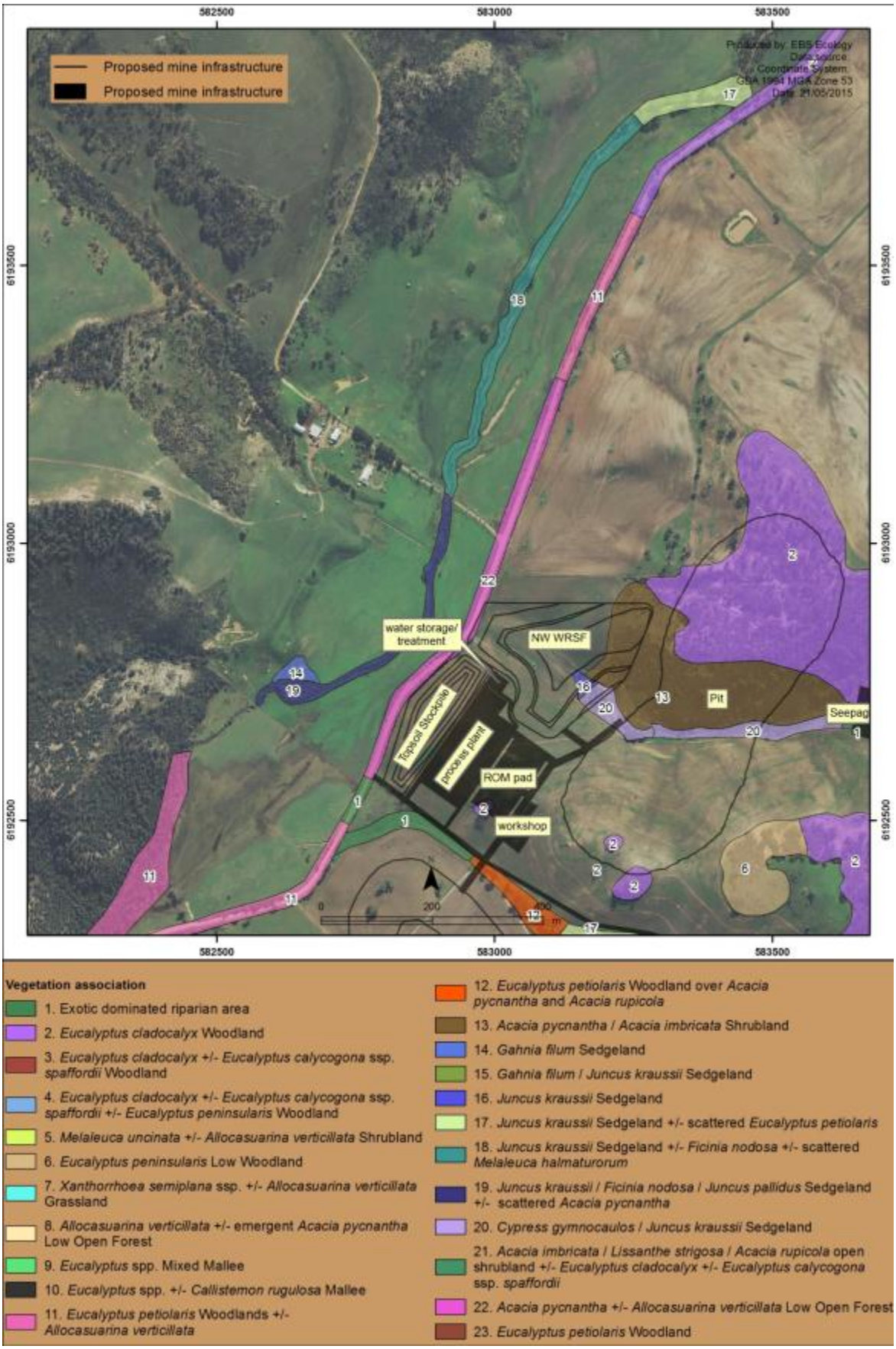


Figure 11. Vegetation Association mapping within project area. (Focussing on creek areas).

Figure 12. L. Bebbington vegetation mapping on Borthwick property (Bebbington, 2015)

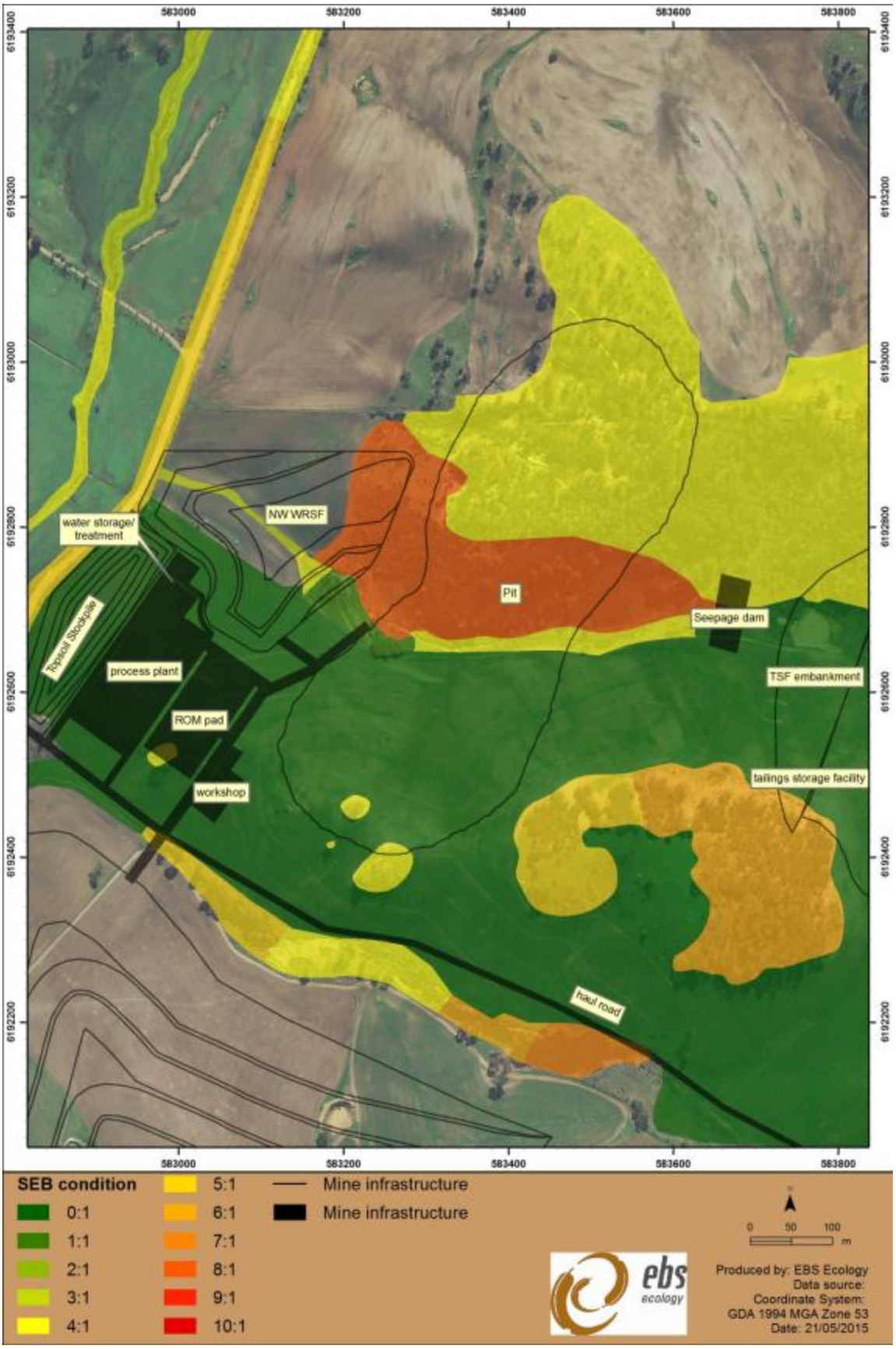


Figure 13. L Condition (SEB) mapping within Cullen Creek area.

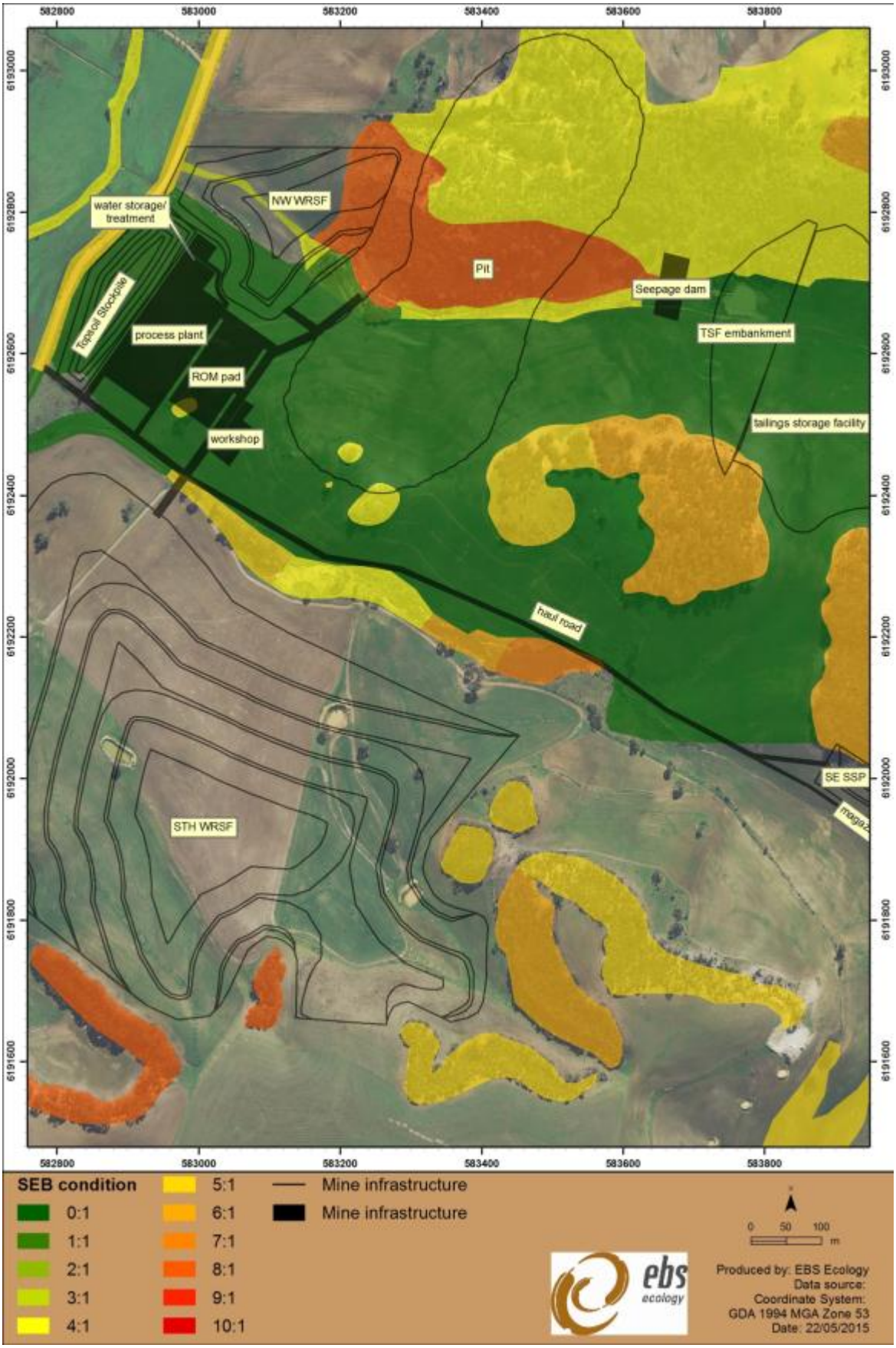


Figure 14. Vegetation Condition (SEB) mapping within Harris-Cullen Creek area.

Figure 15. Vegetation Condition (SEB) mapping within southern area of property.

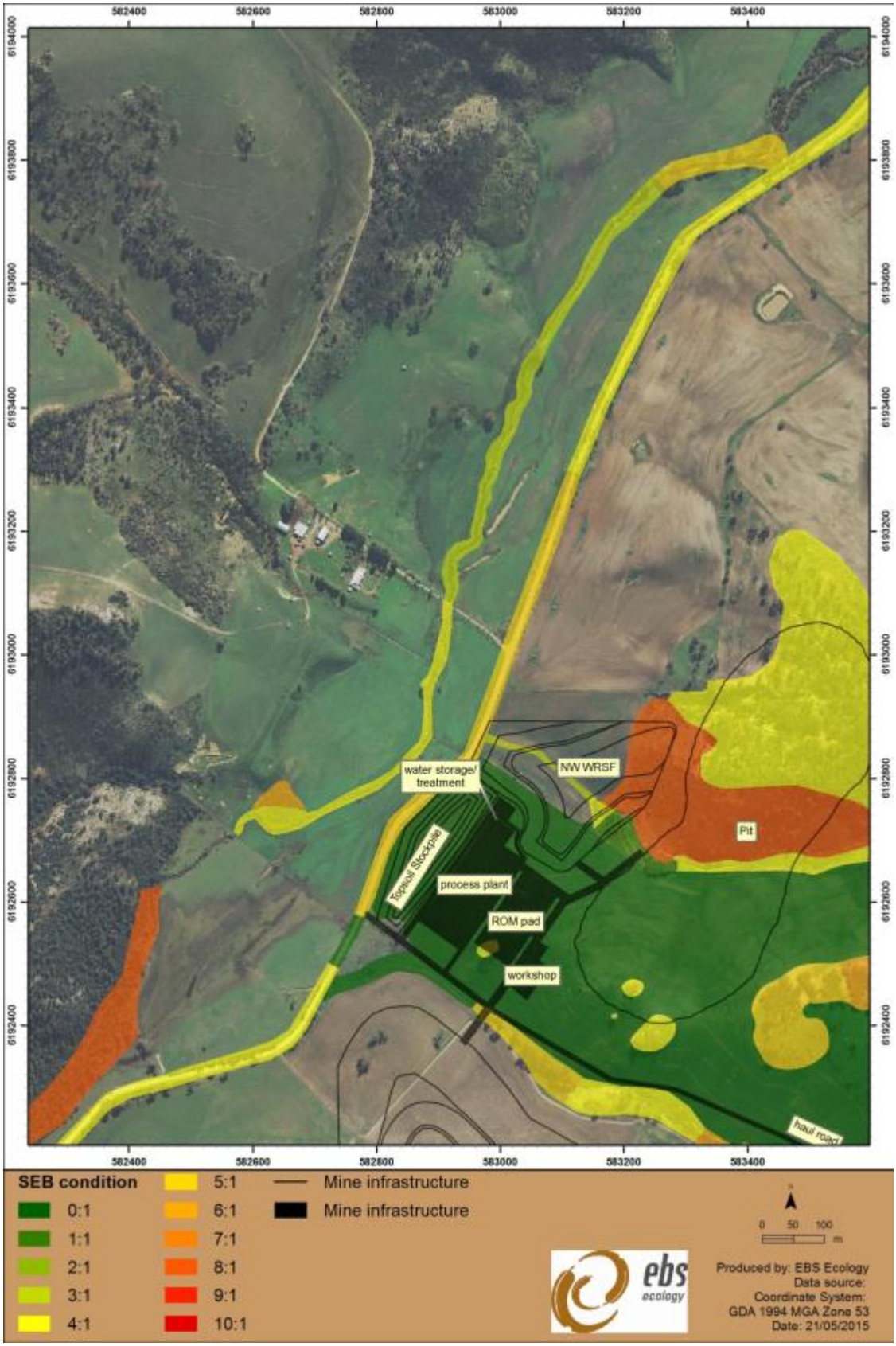


Figure 16. Vegetation Condition (SEB) mapping (Focussing on Pillaworta creek areas).

5.3.1 Association 1- Exotic dominated

These areas are located along Harris and Cullen Creeks and the Pillaworta roadside. They are characterised by exotic grasses including *Avena barbata* (Oat Grass) and *Hordeum* sp. and *Vulpia myuros* (Fescue), *Phalaris aquatica* (Phalaris) and *Dactylis glomerata* (Cocksfoot). *Senecio pterophorus* (African Daisy) is often widespread throughout whilst other woody weed species such as *Olea europaea* (Olive) are scattered. The areas are considered to be in very poor condition (SEB ratio of 0:1).

5.3.2 Association 2 - Eucalyptus cladocalyx (Sugar Gum) Woodland

This vegetation association dominated the proposed mining area. The structure of the community varied depending on its fire history. Within the Cullen property, understorey diversity was moderate to low with sheep grazing removing palatable shrubs and ground layer herbaceous species. This anecdotally resulted in the 2005 fire in this area dominating the canopy in a colder less intense burn than that in more intact communities which resulted in widespread death or significant damage of many trees with epicormic growth emerging from the lower trunks only. Condition therefore was variable, but in all cases more than capable of supporting a range of threatened species at state and national level.

Table 12. Summary of vegetation association 2. *Eucalyptus cladocalyx* Woodland.

Representation	Dominant community in mining area
Conservation value	Very High
Vegetation condition	Poor to moderate, dependent on grazing pressure and fragmentation of patch.
Overstorey species	*Eucalyptus cladocalyx* (Sugar Gum)
Midstorey species	*Acacia imbricata* (Feathery Wattle), *Acacia rupicola* (Rock Wattle)
Understorey species	*Rytidosperma* spp. (Wallaby Grass)
Threatened species	*Acacia imbricata* (Feathery Wattle), *Daviesia pectinata* (Zig-zag Bitter pea), *Eremophila gibbifolia* (Coccid Emubush), *Olearia pannosa* ssp. *pannosa* (Silver Daisy-bush), *Pultenaea trichophylla* (Tufted Bush-pea)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 17. *Eucalyptus cladocalyx* (Sugar Gum) Woodland

5.3.3 Association 3 – Eucalyptus cladocalyx +/- Eucalyptus calycogona ssp. spaffordii Woodland

This vegetation association dominated a small patch in the south on the Harris property. The community structure comprised a scattered and sometimes sparse understorey dominated by *Acacia rupicola* (Rock Wattle), *Eutaxia microphylla* (Common Eutaxia), *Gonocarpus mezianus* (Broad-leaf Raspwort), *Daviesia pectinata* (Zig-zag Bitter pea) and *Rytidosperma setaceum* (Small-flower Wallaby-grass). Overall condition was moderate (6:1) with a moderately low understorey species richness, due mainly to removal of species from high levels of stock grazing.

Table 13. Summary of vegetation association 3. *Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii* Woodland.

Representation	Small patch south of the project area
Conservation value	High
Vegetation condition	Moderate, dependent on grazing pressure and fragmentation of patch.
Overstorey species	*Eucalyptus cladocalyx* (Sugar Gum) / *Eucalyptus calycogona* ssp. *spaffordii* (Spafford's Square-fruit Mallee)
Midstorey species	*Eutaxia microphylla* (Common Eutaxia), *Acacia rupicola* (Rock Wattle), *Daviesia pectinata* (Zig-zag Bitter pea)
Understorey species	*Rhytidosperma setaceum* (Small-flower Wallaby-grass), *Gonocarpus mezianus* (Broad-leaf Raspwort)
Threatened species	*Daviesia pectinata* (Zig-zag Bitter pea)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 18. *Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii* Woodland on Harris property.

5.3.4 Association 4 – Eucalyptus cladocalyx +/- Eucalyptus calycogona ssp. spaffordii +/- Eucalyptus peninsularis Woodland

This vegetation association dominated two small patches in the south on the Harris property. The community structure comprised a scattered and mostly sparse understorey dominated by *Acacia rupicola* (Rock Wattle), *Acacia imbricata* (Feathery Wattle), *Gonocarpus mezianus* (Broad-leaf Raspwort) and *Daviesia pectinata* (Zig-zag Bitter Pea). *Senecio pterophorus* (African Daisy) is widespread throughout and grazing levels are high, leading to a moderately poor understorey.

Table 14. Summary of vegetation association 4. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland.

Representation	Small patches south of the project area
Conservation value	Moderately high
Vegetation condition	Moderate, dependent on grazing pressure and fragmentation of patch.
Overstorey species	*Eucalyptus cladocalyx* (Sugar Gum) / *Eucalyptus calycogona* ssp. *spaffordii* (Spafford's Square-fruit Mallee)
Midstorey species	*Eutaxia microphylla* (Common Eutaxia), *Acacia rupicola* (Rock Wattle), *Daviesia pectinata* (Zig-zag Bitter pea)
Understorey species	*Rhytidosperma setaceum* (Small-flower Wallaby-grass)
Threatened species	*Acacia imbricata* (Feathery Wattle), *Daviesia pectinata* (Zig-zag Bitter pea)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 19. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland on Harris property.

5.3.5 Association 5 - Melaleuca uncinata shrubland

This community varied in condition and composition where some patches had higher abundance of *Melaleuca* than others. Patches in close proximity to the mining area were in very good condition and displayed a high diversity of perennial herbaceous species, grasses and sedges. Two nationally threatened plant species were recorded within this area as well as potentially others, given the obvious signs of recently flowering Orchid species present at the time of the survey. Due to the type of soil profile this community inhabits, it is relatively well preserved within the region. Despite the variation in condition, the community is considered to possess very high conservation value given the large number of species it provides habitat for.

Table 15. Summary of vegetation association 5. *Melaleuca uncinata* +/- *Allocasuarina verticillata* Shrubland

Representation	Widespread within the wider region, locally not dominant.
Conservation value	Moderate
Vegetation condition	Moderate
Overstorey species	*Acacia pycnantha*(Golden Wattle) *Melaleuca uncinata* (Broombush),
Midstorey species	*Hakea rugosa* (Dwarf Hakea), *Lepidosperma* sp (Sedge), *Babingtonia behrii* (),
Understorey species	*Eutaxia microphylla* (Common Eutaxia),
Threatened species	*Pultenaea trichophylla* (Tufted-bush Pea), *Olearia pannosa* ssp. *pannosa* (Silver Daisy Bush), *Eremophila gibbifolia* (Coccid Emubush),
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 20. *Melaleuca uncinata* shrubland with diverse understorey

5.3.6 Association 6 - Eucalyptus peninsularis low woodland

This community was observed as small pockets adjacent to *Eucalyptus cladocalyx* Woodlands south of the proposed mining area. Primarily, these were present as intact canopies over degraded grazed understorey. Overall, this community is poorly represented in the project area but has large intact remnants north of the site near Ungarra.

Table 16. Summary of vegetation association 6 *Eucalyptus peninsularis* Low Woodland.

Representation	Small fragmented patches
Conservation value	Moderate
Vegetation condition	Poor
Overstorey species	*Eucalyptus peninsularis*
Midstorey species	*Bursaria spinosa* (Sweet Bursaria), *Acacia rupicola* (Rock wattle)
Understorey species	*Rhytidosperma* spp. (Wallaby Grass), *Austrostipa* spp. (Spear Grass) and exotic emergent species
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy)

5.3.7 Association 7 - Xanthorrhoea semiplana ssp. +/- Allocasuarina verticillata Grassland.

This community occupies exposed hill tops where soil profiles are shallow which prevents deeper rooted larger trees from establishing other than *Allocasuarina verticillata* (Sheoak). Most cover is provided by low shrubs less than one metre. Moderate exotic species invasion has occurred, predominantly *Avena barbata* (Oats) and other pasture species with scattered *Senecio pterophorus* (African Daisy) throughout. Indigenous vegetation was in good health with the dominant overstorey displaying widespread flowering stalks.

Table 17. Summary of vegetation association 7. *Xanthorrhoea semiplana* ssp. +/- *Allocasuarina verticillata* Grassland.

Representation	Widespread on tops of ridges especially to eastern side of project area
Conservation value	High value
Vegetation condition	Poor to moderate
Overstorey species	*Xanthorrhoea semiplana* ssp.(Yacca)
Midstorey species	*Acacia rupicola* (Rock Wattle), *Acacia paradoxa* (Kangaroo Thorn), *Melaleuca uncinata* (Broombush)
Understorey species	*Eutaxia microphylla* (Common Eutaxia),
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 21. Hill crest with dominant *Xanthorrhoea semiplana ssp.* grassland.

5.3.8 Association 8 - Allocasuarina verticillata +/- emergent Acacia pycnantha Low Open Forest

This community has emerged in response to the Wangary fires. These species are commonly associated with 'en masse' germinations following fire events and are known as pioneer species and nitrogen fixers which enable the follow-up colonisation of other species. The cover varied considerably, with some areas having very dense thickets of many small individuals. Condition was generally good with the density of regrowth excluding any other smaller herbaceous weed species.

Table 18. Summary of vegetation association 8. *Allocasuarina verticillata* + emergent *Acacia pycnantha* Low Open Forest

Representation	Widespread regeneration across project area especially on roadsides.
Conservation value	Moderate
Vegetation condition	Moderate
Overstorey species	*Allocasuarina verticillata* (Sheoak)
Midstorey species	*Acacia imbricata* (Feathery Wattle), *Acacia rupicola* (Rock Wattle)
Understorey species	*Dampiera dysantha* (Dampiera), *Hibbertia paeninsularis, Astroloma sp, Adenanthos terminalis, Dianella revoluta.*
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 22. Roadside reserve with dominant regrowth of *Allocasuarina* and *Acacia pycnantha*.

5.3.9 Association 9 - Eucalyptus spp*. Mixed Mallee*

This association formed small isolated patches fringing the dominant *Melaleuca uncinata* shrublands. There appeared to be a high number of mallee tree species mixed within this association and changing frequently at times. This association is widespread and well represented in the wider region particularly towards the coast on sandy soil profiles. It is likely to provide habitat for a range of fauna species particularly given the variation of flowering times throughout the year.

Table 19. Summary of vegetation association 9 *Eucalyptus* spp. Mixed Mallee.

Representation	Widespread across region, isolated patches present in the project area
Conservation value	Low,
Vegetation condition	Poor to moderate
Overstorey species	Eucalyptus mallee species with potentially, *E. leptophylla, E. phenax, E. diversifolia, E. rugosa, E. peninsularis* and *E. incrassata.*
Midstorey species	*Melaleuca uncinata, Acacia pycnantha, Babingtonia behrii.*
Understorey species	*Dianella revoluta, Adenanthos terminalis, Lasiopetalum behrii, Pimelea sp.*
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 23. *Eucalyptus leptophylla* +/- *Eucalyptus phenax* Low Mallee

5.3.10 Association 10 - Eucalyptus spp. +/- Callistemon rugulosa Mallee

Recorded in the upper reaches of the minor drainage lines this community was largely restricted to a number of channels south of the proposed mining area. This community is poorly represented in the area due to the higher value of soils and the remnants exist only in the steepest bank sections. This association is generally in very poor condition and highly fragmented, due to the narrow linear nature of the patches and preference for sheep to use these areas for shelter in poor weather conditions, coupled with increased edge effects leading to high levels of weed invasion.

Table 20. Summary of vegetation association 10 *Eucalyptus* spp. +/- *Callistemon rugulosus* Mallee.

Representation	Isolated to steep creek lines
Conservation value	Low
Vegetation condition	Poor
Overstorey species	Eucalyptus mallee species with potentially, *E. leptophylla, E. phenax, E. diversifolia, E. rugosa, E. peninsularis* and *E. incrassata*.
Midstorey species	*Callistemon rugulosus*
Understorey species	Exotic grass species dominate
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy)

5.3.11 Association 11 - Eucalyptus petiolaris Woodlands +/- Allocasuarina verticillata +/- Acacia pycnantha

Primarily restricted to the drainage lines north of the project area this community is a national TEC and endemic to the southern Eyre Peninsula. All areas observed along the potential access route to the north of the project areas were moderately degraded with high weed density in the understorey including some weeds of national significance (*Asparagus asparagoides*). Due to the large size, maturity and density of the trees in this habitat, it is considered that this community is of high conservation value.

Table 21. Summary of vegetation association 11 *Eucalyptus petiolaris +/- Allocasuarina verticillata*.

Representation	Primarily north of the project area, this community has suffered from widespread clearance in the area.
Conservation value	High
Vegetation condition	Moderate
Overstorey species	*Eucalyptus petiolaris* (Eyre Peninsula Blue Gum)
Midstorey species	*Acacia paradoxa* (Kangaroo Thorn), *Acacia imbricata* (Feathery Wattle), *Acacia pycnantha* (Golden Wattle)
Understorey species	*Grevillea aspera* (Rasp Grevillea), *Dianella revoluta* (Flax Lily), *Rhagodia candolleana* (Sea berry Saltbush), *Ehrharta longifolia* (Annual Veldt Grass)
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy), *Asparagus asparagoides* (Bridal Creeper), *Chrysanthemoides monilifera* (African Boneseed)

Figure 24. *Eucalyptus petiolaris* open woodland with high density of exotic grass.

Figure 25. *Senecio pterophorus* (African daisy) high cover in *E. leucoxylon* ssp. *petiolaris* Woodland

5.3.12 Association 12 - Eucalyptus petiolaris Woodland over Acacia pycnantha and Acacia rupicola

This community was recorded from a small area associated with the creekline between Cullen and Harris properties (Harris Ck). Understorey was dominated by *Acacia pycnantha* (Golden Wattle) and *Acacia rupicola* (Rock Wattle) and *Acacia imbricata* (Feathery Wattle), but was largely in moderately poor condition given the high levels of weed invasion from exotic grasses, *Puccinellia distans* (Reflexed Poa), *Asparagus asparagoides* (Bridal Creeper) and *Senecio pterophorus* (African Daisy).

Table 22. Summary of vegetation association 12 *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*

Representation	Small area associated with the creekline between Cullen and Harris properties (Harris Creek)
Conservation value	High
Vegetation condition	Moderate
Overstorey species	*Eucalyptus petiolaris* (Eyre Peninsula Blue Gum)
Midstorey species	*Acacia pycnantha* (Golden Wattle) and *Acacia rupicola* (Rock Wattle)
Understorey species	Exotic grasses
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy), *Asparagus asparagoides* (Bridal Creeper)

Figure 26. *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*

5.3.13 Association 13 - Acacia pycnantha / Acacia imbricata Shrubland

This community was recorded in close proximity to the mining area and is assumed to be a result of a mass germination following the Wangary fire in 2005. Density of both *Acacia pycnantha* and *Acacia imbricata* was exceptionally high. This covered a large part of the southern facing slope on the Cullen property and dominated the area where *Eucalyptus cladocalyx* was absent.

Table 23. Summary of vegetation association 13 Acacia pycnantha / Acacia imbricata *Shrubland*

Representation	Small patch on southern slope of proposed mining area.
Conservation value	High
Vegetation condition	Moderate
Overstorey species	*Acacia pycnantha* (Golden Wattle)
Midstorey species	*Acacia imbricata* (Feathery Wattle), *Acacia rupicola* (Rock Wattle)
Understorey species	*Lomandra effusa* (Scented Mat-rush)
Threatened species	*Acacia imbricata* (Feathery Wattle), *Eremophila gibbifolia* (Coccid Emu-bush)
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 27. *Acacia pycnantha / Acacia imbricata* shrubland.

5.3.14 Association 14 - Gahnia filum Sedgeland

This community was located in association with a small swamp along the southern section of the Pillaworta Creek, prior to flowing into the large woodland remnant. The community is considered a vulnerable ecosystem under the *Provisional List of Threatened Ecosystems* (DEH, 2005), where it has historically suffered severe degradation from factors such as grazing and salinity, and only small areas conserved in the reserve system. A number of emergent species were evident throughout including *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia pycnantha* (Golden Wattle) and *Allocasuarina verticillata* (Drooping Sheoak). A number of exotics have invaded the swamp including *Senecio pterophorus* (African Daisy), *Rubus* sp. (Blackberry) and *Phalaris aquatica* (Phalaris), but only in low levels.

Table 24.Summary of vegetation association 14 Gahnia filum Sedgeland

Representation	Small swamp along the southern section of the Pillaworta Creek
Conservation value	High
Vegetation condition	Moderate
Overstorey species	Emergent *Acacia pycnantha* (Golden Wattle), *Melaleuca brevifolia* (Short-leaf Honey-myrtle) and *Allocasuarina verticillata* (Drooping Sheoak)
Midstorey species	*Gahnia filum* (Thatching Grass)
Understorey species	*Juncus kraussii* (Sea Rush), *Carex tereticaulis* (Rush Sedge)
Threatened species	-
Declared weeds	*Senecio pterophorus* (African Daisy), *Rubus* sp. (Blackberry)

Figure 28. *Gahnia filum* Sedgeland

5.3.15 Association 15 – Gahnia filum / Juncus kraussii Sedgeland

This small community was located in association with the creekline between Cullen and Harris properties (Harris Creek). The community is considered to be in a moderate condition with some level of weed invasion, mainly consisting of *Senecio pterophorus* (African Daisy) and *Hypochaeris radicata* (Rough Cats Ear). The occasional *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) was found growing in the channel.

Table 25. Summary of vegetation association 15 *Gahnia filum* / *Juncus kraussii* Sedgeland

Representation	Small section associated with the creekline between Cullen and Harris properties (Harris Creek)
Conservation value	Moderate - High
Vegetation condition	Moderate
Overstorey species	Scattered *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum)
Midstorey species	*Gahnia filum* (Thatching Grass)
Understorey species	*Juncus kraussii* (Sea Rush)
Threatened species	-
Declared weeds	*Senecio pterophorus* (African Daisy)

Figure 29. *Gahnia filum* / *Juncus kraussii* Sedgeland along the creekline between Cullen and Harris properties

5.3.16 Association 16, 17, 18 and 19 – Juncus kraussii Sedgeland

Juncus kraussii Sedgeland dominates a number of sections along the creeklines on the Cullen and Harris properties and the Pillaworta Creek. The communities vary slightly in terms of species composition with a number of different co-dominants including *Ficinia nodosa* (Knobby Club-rush) or *Juncus pallidus* (Pale Rush) and emergent species scattered throughout including *Melaleuca halmaturorum* (Swamp Paperbark), *Acacia pycnantha* (Golden Wattle) and/or *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum). The communities vary from poor to moderate depending mainly on the level of weed invasion. There are four associations that fall within this broader community description and have been mapped individually (Figure 7). The most dominant weeds present include *Senecio pterophorus* (African Daisy), *Rosa canina* (Dog Rose), *Juncus acutus* (Spike Rush) and *Oxalis pes-caprae* (Sour Sob).

Table 26. Summary of vegetation association 16, 17, 18 and 19 *Gahnia filum* Sedgeland

Representation	Small section associated with the creekline between Cullen and Harris properties (Harris Creek)
Conservation value	Moderate
Vegetation condition	Moderate- Poor
Overstorey species	Scattered *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum), *Melaleuca halmaturorum* (Swamp Paperbark), *Acacia pycnantha* (Golden Wattle)
Midstorey species	*Juncus pallidus* (Pale Rush), *Gahnia filum* (Thatching Grass)
Understorey species	*Juncus kraussii* (Sea Rush), *Ficinia nodosa* (Knobby Club-rush), *Lepidosperma viscidum* (Sticky Sword-sedge)
Threatened species	
Declared weeds	*Senecio pterophorus* (African Daisy), *Oxalis pes-caprae* (Sour Sob), *Rosa canina* (Dog Rose), *Asparagus asparagoides* (Bridal Creeper)

Figure 30. *Juncus kraussii* Sedgeland with scattered *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) along the Pillaworta Creek

Figure 31. *Juncus kraussii* Sedgeland along the Pillaworta Creek

Figure 32. *Juncus kraussii* Sedgeland along the creekline on Cullen property

5.3.17 Association 20 – Cyperus gymnocaulos / Juncus kraussii Sedgeland

This community was located along a small section of the creekline on the Cullen property. It was in similar condition (moderate - low) to that of other communities along the creekline, with high levels of *Senecio pterophorus* (African Daisy) throughout.

Table 27. Summary of vegetation association Cypress gymnocaulos / Juncus kraussii Sedgeland

Representation	Small section of the creekline on the Cullen property.
Conservation value	Moderate
Vegetation condition	Moderate- Poor
Overstorey species	*Juncus kraussii* (Sea Rush), *Cyperus gymnocaulos* (Spiny Flat-sedge)
Midstorey species	-
Understorey species	*Exotic grasses and Moraea setifolia* (Thread Iris)
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy), *Oxalis pes-caprae* (Sour Sob), *Rosa canina* (Dog Rose), *Asparagus asparagoides* (Bridal Creeper)

5.3.18 Association 21 – Acacia imbricata / Lissanthe strigosa / Acacia rupicola open shrubland *+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp*. spaffordii*

This association was typical on the hill crests and associated upper slopes in the eastern extent of the project area. The community possibly had a greater cover of eucalypts in previous years and has been reduced to a degraded shrubland with scattered *Eucalyptus cladocalyx* (Sugar Gums) and *Eucalyptus calycogona* ssp*. spaffordii* (Yeelana Mallee).

Table 28. Summary of vegetation association *Acacia imbricata / Lissanthe strigosa / Acacia rupicola open shrubland+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp*. spaffordii*

Representation	East of the project area on Cullen property
Conservation value	Moderate
Vegetation condition	Moderate- Poor
Overstorey species	*Acacia imbricata* (Feathery Wattle) / *Lissanthe strigosa* (Peach Heath)/ *Acacia rupicola* (Rock Wattle), Daviesia pectinata (Zig-zag Bitter Pea)
Midstorey species	-
Understorey species	*Austrostipa* sp. (Spear Grass), *Rytidosperma setaceum* (Wallaby Grass)
Threatened species	*Acacia imbricata* (Feathery Wattle), *Eucalyptus calycogona* ssp*. spaffordii* (Yeelana Mallee), *Daviesia pectinata* (Zig-zag Bitter pea)
Declared weeds	*Senecio pterophorus* (African Daisy), *Asparagus asparagoides* (Bridal Creeper)

Figure 33. Typical view of Association 21.

5.3.19 Association 22 – Acacia pycnantha +/- Allocasuarina verticillata Low Open Forest

This association was evident along the road reserves of Pillaworta Road. The *Acacia pycnantha* overstorey is extremely dense with an understorey defined by patch native grasses and exotics throughout its linear length. A number of eucalypts were also scattered along the roadside.

Table 29. Summary of vegetation association 22, *Acacia imbricata / Lissanthe strigosa / Acacia rupicola open shrubland+/- Eucalyptus cladocalyx +/- Eucalyptus calycogona* ssp. *spaffordii*

Representation	Patch along Pillaworta Road
Conservation value	Moderate
Vegetation condition	Poor
Overstorey species	*Acacia pycnantha* (Golden Wattle), *Allocasuarina verticillata* (Drooping Sheoak)
Midstorey species	-
Understorey species	*Austrostipa* sp. (Spear Grass), *Rytidosperma setaceum* (Wallaby Grass), *Dampiera rosmarinifolia* (Rosemary Dampiera)
Threatened species	-
Declared weeds	*Asparagus asparagoides* (Bridal Creeper), *Oxalis pes-caprae* (Sour Sob)

Figure 34. Typical view of Association 22.

5.3.20 Association 23 – Eucalyptus petiolaris Woodland

Association 23 was associated with the Pillaworta Creek on the western side of Pillaworta Road. The association is similar to Associations 11 and 12, with a different assemblage of understorey species. The understorey was dominated by *Acacia imbricata* (Feathery Wattle), *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia pycnantha* (Golden Wattle) and native grasses including *Austrostipa* sp. (Spear Grass) and *Rytidosperma setaceum* (Wallaby Grass). See Table 30. The waterholes associated with the Pillaworta Creek are characterised by a similar mix of species, but in different densities.

Table 30. Summary of vegetation association 23, *Eucalyptus petiolaris* Woodland

Representation	Pillaworta Creek
Conservation value	Moderate
Vegetation condition	Moderate- Poor
Overstorey species	*Eucalyptus petiolaris* (Eyre Peninsula Blue Gum), *Acacia pycnantha* (Golden Wattle)
Midstorey species	*Acacia imbricata* (Feathery Wattle) / *Lissanthe strigosa* (Peach Heath)/ *Acacia rupicola* (Rock Wattle), *Daviesia pectinata* (Zig-zag Bitter Pea)
Understorey species	*Austrostipa* sp. (Spear Grass), *Rytidosperma setaceum* (Wallaby Grass)
Threatened species	*Acacia imbricata* (Feathery Wattle), *Eucalyptus calycogona* ssp. *spaffordii* (Yeelana Mallee), *Daviesia pectinata* (Zig-zag Bitter pea)
Declared weeds	*Senecio pterophorus* (African Daisy), *Asparagus asparagoides* (Bridal Creeper)

Figure 35. Typical view of Association 23, Pillaworta Creek.

Waterhole 1

Waterhole 1 is defined by the same vegetation association (23) as the adjacent sections of Pillaworta Creek. It has low species diversity however, with a total of nine native species and two exotic species. There are no native species growing directly around the water's edge, possibly due to the high salinity levels within (~18,000EC) (D. Povey pers. comm, 2015). The fringes are dominated by *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia imbricata* (Feathery Wattle) and *Acacia pycnantha* (Golden Wattle). See Figure 36.

Figure 36. Waterhole 1.

Table 31. Summary of vegetation association 23, *Eucalyptus petiolaris* Woodland at Waterhole1

Representation	Waterhole 1
Conservation value	Moderate
Vegetation condition	Moderate - Poor
Overstorey species	*Eucalyptus petiolaris* (Eyre Peninsula Blue Gum), *Acacia pycnantha* (Golden Wattle)
Midstorey species	*Acacia imbricata* (Feathery Wattle) / *Melaleuca brevifolia* (Short-leaf Honey-myrtle)
Understorey species	**Paspalum vaginatum* (Salt Couch), **Rumex* sp. (Dock)
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy)

Waterhole 2

Waterhole 2 is also defined by the same vegetation association (23) as the adjacent sections of Pillaworta Creek. It is in better condition and has more native species directly surrounding the water's edge (See Figure 37). Native understorey is dominated by *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia imbricata* (Feathery Wattle), *Acacia pycnantha* (Golden Wattle) and patches of *Lepidosperma viscidum* (Sticky Sword-sedge) and scattered *Allocasuarina verticillata* (Drooping Sheoak). A number of weeds are prevalent around the fringe including *Paspalum vaginatum* (Salt Couch), *Rumex* sp. (Dock) and small amounts of *Phalaris aquatica* (Phalaris) and *Oxalis pes-capre* (Soursob). See Table 33 for complete species lists obtained from each of the waterholes surveyed.

Figure 37. Waterhole 2.

Table 32. Summary of vegetation association 23, *Eucalyptus petiolaris* Woodland at Waterhole2

Representation	Waterhole 2
Conservation value	Moderate
Vegetation condition	Good - Moderate
Overstorey species	*Eucalyptus petiolaris* (Eyre Peninsula Blue Gum), *Acacia pycnantha* (Golden Wattle)

Midstorey species	*Acacia imbricata* (Feathery Wattle) / *Melaleuca brevifolia* (Short-leaf Honey-myrtle)
Understorey species	*Lepidosperma viscidum* (Sticky Sword-sedge) , **Paspalum vaginatum* (Salt Couch), **Rumex* sp. (Dock)
Threatened species	*Acacia imbricata* (Feathery Wattle)
Declared weeds	*Senecio pterophorus* (African Daisy), *Oxalis pes-capre* (Soursob)

Table 33. Species list for Waterholes 1 and 2 along the Pillaworta Creek Waterhole2

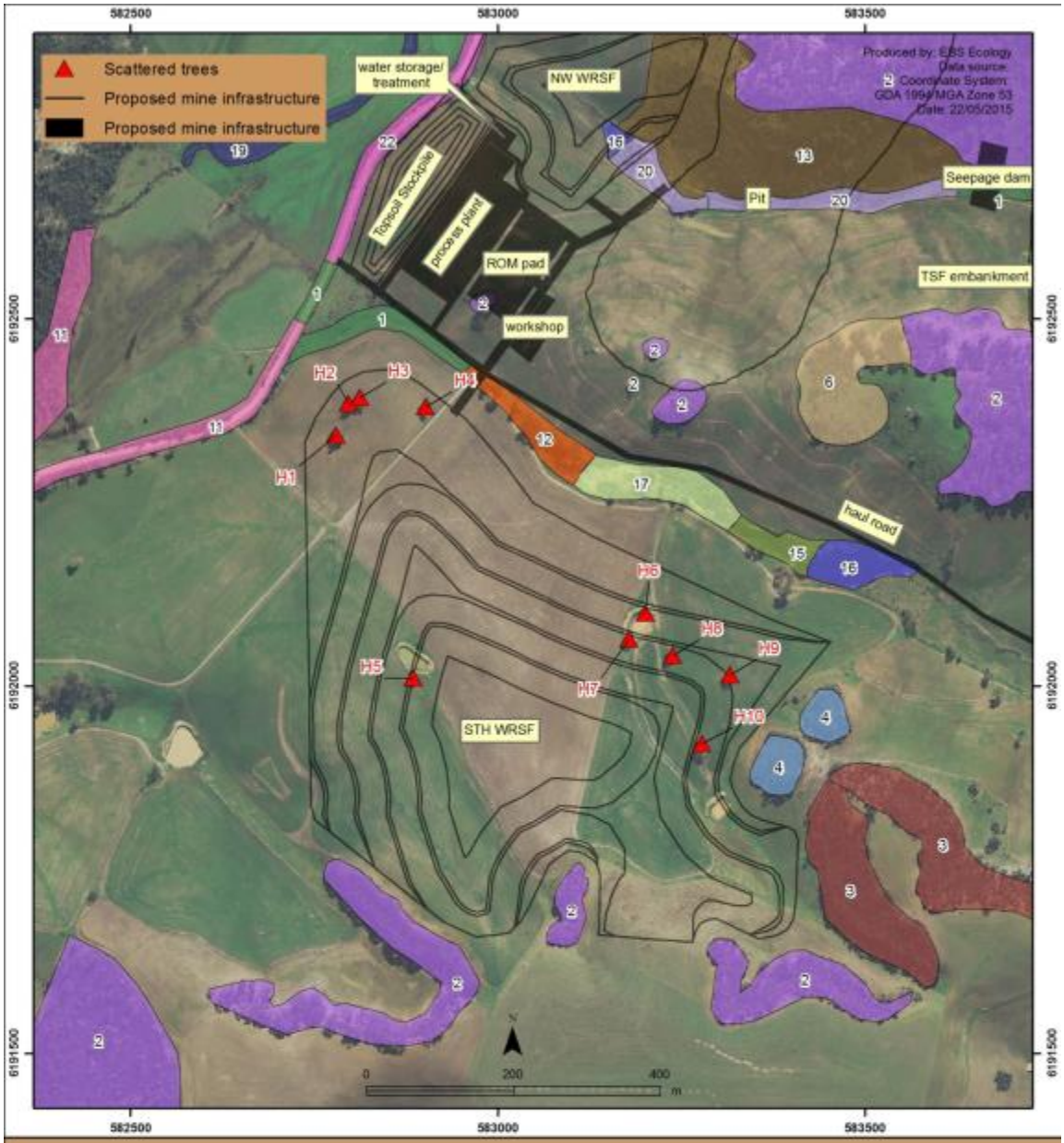
Scientific Name	Common Name	Cons. status		Waterhole	
		Aus	SA	1	2
Acacia imbricata	Feathery Wattle		R	✓	✓
Acacia paradoxa	Kangaroo Thorn				✓
Acacia pycnantha	Golden Wattle			✓	✓
Allocasuarina verticillata	Drooping Sheoak			✓	✓
Baumea juncea	Bare Twig-rush			✓	✓
Callistemon rugulosus	Scarlet Bottlebrush			✓	
Eucalyptus petiolaris	Eyre Peninsula Blue Gum			✓	✓
Ficinia nodosa	Knobby Club-rush				✓
Hibbertia paeninsularis					✓
Juncus kraussii	Sea Rush			✓	
Lasiopetalum behrii	Pink Velvet-bush				✓
Lepidosperma viscidum	Sticky Sword-sedge			✓	✓
Lissanthe strigosa ssp. subulata	Peach Heath				✓
Melaleuca brevifolia	Short-leaf Honey-myrtle			✓	✓
Melaleuca decussata	Totem-poles			✓	
Samolus repens	Creeping Brookweed			✓	
**Asparagus asparagoides*	Bridal Creeper				✓
**Oxalis pes caprae*	Soursob				✓
**Paspalum vaginatum*	Salt Couch			✓	✓
**Phalaris aquatica*	Phalaris				✓
**Rubus sp.*	Blackberry			✓	✓
**Senecio pterophorus*	African Daisy			✓	

5.3.21 Scattered Trees

A number of scattered trees are located within the footprint of the proposed southern Waste Rock Storage Facility. A total of 10 native trees were mapped and recorded as *Eucalyptus petiolaris* (Eyre Peninsula Bluegum) (Table 34. and Figure 38). Representative photos of trees are recorded in **Error! Reference source not found.**.

Table 34. Scattered Tree details.

Tree #	Species	Height (m)	Health (% Dieback)	Hollows	Tree Score
H1	*Eucalyptus petiolaris*	20	25	1 x small	**51.0**
H2	*Eucalyptus petiolaris*	18	15	nil	**40.5**
H3	*Eucalyptus petiolaris*	16	15	nil	**31.5**
H4	*Eucalyptus petiolaris*	16	55	nil	**18.3**
H5	*Eucalyptus petiolaris*	10	20	nil	**27.0**
H6	*Eucalyptus petiolaris*	5	20	nil	**20.3**
H7	*Eucalyptus petiolaris*	11	15	nil	**28.5**
H8	*Eucalyptus petiolaris*	11	20	nil	**27.0**
H9	*Eucalyptus petiolaris*	10	15	nil	**31.1**
H10	*Eucalyptus petiolaris*	14	30	nil	**26.7**



Vegetation association

1. Exotic dominated riparian area
2. *Eucalyptus cladocalyx* Woodland
3. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* Woodland
4. *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland
5. *Melaleuca uncinata* +/- *Allocasuarina verticillata* Shrubland
6. *Eucalyptus peninsularis* Low Woodland
7. *Xanthorrhoea semiplana* ssp. +/- *Allocasuarina verticillata* Grassland
8. *Allocasuarina verticillata* +/- emergent *Acacia pycnantha* Low Open Forest
9. *Eucalyptus* spp. Mixed Mallee
10. *Eucalyptus* spp. +/- *Callistemon rugulosa* Mallee
11. *Eucalyptus petiolaris* Woodlands +/- *Allocasuarina verticillata*
12. *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*
13. *Acacia pycnantha* / *Acacia imbricata* Shrubland
14. *Gahnia filum* Sedgeland
15. *Gahnia filum* / *Juncus kraussii* Sedgeland
16. *Juncus kraussii* Sedgeland
17. *Juncus kraussii* Sedgeland +/- scattered *Eucalyptus petiolaris*
18. *Juncus kraussii* Sedgeland +/- *Ficinia nodosa* +/- scattered *Melaleuca halmaturorum*
19. *Juncus kraussii* / *Ficinia nodosa* / *Juncus pallidus* Sedgeland +/- scattered *Acacia pycnantha*
20. *Cypress gymnocaulos* / *Juncus kraussii* Sedgeland
21. *Acacia imbricata* / *Lissanthe strigosa* / *Acacia rupicola* open shrubland +/- *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii*
22. *Acacia pycnantha* +/- *Allocasuarina verticillata* Low Open Forest
23. *Eucalyptus petiolaris* Woodland

Figure 38. Scattered Tree locations.

5.4 Targeted vegetation structures

A focus was directed at communities potentially impacted by the proposed mine and associated infrastructure, resulting in targeted surveys in areas of Sugar Gum Woodlands and Shrublands in close proximity to the proposed mining area and those in run-off zones and adjacent to potential access roads. Seven baseline flora sites were surveyed across the project area to obtain an indicative dataset of the species richness and type of vegetation structures present in the areas. A full list of all species observed in these plots is tabled in Appendix 1. The summary (Table 35.) shows that *Melaleuca uncinata* shrublands provided the highest species richness but this included 11 exotic species from 43. *Eucalyptus cladocalyx* woodlands have a mean species richness of 25 with the lowest exotic species recordings in these for all sites assessed.

Table 35. Baseline quadrat summary.

Site name	Vegetation Association	Species Richness	Exotic species	Threatened species
1	*Eucalyptus cladocalyx* Woodland	27	5	3
2	*Melaleuca uncinata* Shrubland	43	11	1
3	*Eucalyptus cladocalyx* Woodland	19	4	1
4	*Acacia pycnantha/Acacia imbricata* Shrubland	35	7	1
5	*Eucalyptus petiolaris* Woodland	30	7	1
6	*Eucalyptus petiolaris* (planted) Woodland	19	7	1
7	*Eucalyptus cladocalyx* Woodland	29	5	

The most widespread indigenous species were *Acacia imbricata, Acacia pycnantha* and *Acacia rupicola* recorded at six sites each. Exotic species *Avena barbata* and *Lachnagrostis* sp. were recorded at six sites and with *Senecio pterophorus* observed at five sites. *Asparagus asparagoides* (Bridal Creeper) was found in the understorey of *Eucalyptus petiolaris* woodlands at low density.

5.5 Threatened flora surveys

Six flora species of conservation significance were observed in close proximity to the proposed mining site (Table 36.). Two of these were rated at state and national level (Figure 39 and Figure 40), whilst three were state rated only. Threatened flora species recorded within the project area are mapped in Figure 41. The timing of the initial survey was not ideal for annual and emergent species and so a further survey was undertaken in spring 2014. Additional areas were also assessed during this survey, where one additional state rare species was recorded, *Eucalyptus calycogona* ssp. *spaffordii* (Spafford's Square-fruit Mallee). This species was the sub-dominant overstorey species in association with *Eucalyptus cladocalyx* (Sugar Gum) in woodland patches on the Harris property (See Figure 10). A number of additional locations of threatened flora species were recorded during the spring survey and have subsequently been included in the dataset (Figure 41.).

A number of orchid species were recorded throughout the vegetated areas, none of which were listed under State or Federal legislation. See Appendix 2.

Table 36. Threatened species recorded in baseline plots.

Species	Common	Conservation rating	
		AUS	SA
Pultenaea trichophylla	Tufted Bush Pea	EN	R
Olearia pannosa ssp. *pannosa*	Silver Daisy Bush	VU	V
Acacia imbricata	Feathery Wattle		R
Daviesia pectinata	Zig-zag Bitter Pea		R
Eremophila gibbifolia	Coccid Emu Bush		R
Eucalyptus calycogona ssp. *spaffordii*	Spafford's Square-fruit Mallee		R

Figure 39. *Olearia pannosa* ssp. *pannosa* (Silver Daisy Bush).

Figure 40. *Pultenaea trichophylla* (Tufted Bush Pea).

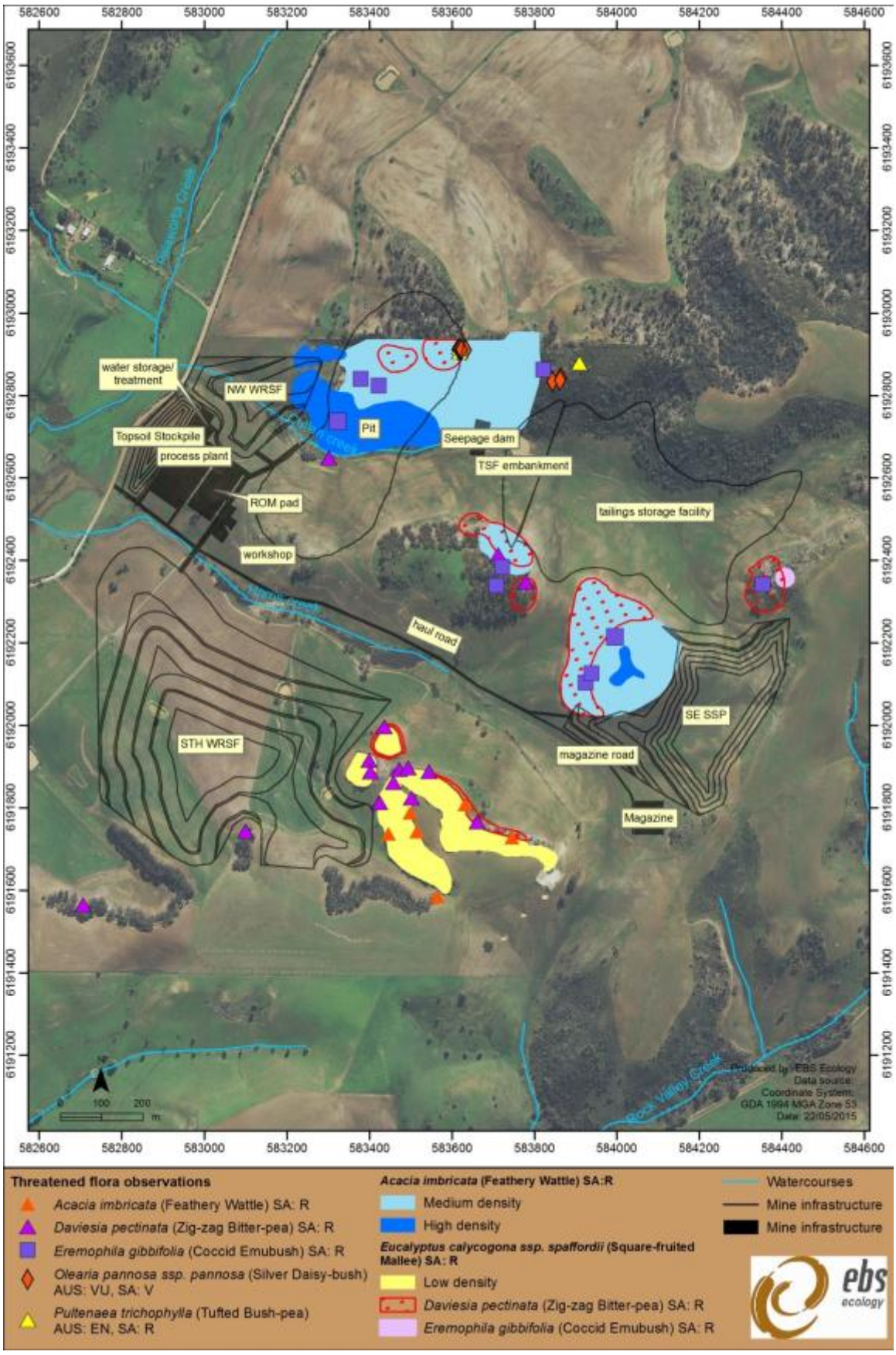


Figure 41. Threatened flora observations within the project area.

5.6 Fauna

Overall, 68 fauna species with 698 individuals were recorded across the project area. Six hundred and fifty seven birds were observed from 58 species, 15 reptile observations from four species and 25 mammals observed from six species. No Amphibians were recorded during the survey (Table 37).

5.6.1 Birds

Four of the bird species recorded are listed as threatened species. The Diamond Firetail (*Stagonopleura guttata*), which is rated state Vulnerable was observed within the project area (Figure 42). Three state rare species were also found in the project area; White-winged Chough (*Corcorax melanorhamphos*), Western Gerygone (*Gerygone fusca*) and the Shy Heathwren (*Calamanthus cautus*). See Figure 43 for locations of threatened fauna observed within the project area.

Four hundred and thirty-three birds and 36 species were recorded in the formalised bird sites whereas 225 individuals and 30 species were recorded opportunistically. Galahs were the most common bird observed across the project area with 185 records during the survey.

Chestnut Teals (*Anas castanea*) and the Australian Wood duck *(Chenonetta jubata*) were recorded using the dam which is located within proposed impact area.

Figure 42. Diamond Firetail (*Stagonopleura guttata*)

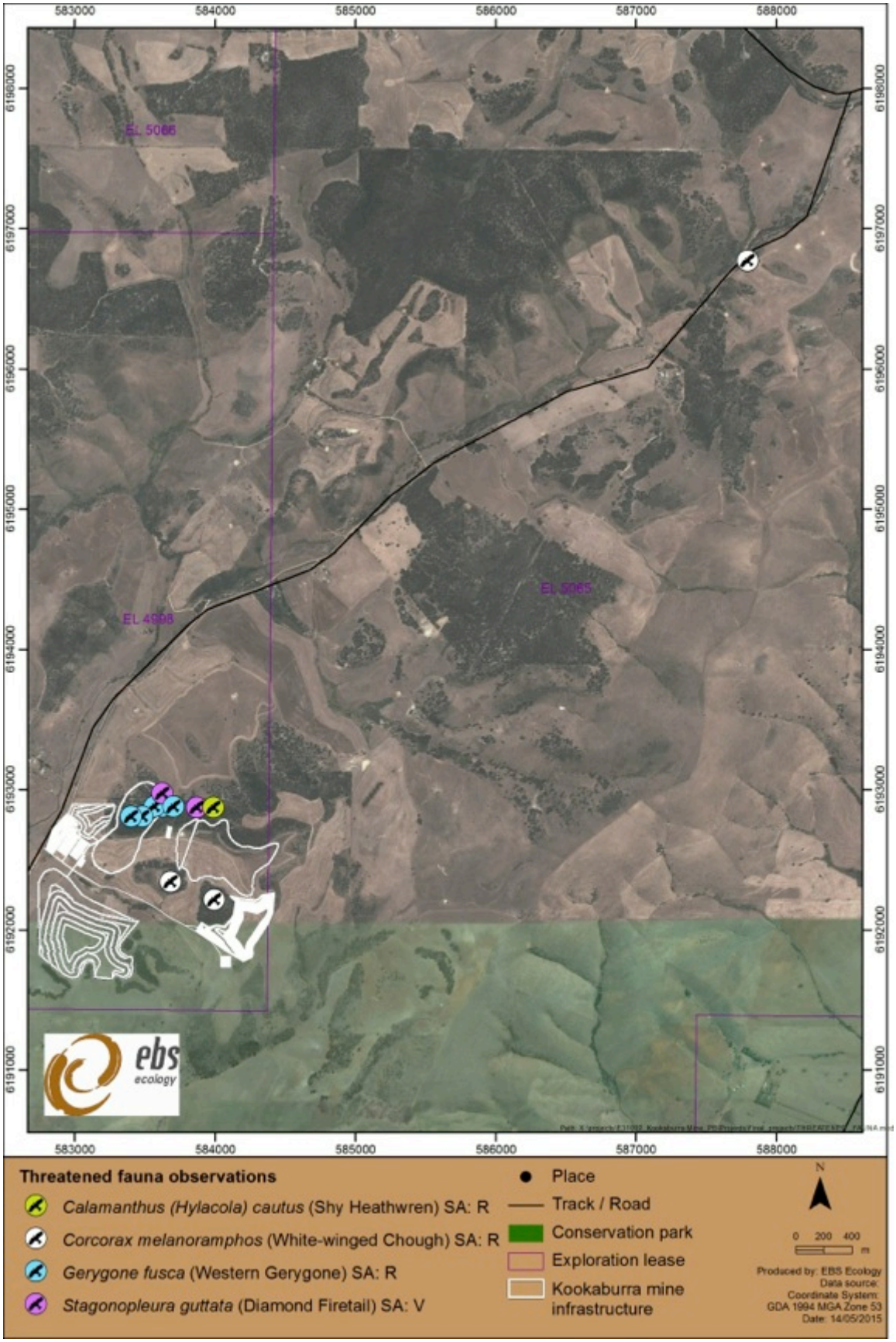


Figure 43. Threatened Fauna observations within the Kookaburra Gully project area.

Table 37. All fauna observations recorded in the project area

Family Name	Scientific Name	Common Name	EPBC	NWP	Site									
					1	2	3	4	5	6	7	8	Opp	Grand Total
Birds														
ACANTHIZIDAE	*Acanthiza apicalis*	Inland Thornbill				4								4
	Acanthiza chrysorrhoa	Yellow-rumped Thornbill											10	10
	Acanthiza uropygialis	Chestnut-rumped Thornbill			20									20
	Calamanthus (Hylacola) cautus	Shy Heathwren		R				3						3
	Gerygone fusca	Western Gerygone		R			2					3		5
	Sericornis frontalis	White-browed Scrubwren				3		10						13
	Smicrornis brevirostris	Weebill			34		6				4			44
ACCIPITRIDAE	*Aquila audax*	Wedge-tailed Eagle						1						1
ALCEDINIDAE	*Dacelo novaeguineae*	Laughing Kookaburra					2						3	5
ANATIDAE	*Anas castanea*	Chestnut Teal											6	6
	Chenonetta jubata	Australian Wood Duck											6	6
ARDEIDAE	*Egretta novaehollandiae*	White-faced Heron											5	5
ARTAMIDAE	*Artamus cinereus*	Black-faced Woodswallow											2	2
	Artamus cyanopterus	Dusky Woodswallow						4		2				6
	Gymnorhina tibicen	Australian Magpie			6	4						2	2	14
	Strepera versicolor	Grey Currawong				2					2	3		7
CACATUIDAE	*Cacatua sanguinea*	Little Corella				4								4
	Eolophus roseicapilla	Galah			26	8	24	27		6	8	12	74	185
	Nymphicus hollandicus	Cockatiel								4			1	5
COLUMBIDAE	*Ocyphaps lophotes*	Crested Pigeon				3							4	7

Family Name	Scientific Name	Common Name	EPBC	NWP	Site									
					1	2	3	4	5	6	7	8	Opp	Grand Total
	Phaps chalcoptera	Common Bronzewing					1							1
CORCORACIDAE	*Corcorax melanorhamphos*	White-winged Chough		R	6								12	18
CORVIDAE	*Corvus mellori*	Little Raven			9			6			6	4	6	31
CUCULIDAE	*Cacomantis pallidus*	Pallid Cuckoo			2									2
DICAEIDAE	*Dicaeum hirundinaceum*	Mistletoebird			1			2						3
ESTRILDIDAE	*Stagonopleura guttata*	Diamond Firetail		V				2				3		5
FALCONIDAE	*Falco berigora*	Brown Falcon											1	1
HIRUNDINIDAE	*Hirundo neoxena*	Welcome Swallow											2	2
	Petrochelidon nigricans	Tree Martin			4		2	4						10
LOCUSTELLIDAE	*Cincloramphus cruralis*	Brown Songlark											1	1
MALURIDAE	*Malurus cyaneus*	Superb Fairywren			6	8	4	14		6	6	3		47
	Malurus pulcherrimus	Blue-breasted Fairywren									4			4
MELIPHAGIDAE	*Acanthagenys rufogularis*	Spiny-cheeked Honeyeater											2	2
	Anthochaera carunculata	Red Wattlebird					2							2
	Epthianura albifrons	White-fronted Chat											2	2
	Melithreptus brevirostris	Brown-headed Honeyeater									9			9
	Phylidonyris novaehollandiae	New Holland Honeyeater											4	4
	Ptilotula penicillata	White-plumed Honeyeater						2						2
MONARCHIDAE	*Grallina cyanoleuca*	Magpielark											13	13
MOTACILLIDAE	*Anthus australis*	Australian Pipit											2	2
PACHYCEPHALIDAE	*Colluricincla harmonica*	Grey Shrikethrush											1	1
	Pachycephala pectoralis	Golden Whistler										1	1	2

Family Name	Scientific Name	Common Name	EPBC	NWP	Site									
					1	2	3	4	5	6	7	8	Opp	Grand Total
	Pachycephala rufiventris	Rufous Whistler											1	1
PARDALOTIDAE	*Pardalotus striatus*	Striated Pardalote			6		7				4	4		21
PASSERIDAE	**Passer domesticus*	House Sparrow											30	30
PETROICIDAE	*Eopsaltria australis*	Eastern Yellow Robin					1							1
PHALACROCORACIDAE	*Phalacrocorax varius*	Pied Cormorant											1	1
PODARGIDAE	*Podargus strigoides*	Tawny Frogmouth											1	1
PSITTACIDAE	*Barnardius zonarius*	Australian Ringneck			12	2	6	4						24
	Glossopsitta porphyrocephala	Purple-crowned Lorikeet									4	4		8
	Melopsittacus undulatus	Budgerigar											5	5
	Trichoglossus haematodus	Rainbow Lorikeet					2							2
RHIPIDURIDAE	*Rhipidura albiscapa*	Grey Fantail					3			2	2			7
	Rhipidura leucophrys	Willie Wagtail											2	2
STURNIDAE	**Sturnus vulgaris*	Common Starling											24	24
TIMALIIDAE	*Zosterops lateralis*	Silvereye				6		7						13
TURDIDAE	**Turdus merula*	Common Blackbird											1	1
Total Bird Abundance					**132**	**44**	**63**	**86**	+	**20**	**49**	**39**	**225**	**658**
Total Bird Diversity					**12**	**10**	**14**	**13**	+	**5**	**10**	**10**	**31**	**58**
Mammals														
MACROPODIDAE	*Macropus fuliginosus*	Western Grey Kangaroo											3	3
LEPORIDAE	*Oryctolagus cuniculus*	Rabbit (European Rabbit)											18	18
Total Mammal Abundance													**21**	**21**
Total Mammal Diversity													**2**	**2**

Family Name	Scientific Name	Common Name	EPBC	NWP	Site									
					1	2	3	4	5	6	7	8	Opp	Grand Total
Reptiles														
AGAMIDAE	*Pogona barbata*	Eastern Bearded Dragon					1						1	2
SCINCIDAE	*Cryptoblepharus pulcher*	Striped Wall Skink											4	4
	Ctenotus sp.	Ctenotus											2	2
	Tiliqua rugosa	Sleepy Lizard						2					5	8
	Pseudonaja textilis	Eastern Brown Snake											6	
Total Reptile Abundance							**1**	**2**					**18**	**21**
Total Reptile Diversity							**1**	**1**					**5**	**5**

*Introduced species # Recorded at Anabat sites + No bird surveys vegetation surveys only

5.6.2 Bats

Four common bat species were recorded on the Anabats. Due to the weather conditions, low numbers were recorded. The four species are:

- Gould's Wattled Bat (*Chalinolobus gouldii*)
- White-Striped Freetail Bat (*Austronomus australis*)
- Lesser Long-eared Bat (*Nyctophilus geoffroyi)*
- Southern Forest Bat *(Vespadelus regulus)*

5.6.3 Active searching / Opportune

Four species of common reptiles were recorded across the project area with a total of 15 individuals recorded. Four Elegant Snake-eyed Skinks (*Cryptoblepharus pulcher*), two *Ctenotus* sp, eight Sleepy Lizards (*Tiliqua rugosa*) and one Eastern Bearded Dragon (*Pogona Barbata*) were recorded. All were recorded opportunistically; two Sleepy Lizards and one Eastern Bearded Dragon were recorded within a bird/ vegetation survey site. Six Eastern Brown Snakes (*Pseudonaja textilis*) were encountered during the spring targeted survey.

Three Western Grey Kangaroos (*Macropus fuliginosus*) and three European Rabbits (*Oryctolagus cuniculus*) were recorded opportunistically.

5.6.4 Spotlighting

Spotlighting was completed across the site in the vehicle and by foot. Fifteen European Rabbits were recorded and two Laughing Kookaburras (*Dacelo novaeguineae*). Conditions for spotlighting were not ideal as it was cold, windy with scattered showers.

5.7 Fauna Habitat

Eucalyptus cladocalyx Woodlands provide high value fauna habitat within the area, where the state vulnerable Diamond Firetail as well as the state rare Gerygone and Shy Heathwren were all recorded. The mature hollows bearing trees provide suitable habitat for nesting birds and potentially Brush-tailed Possums. The dam located within the proposed mine area provides a good water source which attracts water birds and potentially threatened birds to use as habitat.

Eucalyptus petiolaris (Eyre Peninsula Blue Gum) woodlands located along creeklines within the Pillaworta Creek provide high value fauna habitat within the study area. Many of these woodlands have diverse vegetation structures, which allows many bird species suitable resources, and as such if

disturbed may create an impact for many species. Many small species of bird such as Blue-breasted and Superb Fairy-wren would frequent these areas and potentially breed in the dense understorey, as well as being of importance to conservational rated species such as the Shy Heathwren.

Other species would use the larger and established trees, with species such as the Purple Crowned Lorikeet frequently observed feeding in the treetops along this creekline. Others such as the state listed Western Gerygone would also be found in the upper regions of the eucalypts, feeding on insects or lerp.

These woodlands also provide habitat for species such as the Eyre Peninsula Yellow-tailed Black Cockatoo, a species which is known to utilise creeklines lined with Eyre Peninsula Blue-gums within the Koppio Hills region, feeding or potentially using these sites with mature tree hollows for breeding (Way and Weenen, 2008). The larger trees with hollows also are an important habitat for the Brush-tailed Possums as well as small mammal species such as micro bats.

Historically the Pillaworta creekline were also one of the strongholds of the Southern Emu-wren. These were however, generally located to the south of the study area, closer to the Tod Reservoir. Southern Emu-wren does not tend to utilise the woodland per se, but they can be found in the adjoining denser shrubs and bushes. This species is however, unlikely to be found along this creekline due to large scale fragmentation of habitat and populations being affected by stochastic events such as the 2005 fires, a reduction or complete removal of habitat will render any migrations impossible.

The waterholes located along the creekline may also support a number of waterfowl species, with ducks, moor hens, herons all utilising these water sources. They may also support other native species such as kangaroos, possums and many of the microbats.

6 DISCUSSION

6.1 General flora observations

Results of the mapping and vegetation surveys show the following key findings;

- There are a number of different vegetation communities present within the study area, mostly fragmented which contain a moderate level of species diversity dependent on level of grazing impacts and disturbance by weed invasion.
- There are four assessed patches of the nationally endangered Threatened Ecological Community (TEC) Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland
- Threatened species are common within these woodland and shrubland communities.
- Declared weeds are widespread throughout the project area.
- *Eucalyptus cladocalyx* Woodlands and associated communities provide high habitat values for a range of species by providing valuable habitat within a variety of vegetation strata.

The proposed vegetation clearance associated with the mining proposal for this area poses a threat to the recorded nationally and state listed flora species which rely on the moderately degraded, but intact woodland communities. The level of impact will need to be further quantified along with the wider impacts posed to the species' at a local and regional level. Threatened species recorded at this survey were found to be widespread. A targeted survey conducted in spring 2014 showed that annual herbaceous species, particularly from the family Orchidaceae (Orchids), were present, however none of the species detected were found to be listed under State or Federal legislation.

The large areas which have been previously cleared of vegetation provide little value from an ecological perspective. Utilisation of the cleared areas for associated infrastructure, such as tailings and waste rock storage facilities and other storage areas would aim to minimise the need for excessive vegetation clearance, thereby reducing habitat destruction and SEB offset requirements under the *Native Vegetation Act, 1991.*

A number of communities were assessed and mapped by L. Bebbington (2015) who was commissioned by the Borthwick family to undertake a vegetation assessment of the remnant vegetation block located directly north of the Cullen – Borthwick boundary. Eight communities were described in the report with general comments regarding condition provided, however no species lists were included in the report or the location data for threatened flora species. Two state rare species, *Acacia imbricata* (Feathery Wattle) and *Daviesia pectinata* (Zig-zag Bitter pea) were recorded throughout the *E. cladocalyx* Low Open Woodland areas and the outwash lower section of the gully, which is reportedly characterised by *Acacia rupicola* / *Acacia imbricata* Low Open Shrubland. These observations are consistent with that of EBS Ecology taken from the boundary fence during various field surveys, along with some of the vegetation communities listed and described for the Borthwick property. A number of threatened fauna species were

also recorded during a surveying expedition on the Borthwick property by D. Povey (2015), which are consistent with EBS Ecology records from the adjacent Cullen remnant.

In the absence of a thorough survey of the area, threatened flora data will need to obtained and verified in addition to an assessment of the condition of the vegetation to properly assign SEB ratios, prior to calculation of the final SEB.

6.1.1 Weed species and soil pathogen management

Weed management strategies (including weed hygiene procedures) should be implemented to ensure that weed species are not introduced onto the site or further spread throughout the sites or spread off site. Ongoing weed monitoring and management as required is recommended to ensure that the construction and operation of the proposed mine is not increasing weed abundance, distribution or diversity across the site. The following weed species are particularly problematic on site and will need to be addressed in a site Weed Management Plan

- *Senecio pterophorus* (African Daisy) was extremely widespread throughout the wider area and localised control of this species may be unrealistic.
- *Asparagus asparagoides* (Bridal Creeper) was found in the understorey of *Eucalyptus petiolaris* woodlands at low density and should be controlled where possible or further disturbance to native vegetation is likely.

Given that the project site is located in a 'Moderate Risk' zone for Phytophthora (SA DEH, 2002a) the following principles apply and should be incorporated within the project's environmental management plan(s):

1. Ensure vehicles, equipment and footwear is clean. Visual inspections should confirm that vehicles, equipment and footwear are free of clods of soil, slurry (water and soil mixture) and plant material (in particular roots and lower stem). Dust and grime adhering to vehicles need not be removed.

2. Ensure that raw materials, such as rubble, gravel, sand, soil and water brought into this Zone are free of Phytophthora.

3. Ensure that all floras brought into this Zone are free of Phytophthora. (SA DEH, 2002a).

6.2 Matters of national significance

6.2.1 Threatened Ecological Communities

No Critically Endangered Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia was found to occur in the survey area, however a small patch of *Eucalyptus odorata* Open Mallee over Native Tussock Grassland was recorded by L. Bebbington in a survey undertaken in April 2015. Without further

assessment, it is not possible to confirm the presence of the Nationally Critically Endangered Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia from the mapped area described by Bebbington as a state listed *Eucalyptus odorata* Open Mallee over Native Tussock Grassland, as it was not assessed against the criteria set out in the *EPBC Act Policy Statement 3.7, Peppermint Box (Eucalyptus odorata) Grassy Woodland of South Australia and Iron-grass Natural Temperate Grassland of South Australia* (2007).

A small patch of the Threatened Ecological Community Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland (effective from August 2013) was mapped the along the creekline bordering the Harris and Cullen properties and has been subsequently assessed against the condition thresholds within the *Environment Protection and Conservation Act 1999 (EPBC Act) Approved Conservation Advice for the E*yre *Peninsula Blue Gum* (*Eucalyptus petiolaris*) *Woodland*. See mapped patch (Association 12) in Figure 9. Vegetation Association mapping within project area. (Focussing on proposed waste rock storage facility).

. The total patch was measured at approximately 0.73ha. Overstorey individuals are large and mature, but there was no evidence of recruitment in the population, however there is a high proportion of weeds in the understorey, which is likely to be inhibiting seedling germination to some degree. The understorey contained scattered native species persisting as individuals and in small patches with exotic grasses and herbs dominating the ground cover. See Appendix 2 for total plant list collected during field survey. Table 6 show the results of the sample quadrat. The patch met the condition thresholds for listing as the nationally endangered Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland ecological community (C1 - Medium Quality). See

Figure 26 for typical photo taken of the community.

The community also occurs within the roadside corridor to the north and south of the project area along Pillaworta Road, and along the Pillaworta Creek south of the property. A broad assessment was undertaken along the Pillaworta Creek to ascertain whether this community meets the criteria outlined

under the Commonwealth Conservation Advice. Table 6 shows how the patch qualifies as "B" - High Quality.

Two waterholes along the Pillaworta Creek were also assessed (both met the key diagnostic characteristics and condition thresholds for the ecological community and therefore qualified as C1 - Medium Quality). See Table 6.

The patches are all considered critical to the survival of the Eyre Blue Gum Woodland under the Commonwealth Conservation Advice. This is because the ecological community has a restricted geographic extent and is highly fragmented (Threatened Species Scientific Committee (2013)). To assist in the preservation of the patch, it is recommended that a buffer zone of at least 15m be maintained from the edge of the canopy cover or outer edge of the patch. The purpose of the buffer zone is to protect and manage the patch and to help avoid potential significant impacts to the ecological community. The buffer zone will help protect the root zone of edge trees and the ecological community from surrounding land use. Changes in land-use within the buffer zone must not have a significant impact on the ecological community itself, but there are exemptions for continuing use (Threatened Species Scientific Committee (2013)).

6.2.2 Nationally threatened flora

Two species of national significance were recorded within the project area. A summary of these is below.

Olearia pannosa subsp. pannosa* (*Silver Daisy-bush*), *EPBC Vulnerable, State Vulnerable

A widespread but rare species occurring also on the Fleurieu Peninsula, South East, Yorke Peninsula, Mid North and Kangaroo Island. Two main sub-populations on EP occurring in the Cleve Hills to Coolanie Range area, north-west of Cowell, and in the Koppio Hills and Greenpatch area, Lower Eyre Peninsula. The perennial, low spreading shrub occurs in the understorey of mallee, woodland and forest communities. The southern population is associated with *Eucalyptus cladocalyx* (Sugar Gum), *Allocasuarina verticillata (*Drooping Sheoak), *Melaleuca uncinata (*Broombush), and less often with *Callitris* sp. (Native Pine). The species was recorded adjacent the proposed pit area and therefore outside the area of impact.

Pultenaea trichophylla (Tufted Bush-pea), EPBC Endangered, State Rare

Endemic to southern Eyre Peninsula the species only occurs in Eyre Hills IBRA subregion, where it is considered rare but stable (Gillam and Urban 2009, Pobke 2007). Numerous recent records from 20 subpopulations in the Koppio Hills between Tod Reservoir to just north of Ungarra, The species is commonly associated with *Eucalyptus cladocalyx* (Sugar Gum) woodlands, *Eucalyptus peninsularis* (Cummins Mallee) low woodland/mallee, Drooping Sheoak (*Allocasuarina verticillata*) low open woodland over *E. odorata* (Peppermint Box) and *E. angulosa* (Coast Ridge-fruited Mallee) and *E. foecunda* (Hooked Mallee), mostly over *Melaleuca uncinata* (Broombush) understoreys. Also occurs in tall shrublands dominated by *Melaleuca uncinata* (Broombush) and *Acacia* spp. The species was recorded adjacent the proposed pit area and therefore outside the area of impact.

6.3 FAUNA

Overall across the project area 698 individuals from 68 species were recorded. 657 birds were observed from 58 species, 15 reptile observations from four species recorded and 25 mammals observed from six species.

Bird species recorded good numbers whereas mammal species were low; four bat species were recorded on Anabats, Western Grey Kangaroos and the introduced European Rabbit.

Whilst Gould's wattled Bat (*Chalinolobus gouldii*), White-Striped Freetail Bat (*Tadarida australis*), Lesser Long-eared Bat *(Nyctophilus geoffroyi)* and the Southern Forest Bat (*Vespadelus regulus*) were recorded on this survey, it is expected that three additional species Chocolate Wattled Bat (*Chalinobus morio*), Central Greater Long-eared Bat (*Nyctophilus major ssp. tor*) and the Inland Forest Bat (*Vespadelus baverstocki*) are likely inhabitants. None of these bats are listed under EPBC or the NPW Act.

Frogs that would likely be common to the low lying areas and around creek lines in the area are the Common Froglet (*Crinia signifera*) and the Spotted Grass Frog (*Limnodynastes tasmaniensis*).

Due to the weather conditions during the survey active searching and opportune recordings of mammals and reptiles across the site were relatively low. It is likely that more species would be recorded during more favourable conditions.

No nationally threatened fauna species were recorded on the December 2013 survey, however four state threatened bird species were recorded, including the state Vulnerable Diamond Firetail (*Stagonopleura guttata*) and state Rare White-winged Chough (*Corcorax melanorhamphos*), Western Gerygone (*Gerygone fusca*) and the Shy Heathwren (*Calamanthus cautus*).

Diamond Firetail (Stagonopleura guttata) State Vulnerable

The state Vulnerable Diamond Firetail was observed during the survey, with five individuals recorded. Diamond Firetails live in a wide range of eucalypt dominated vegetation communities that typically have a grassy understorey, including woodland, forest and mallee. This preferred habitat type correlates with the grassy understorey/Sugar Gum Woodland upper-storey habitat where the Diamond Firetails were observed within the project area. They are ground-feeders that predominantly eat ripe and half-ripe seeds of various grasses but are also known to feed on seeds of herbs, bushes and trees as well as insects and worms (Immlemann 1982, Read 1994). Their preferred habitat includes *E. camaldulensis* (Red Gum), *E. leucoxylon* (Blue Gum), *Callitris gracilis* (Southern Cypress Pine) or *Allocasuarina luehmannii* (Buloke).

Shy Heathwren (Calamanthus cautus) State Rare.

The Shy Heathwren inhabits mallee woodlands with a relatively dense understorey of shrubs and heath plants. Also occurs at low densities in rocky hilltop vegetation with a thick shrub layer such as Broombush or Tea-tree. This species was observed during the December 2013 EBS survey in

Eucalyptus cladocalyx (Sugar Gum woodland) with thick understorey *of Acacia imbricata* (Feathery Wattle) within the proposed mine area.

White-winged Choughs (Corcorax melanorhamphos) State Rare

Eighteen individuals of White-winged Choughs were observed during the survey within the project area. This species was observed at three separate locations within woodland habitat south of the proposed mine area and within the vegetation corridor to the north of the proposed mine area. This species is generally found in open forests and woodlands. They tend to prefer the wetter areas, with lots of leaf-litter for feeding and available mud for nest building. They forage through the leaf litter in search of beetles, worms, insects and snails. White-winged Choughs build deep, cup-shaped nest of grasses held together with mud or sometimes manure in a tree fork. Breeding is communal with all members of the family helping to raise the young.

Western Gerygone (Gerygone fusca) State Rare

The state rare Western Gerygone was observed during the survey, with five individuals recorded. It forages in tree canopies and often hovers about outer foliage; It is generally solitary or in pairs, rarely in small mixed or same-species parties.

The proposed mine may have a localised impact on the state rated fauna species. Populations in the area may be displaced and forced into neighbouring habitat in response to impacts to vegetation.

It is possible that the Brush-tailed Possum could potentially utilise the area. The nearest record from the BDBSA is 3km south-west of the proposed mine area and was recorded in 1970. There is some potential habitat available, particularly hollow bearing trees within the woodland community, however there were no scats and/or scratches detected on trees within the proposed mine area. There is some evidence to suggest the species inhabits the woodland areas, albeit in low numbers, with occasional observations made by local landholders (Cullen pers. comm.).

6.4 Potential impact of the mine on flora and fauna

Potential impacts associated with the construction and operation of the proposed mine include:

- direct vegetation clearance for the mine pit, tracks and associated infrastructure
- loss of flora and fauna habitat
- habitat fragmentation/impact on fauna and flora movements locally (i.e. vehicle tracks, mine pit)
- direct fauna mortality (i.e. vehicle collision)
- noise disturbances
- artificial light sources and potential impact on fauna
- dust generation and associated impacts to vegetation
- changes to hydrology and run-off
- accumulation of litter
- introduction and/or spread of pest species

7 RECOMMENDATIONS

The following recommendations have been made to assist with minimising potential impacts posed by the project.

7.1 Legislative approvals

EPBC Act, 2003

- Due to the Matters of National Environmental Significance within the proposed development area, a referral under the EPBC Act may be required for the project. Extensive consultation with DSEWPaC will also be required.

  The nationally endangered ecological community Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Woodland was recorded as potentially occurring within the roadside corridor to the north and south of the project area along potential access routes. A detailed assessment may be required to ascertain whether these additional communities meet criteria outlined under the Commonwealth Conservation Advice, should potential impacts be anticipated.

Native Vegetation Act, 1991

- The required SEB (Significant Environmental Benefit) offset will need to be calculated based on the extent of vegetation removal. The provision of an SEB can be undertaken in several forms including managing and conserving areas of native vegetation, undertaking native vegetation restoration activities or making a payment into the Native Vegetation Fund.

7.2 General recommendations

- Any areas where detailed surveys did not occur due to access issues will need to be surveyed in detail if any impacts are to occur.

- If the project is to proceed, a detailed environmental management plan, incorporating best practice principles, should be developed and implemented. This would include, but would not be limited to, threatened species management, vegetation management, weed management and rehabilitation requirements.

- Best practice environmental management measures should be adopted during and following the construction phase. Ensure that any construction machinery is clean and free from soil pathogens such as Phytophthora and any plant materials before entering the area. This includes performing appropriate hygiene before entering and leaving the project area to avoid potential spread.

- Control of the declared and environmental weed species should be undertaken in the area prior to construction works commencing to help prevent the spread of weeds within the construction site.

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9 APPENDICES

Appendix 1. Flora species observed within formal sites within the project area during the field survey.

Scientific name	Common name	Conservation status		Vegetation Sites						
		Aus	SA	1	2	3	4	5	6	7
Acacia imbricata	Feathery Wattle		R	N	N	N	N	T	2	
Acacia paradoxa	Kangaroo Thorn									2
Acacia pycnantha	Golden Wattle			N	T	1	2	T	T	
Acacia rupicola	Rock Wattle			T	T	2	2		2	3
Acacia spinescens	Spiny Wattle				N			N		
Acaena echinata	Sheep's Burr						T			
Acrotriche sp.	Ground-berry				T					
Allocasuarina verticillata	Drooping Sheoak							N	N	
Asparagus asparagoides	Bridal Creeper						N	1	N	
Astroloma conostephioides	Flame Heath				T	N	N	N		N
Astroloma sp.	Heath						N			
Austrostipa elegantissima	Feather Spear-grass			N						
Austrostipa flavescens	Coast Spear-grass				T	T				
Austrostipa sp.	Spear-grass			N	T		T	1		
Avena barbata	Bearded Oat			N	T	T	T	1	2	
Babingtonia behrii	Silver Broombush				2			T		T
Briza maxima	Large Quaking-grass				T					
Bromus sp.	Brome			N			T	1	1	
Callistemon rugulosus	Scarlet Bottlebrush								T	
Centaurium sp.	Centaury									1
Cheilanthes austrotenuifolia	Annual Rock-fern									1
Correa sp.	Correa				N					
Cynoglossum australe	Australian Hound's-tongue			N						

Scientific name	Common name	Conservation status		Vegetation Sites						
		Aus	SA	1	2	3	4	5	6	7
Cynosurus sp.	Dog's-tail Grass								1	
Dampiera dysantha	Shrubby Dampiera				T					
Daucus glochidiatus	Native Carrot					N	N			
Daviesia pectinata	Zig-zag Bitter-pea		R	N						
Dianella revoluta var.	Flax Lily			N			T	T	N	N
Dodonaea hexandra	Horned Hop-bush									T
Dysphania sp.	Crumbweed/Rat Tails			N	1	T	T	N		
Ehrharta calycina	Perennial Veldt Grass							3	1	
Ehrharta longiflora	Annual Veldt Grass			N	T	T				
Ehrharta sp.	Veldt Grass						T			
Eremophila gibbifolia	Coccid Emubush		R	N						
Erodium sp.	Heron's-bill/Crowfoot						T			
Eucalyptus cladocalyx ssp.	Sugar Gum			2		3	3			2
Eucalyptus dumosa	White Mallee				N					
Eucalyptus petiolaris	Eyre Peninsula Blue Gum							3	2	
Eutaxia microphylla	Common Eutaxia				2		T	T		1
Exocarpos aphyllus	Leafless Cherry			N	N					
Goodenia ovata	Hop Goodenia					1	1			
Gramineae sp.	Grass Family								2	
Grevillea aspera	Rough Grevillea							T		N
Hakea rugosa	Dwarf Hakea				N					
Hakea sp.	Hakea/Needlewood				N		N			
Haloragis sp.	Raspwort			N	1	1	1			1
Helichrysum leucopsideum	Satin Everlasting							N		
Hibbertia exutiacies	Prickly Guinea-flower			N	2		T	T		T
Hibbertia virgata	Twiggy Guinea-flower							T		
Juncus sp.	Rush							N	N	

Scientific name	Common name	Conservation status		Vegetation Sites						
		Aus	SA	1	2	3	4	5	6	7
Kennedia prostrata	Scarlet Runner							N		
Lachnagrostis sp.	Blown-grass			N	T	1	1	N		1
Lasiopetalum behrii	Pink Velvet-bush			N						
Lepidosperma viscidum	Sticky Sword-sedge				T		N			N
Lissanthe strigosa ssp. subulata	Peach Heath					N				
Logania nuda	Leafless Logania				N					T
Lolium perenne	Perennial Ryegrass			N						
Lolium sp.	Ryegrass				T					
Lomandra collina	Sand Mat-rush				T					
Lomandra effusa	Scented Mat-rush			N			1	N		
Medicago polymorpha var. polymorpha	Burr-medic				T		T	N	1	N
Melaleuca decussata	Totem-poles								N	
Melaleuca lanceolata	Dryland Tea-tree						N			
Melaleuca uncinata	Broombush			N	2					T
Moraea setifolia	Thread Iris				1	T	T			
Neurachne alopecuroidea	Fox-tail Mulga-grass				T					1
Olearia ramulosa	Twiggy Daisy-bush									T
Oxalis perennans	Native Sorrel			N	T		N			
Ozothamnus retusus	Notched Bush-everlasting			N	T	N				
Ozothamnus sp.	Bush-everlasting						N			
Pimelea sp.	Riceflower				T	T	T			T
Prostanthera spinosa	Spiny Mintbush									1
Pultenaea sp.	Bush-pea						N			
Rhagodia candolleana ssp.	Sea-berry Saltbush							N		
Rytidosperma setaceum	Small-flower Wallaby-grass			1		1	1	1		
Rytidosperma caespitosum	Wallaby Grass				T		1		1	1

Scientific name	Common name	Conservation status		Vegetation Sites						
		Aus	SA	1	2	3	4	5	6	7
Senecio pterophorus	African Daisy			N	T	T	T	2		
Sonchus oleraceus	Common Sow-thistle				T			N	N	
Spyridium parvifolium	Dusty Miller				N					
Stenanthemum leucophractum	White Cryptandra									N
Taraxacum officinale	Dandelion				T					T
Trifolium sp.	Clover				T		1	1	1	1
Vittadinia cuneata var.	Fuzzy New Holland Daisy							T		
Vulpia myuros f.	Fescue			1	T					1
Wahlenbergia sp.	Native Bluebell									T
Xanthorrhoea semiplana ssp.	Yacca				T					T

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. *: Introduced.

Appendix 2. Flora species within each vegetation association recorded during the field surveys.

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Acacia continua	Thorn Wattle			✓						✓															
Acacia gillii	Gill's Wattle			✓																					
Acacia imbricata	Feathery Wattle		R	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓								✓		✓
Acacia myrtifolia	Myrtle Wattle			✓					✓																
Acacia paradoxa	Kangaroo Thorn			✓				✓	✓		✓														
Acacia pycnantha	Golden Wattle			✓			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓		✓	✓	✓
Acacia rupicola	Rock Wattle			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓								✓	✓		✓
Acacia spinescens	Spiny Wattle			✓			✓		✓	✓			✓										✓		
Acaena echinata	Sheep's Burr			✓					✓						✓	✓									
Acrotriche sp.	Ground-berry						✓		✓																
Adenanthos terminalis	Yellow Grand Flower			✓						✓	✓														
Allocasuarina verticillata	Drooping Sheoak			✓					✓	✓	✓		✓			✓								✓	✓
Alyogyne huegelii	Native Hibiscus												✓												
Anthosachne scabra	Native Wheat-grass			✓																					
Arachnorchis septuosa	Eyre Peninsula Spider-orchid			✓																					
Astroloma conostephioides	Flame Heath			✓			✓		✓	✓			✓		✓										
Astroloma humifusum	Cranberry Heath				✓																		✓		
Austrostipa elegantissima	Feather Spear-grass			✓				✓			✓														
Austrostipa flavescens	Coast Spear-grass			✓			✓																		
Austrostipa sp.	Spear-grass			✓			✓	✓		✓	✓	✓	✓		✓								✓	✓	
Avena barbata	Bearded Oat			✓			✓	✓	✓	✓	✓	✓	✓		✓										
Babingtonia behrii	Silver Broombush			✓			✓		✓		✓		✓												
Baumea juncea	Bare Twig-rush																								✓

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Beyeria sp.	Turpentine Bush			✓							✓														
Briza maxima	Large Quaking-grass			✓			✓	✓	✓	✓	✓														
Bromus sp.	Brome			✓					✓	✓	✓		✓		✓										
Bursaria spinosa ssp.	Bursaria								✓		✓	✓													✓
Callistemon rugulosus	Scarlet Bottlebrush										✓	✓							✓						✓
Calocephalus citreus	Lemon Beauty-heads			✓							✓														
Carex tereticaulis	Rush Sedge															✓			✓			✓			
Chamaescilla corymbosa var. corymbosa	Blue Squill			✓			✓																		
Cheilanthes austrotenuifolia	Annual Rock-fern			✓																					
Correa reflexa var.	Correa			✓					✓	✓	✓														
Cynoglossum australe	Australian Hound's-tongue									✓	✓														
Cyperus gymnocaulos	Spiny Flat-sedge																					✓			
Dampiera dysantha	Shrubby Dampiera						✓			✓	✓														
Dampiera rosmarinifolia	Rosemary Dampiera			✓																				✓	
Dampiera sp.	Dampiera			✓							✓														
Daucus glochidiatus	Native Carrot			✓							✓														
Daviesia asperula ssp. obliqua	Eyre Peninsula Bitter-pea			✓																		✓	✓		
Daviesia pectinata	Zig-zag Bitter-pea		R	✓	✓	✓		✓															✓		
Dianella revoluta var.	Flax Lily			✓					✓	✓	✓		✓		✓										
Diuris pardina	Spotted Donkey-orchid						✓																		
Dodonaea hexandra	Horned Hop-bush			✓							✓														
Dysphania sp.	Crumbweed/Rat Tails			✓			✓						✓												
Einadia nutans ssp.	Climbing Saltbush			✓				✓			✓														

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Eremophila behriana	Rough Emubush			✓						✓	✓														
Eremophila gibbifolia	Coccid Emubush		R												✓								✓		
Erodium sp.	Heron's-bill/Crowfoot			✓																					
Eucalyptus calycogona ssp. spaffordii	Spafford's Square-fruit Mallee		R			✓																	✓		
Eucalyptus cladocalyx ssp.	Sugar Gum					✓	✓	✓	✓	✓													✓	✓	
Eucalyptus dumosa	White Mallee																								
Eucalyptus leptophylla	Narrow-leaf Red Mallee			✓						✓	✓	✓													
Eucalyptus petiolaris	Eyre Peninsula Blue Gum												✓	✓			✓		✓	✓				✓	
Eucalyptus odorata	Peppermint Box			✓							✓	✓										✓			
Eucalyptus peninsularis	Merrit			✓		✓		✓			✓														
Eucalyptus phenax	White Mallee						✓				✓	✓													
Eutaxia microphylla	Common Eutaxia			✓	✓		✓	✓	✓	✓	✓		✓		✓										
Exocarpos aphyllus	Leafless Cherry			✓			✓																		
Ficinia nodosa	Knobby Club-rush																		✓	✓					✓
Gahnia filum	Thatching Grass															✓	✓	✓		✓		✓			✓
Gonocarpus mezianus	Broad-leaf Raspwort			✓	✓																				
Gonocarpus sp.	Raspwort			✓				✓	✓	✓															
Goodenia ovata	Hop Goodenia			✓	✓					✓	✓												✓		✓
Goodenia willisiana	Silver Goodenia			✓			✓																		
Gramineae sp.	Grass Family			✓								✓													
Grevillea aspera	Rough Grevillea												✓												
Hakea rugosa	Dwarf Hakea			✓			✓																		
Hakea cycloptera	Elm-seed Hakea			✓			✓																✓		

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Hakea sp.	Hakea/Needlewood			✓			✓				✓				✓										
Haloragis sp.	Raspwort			✓			✓				✓				✓										
Helichrysum leucopsideum	Satin Everlasting			✓			✓		✓		✓		✓												
Hibbertia exutiacies	Prickly Guinea-flower			✓																					
Hibbertia paeninsularis				✓			✓		✓	✓	✓		✓		✓										✓
Hibbertia virgata	Twiggy Guinea-flower									✓	✓		✓												
Juncus kraussii	Sea Rush			✓								✓	✓	✓		✓	✓	✓	✓	✓	✓	✓			✓
Juncus pallidus	Pale Rush																		✓						
Kennedia prostrata	Scarlet Runner			✓						✓	✓		✓												
Lachnagrostis sp.	Blown-grass			✓			✓		✓	✓	✓		✓		✓										
Lasiopetalum behrii	Pink Velvet-bush			✓						✓	✓														✓
Lepidosperma viscidum	Sticky Sword-sedge			✓	✓		✓		✓	✓	✓				✓				✓				✓		
Leptorhynchos squamatus ssp. squamatus	Scaly Buttons			✓																					
Lissanthe strigosa ssp. subulata	Peach Heath			✓			✓				✓												✓		✓
Logania nuda	Leafless Logania			✓			✓																		
Lomandra collina	Sand Mat-rush			✓			✓				✓														
Lomandra effusa	Scented Mat-rush			✓				✓	✓		✓		✓		✓								✓		
Lomandra sp.	Mat-rush			✓																					
Maireana enchylaenoides	Wingless Fissure-plant			✓																					
Melaleuca brevifolia	Short-leaf Honey-myrtle															✓									✓
Melaleuca decussata	Totem-poles										✓														✓
Melaleuca halmaturorum	Swamp Paper-bark															✓			✓	✓					
Melaleuca lanceolata	Dryland Tea-tree			✓		✓				✓	✓				✓										

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Melaleuca uncinata	Broombush			✓			✓			✓	✓														
Microtis arenaria	Notched Onion-orchid						✓																		
Muehlenbeckia adpressa	Climbing Lignum			✓						✓	✓														
Neurachne alopecuroidea	Fox-tail Mulga-grass			✓			✓		✓		✓														
Olearia decurrens	Winged Daisy-bush			✓							✓														
Olearia pannosa ssp. pannosa	Silver Daisy-bush	VU	V	✓																					
Olearia ramulosa	Twiggy Daisy-bush						✓																		
Opercularia scabrida	Stalked Stinkweed			✓																					
Oxalis perennans	Native Sorrel			✓	✓		✓		✓		✓				✓										
Ozothamnus retusus	Notched Bush-everlasting			✓	✓		✓																✓		
Pimelea phylicoides	Heath Riceflower			✓																					
Pimelea serpyllifolia ssp. serpyllifolia	Thyme Riceflower			✓			✓																		
Pimelea sp.	Riceflower			✓			✓			✓	✓				✓										
Pogonolepis muelleriana	Stiff Cup-flower			✓																					
Pomaderris flabellaris	Fan Pomaderris			✓																					
Portulaca sp.	Purslane															✓									
Prostanthera serpyllifolia ssp. microphylla	Small-leaf Mintbush			✓																					
Prostanthera spinosa	Spiny Mintbush			✓																					
Pterostylis sp.	Greenhood			✓	✓	✓	✓																		
Pultenaea pedunculata	Matted Bush-pea			✓							✓														
Pultenaea trichophylla	Tufted Bush-pea	EN	R	✓																					
Rhagodia candolleana ssp.	Sea-berry Saltbush			✓						✓	✓														
Rumex sp.	Dock																					✓			

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Rytidosperma caespitosum	Wallaby Grass			✓			✓	✓			✓														
Rytidosperma setaceum	Small-flower Wallaby-grass			✓	✓			✓	✓	✓	✓		✓											✓	✓
Rytidosperma sp.	Wallaby Grass																						✓		
Samolus repens	Creeping Brookweed																								✓
Scaevola linearis ssp. linearis	Rough Fanflower			✓						✓	✓														
Spyridium bifidum var.	Spyridium			✓																					
Spyridium parvifolium	Dusty Miller			✓			✓																		
Stenanthemum leucophractum	White Cryptandra			✓																					
Thelymitra luteocilium	Yellow-tuft Sun Orchid			✓			✓								✓										
Thelymitra sp.	Sun-orchid			✓			✓																		
Thysanotus patersonii	Twining Fringe-lily			✓			✓																✓		
Vittadinia cuneata var.	Fuzzy New Holland Daisy			✓				✓	✓	✓	✓	✓	✓												
Wahlenbergia sp.	Native Bluebell			✓					✓	✓	✓														
Xanthorrhoea semiplana ssp.	Yacca			✓			✓		✓	✓	✓												✓		
**Arctotheca calendula*	Cape Weed																					✓			
**Asparagus asparagoides*	Bridal Creeper			✓							✓		✓	✓	✓				✓				✓	✓	
**Avena barbata*	Bearded Oat			✓										✓		✓						✓		✓	
**Briza maxima*	Large Quaking-grass																								
**Bromus diandrus*	Great Brome			✓																					
**Carthamus lanatus*	Saffron Thistle															✓									
**Centaurium sp.*	Centaury									✓	✓	✓													
**Centaurium tenuiflorum*	Branched Centaury			✓																					
**Conyza sp.*	Fleabane															✓									

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
**Cynosurus sp.*	Dog's-tail Grass			✓							✓														
**Ehrharta calycina*	Perennial Veldt Grass			✓									✓												
**Ehrharta longiflora*	Annual Veldt Grass			✓	✓	✓	✓	✓	✓	✓	✓	✓													
**Erodium sp.*	Heron's-bill/Crowfoot			✓											✓										
**Hordeum sp.*														✓											
**Hypochaeris radicata*	Rough Cat's Ear																✓								
**Juncus acutus*	Sharp Rush																			✓					
**Lolium perenne*	Perennial Ryegrass						✓	✓	✓	✓	✓														
**Lolium sp.*	Ryegrass																✓	✓	✓						
**Medicago polymorpha var. polymorpha*	Burr-medic						✓				✓		✓		✓										
**Moraea setifolia*	Thread Iris						✓				✓				✓										
**Olea europaea ssp.*	Olive																					✓			
**Oxalis pes caprae*	Soursob															✓				✓				✓	✓
**Paspalum vaginatum*	Salt Couch																								✓
**Phalaris aquatica*	Phalaris															✓									✓
**Pinus halepensis*	Aleppo Pine																					✓			
**Prunus dulcis*	Almond																					✓			
**Puccinellia distans*	Reflexed Poa			✓										✓											
**Rosa canina*	Dog Rose																		✓	✓		✓			
**Rubus sp.*	Blackberry															✓			✓	✓				✓	✓
**Rumex sp.*	Dock																								✓
**Senecio pterophorus*	African Daisy			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
**Sonchus oleraceus*	Common Sow-thistle			✓			✓	✓		✓	✓	✓	✓												
**Taraxacum officinale*	Dandelion						✓		✓		✓														

Scientific Name	Common Name	Cons. status		Vegetation Associations																					
		Aus	SA	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
**Thinopyrum elongatum*	Tall Wheat-grass			✓																					
**Trifolium sp.*	Clover			✓			✓		✓	✓	✓		✓		✓										
**Vulpia myuros f.*	Fescue			✓			✓		✓	✓	✓	✓													

Aus: Australia (*Environment Protection and Biodiversity Conservation Act 1999*). SA: South Australia (*National Parks and Wildlife Act 1972*). Conservation codes: CE: Critically Endangered. EN/E: Endangered. VU/V: Vulnerable. R: Rare. *: Introduced.

Vegetation Associations

1 **Exotic dominated (no species list)**
2 ***Eucalyptus cladocalyx* Woodland**
3 ***Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* Woodland**
4 ***Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii* +/- *Eucalyptus peninsularis* Woodland**
5 ***Melaleuca uncinata* +/- *Allocasuarina verticillata* Shrubland**
6 ***Eucalyptus peninsularis* Low Woodland**
7 ***Xanthorrhoea semiplana* ssp. +/- *Allocasuarina verticillata* Grassland**
8 ***Allocasuarina verticillata* +/- emergent *Acacia pycnantha* Low Open Forest**
9 ***Eucalyptus* spp. Mixed Mallee**
10 ***Eucalyptus* spp. +/- *Callistemon rugulosa* Mallee**
11 ***Eucalyptus petiolaris* Woodland +/- *Allocasuarina verticillata* +/- *Acacia pycnantha***
12 ***Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola***
13 ***Acacia pycnantha* / *Acacia imbricata* Shrubland**
14 ***Gahnia filum* Sedgeland**
15 ***Gahnia filum* / *Juncus kraussii* Sedgeland**
16 ***Juncus kraussii* Sedgeland**
17 ***Juncus kraussii* Sedgeland +/- scattered *Eucalyptus petiolaris***
18 ***Juncus kraussii* Sedgeland +/- *Ficinia nodosa* +/- scattered *Melaleuca halmaturorum***
19 ***Juncus kraussii* / *Ficinia nodosa* / *Juncus pallidus* Sedgeland +/- scattered *Acacia pycnantha***
20 ***Cypress gymnocaulos* / *Juncus kraussii* Sedgeland**
21 ***Acacia imbricata* / *Lissanthe strigosa* / *Acacia rupicola* open shrubland +/- *Eucalyptus cladocalyx* +/- *Eucalyptus calycogona* ssp. *spaffordii***
22 ***Acacia pycnantha* +/- *Allocasuarina verticillata* Low Open Forest**
23 ***Eucalyptus petiolaris* Woodland**

Appendix 3. Survey site locations.

Site number	Survey	Zone	Easting	Northing
Site 1	Vegetation/ Bird	53H	583996	6192214
Site 2	Vegetation/ Bird	53H	583870	6192873
Site 3	Vegetation/ Bird	53H	583625	6192878
Site 4	Vegetation/ Bird	53H	583287	6192830
Site 5	Vegetation only	53H	587553	6196496
Site 6	Vegetation/ Bird	53H	581722	6191199
Site 7	Vegetation/ Bird	53H	581804	6192855
Site 8	Bird only	53H	583482	6192809

Appendix 4. Scattered Tree photos.

H1. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H2. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H3. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H4. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H5. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H6. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H7. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H8. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H9. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

H10. *Eucalyptus petiolaris* (Eyre Peninsula Bluegum)

10 ADDENDUM

Provision of general advice regarding the status of the surveyed creeklines across the property and whether these and the 'ephemeral springs' observed on the Borthwick property constitute Groundwater Dependent Ecosystems (GDE). This will also include commentary on anything else significant within the riparian areas, including the creeklines on the Harris and Cullen properties and the Pillaworta Creek.

Borthwick property

General comments

Whilst we were unable to access the property, the vegetation associations present adjacent the Cullen boundary fenceline were consistent with the Sugar Gum woodland mapped on the Cullen property and in similar condition, scoring 5:1 SEB ratio (moderate). A number of communities have been mapped and recorded by L. Bebbington (2015) who was commissioned by the Borthwick family to undertake a vegetation assessment of the vegetation block located directly north of the Cullen – Borthwick boundary. Some of the vegetation communities listed and described for the Borthwick property are consistent from observations made by EBS Ecology from the boundary fence during various field surveys and the species recorded in the Bebbington report have been observed also, however it is not possible to confirm the presence of the Nationally Critically Endangered Peppermint Box (*Eucalyptus odorata*) Grassy Woodland of South Australia from the mapped area described by Bebbington as a state listed *Eucalyptus odorata* Open Mallee over Native Tussock Grassland. Assessment against the criteria outlines in the Listing Advice would need to be undertaken. An assessment of the condition of the vegetation to properly assign SEB ratios would also need to be undertaken. Species lists were also not listed in the report or the locations of threatened flora species, however both state rare species, *Acacia imbricata* (Feathery Wattle) and *Daviesia pectinata* (Zig-zag Bitter pea) were recorded throughout the *E. cladocalyx* Low Open Woodland areas and the outwash lower section of the gully, which is reportedly characterised by *Acacia rupicola* / *Acacia imbricata* Low Open Shrubland. A condition rating of "M" (Moderate) was assigned to the remnant, based on condition ratings obtained from Neagle, 1995. Bebbington has rated the habitat potential of the remnant as a "B" category, against the Habitat Significance Rating (HSR) developed under the *Guidelines for a Native Vegetation Significant Environmental Benefit Policy for the clearance of Scattered Trees (DEWNR, 2007).*

The alleged 'ephemeral springs' were difficult to ascertain with no direct access, however we did not see any clear evidence of water logged ground or riparian flora species which would normally be expected with wet areas such as natural seepage or soaks. It is possible that these areas are subject to heavy grazing and that has lead to removal of the vegetation, however given observations were made in the spring, following an average rainfall winter season, we would expect to see some evidence of water seepage.

Photo 1 – Example of alleged 'ephemeral spring' on Borthwick property.

Photo 2 – Example of alleged 'ephemeral spring' on Borthwick property. Arrow indicates approximate location.

Aquatic areas

It is advised that surface water will be diverted around the TSF and channelled into the existing creek that sits in the road reserve between the WRSF South and the Pit. EBS has assessed these areas and provided comments on evidence of GDE, or anything else significant.

Pillaworta Creek

The upper reaches of the creekline is dominated by Sedgeland communities (Photo 4) with scattered small patches and individual *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) (Photo 3), *Melaleuca halmaturorum* (Swamp Paperbark) and *Acacia pycnantha* (Golden Wattle). These include the following described associations:

- *Juncus kraussii* +/- *Ficinia nodosa* Sedgeland +/- scattered *Melaleuca halmaturorum*
- *Juncus kraussii* Sedgeland +/- scattered *Eucalyptus petiolaris*
- *Juncus kraussii / Ficinia nodosa / Juncus pallidus* Sedgeland +/- scattered *Acacia pycnantha*
- *Gahnia filum* Sedgeland

The latter is a small swamp adjacent to the main channel and is listed as a state vulnerable community under the *Provisional List of Threatened Ecosystems of South Australia* (DEH, 2005), where it has historically suffered severe degradation from factors such as grazing and salinity, and only small areas conserved in the reserve system.

Overall this vegetation is typical of a riparian zone and the presence of intact and moderately healthy Sedgeland communities and *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum), indicates that they are dependent on fairly regular and reliable flows down Pillaworta Creek. Certainly a proportion of the overall volume originates as runoff from the surrounding catchment, particularly during the winter months, but it is unknown whether additional flows are coming from underground sources.

The density of the scattered *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) does not represent a woodland community and therefore is not necessary to assess under the Commonwealth Conservation Advice for the Nationally Endangered TEC Eyre Peninsula Blue Gum (*Eucalyptus petiolaris*) Grassy Woodland.

Photo 3 – Scattered *Eucalyptus petiolaris* (Eyre Peninsula Blue Gum) along Pillaworta Creek.

Photo 4 – *Juncus kraussii* / *Ficinia nodosa* / *Juncus pallidus* Sedgeland

Further downstream the Pillaworta Creek, Association 23 dominated the vegetation. The association is similar to Associations 11 and 12, with a different assemblage of understorey species. The understorey was dominated by *Acacia imbricata* (Feathery Wattle), *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia pycnantha* (Golden Wattle) and native grasses including *Austrostipa* sp. (Spear Grass) and

Rytidosperma setaceum (Wallaby Grass). See Table 30. The waterholes associated with the Pillaworta Creek are characterised by a similar mix of species, but in different densities.

Photo 5 – Typical view of Association 23, Pillaworta Creek

Waterhole 1

Waterhole 1 is defined by the same vegetation association (23) as the adjacent sections of Pillaworta Creek. It has low species diversity however, with a total of nine native species and two exotic species. There are no native species growing directly around the water's edge, possibly due to the high salinity levels within (~18,000EC) (D. Povey pers. comm, 2015). The fringes are dominated by *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia imbricata* (Feathery Wattle) and *Acacia pycnantha* (Golden Wattle).

Photo 6 – Typical view of Waterhole 1

Waterhole 2

Waterhole 2 is also defined by the same vegetation association (23) as the adjacent sections of Pillaworta Creek. It is in better condition and has more native species directly surrounding the water's edge (See Figure 37). Native understorey is dominated by *Melaleuca brevifolia* (Short-leaf Honey-myrtle), *Acacia imbricata* (Feathery Wattle), *Acacia pycnantha* (Golden Wattle) and patches of *Lepidosperma viscidum* (Sticky Sword-sedge) and scattered *Allocasuarina verticillata* (Drooping Sheoak). A number of weeds are prevalent around the fringe including *Paspalum vaginatum* (Salt Couch), *Rumex* sp. (Dock) and small amounts of *Phalaris aquatica* (Phalaris) and *Oxalis pes-capre* (Soursob). See Table 33 for complete species lists obtained from each of the waterholes surveyed.

Photo 7 – Typical view of Waterhole 2

Creekline – Cullen property

The creekline is dominated by Sedgeland communities and exotic areas. These include the following described associations:

- Exotic dominated riparian area
- *Cyperus gymnocaulos* / *Juncus kraussii* Sedgeland
- *Juncus kraussii* / *Senecio pterophorus* (African Daisy) Sedgeland

This vegetation is typical of a riparian area and the presence of intact and moderately healthy Sedgeland communities indicate that they are dependent on fairly regular and reliable flows. It is unknown whether the source of this water is from underground, but there is certainly seepage evident from the southern slopes abutting the drainage line (Photo 5). Given the timing of year and the cleared nature of the land to the south, seepage from the hill is probably seasonal.

Photo 5 – *Juncus kraussii* Sedgeland on Cullen property. Water flows from seepage on southern side of creekline.

Creekline – Harris property

The creekline is dominated by Sedgeland communities with small patches of eucalypts and exotic areas. These include the following described associations:

- Exotic dominated riparian area
- *Eucalyptus petiolaris* Woodland over *Acacia pycnantha* and *Acacia rupicola*
- *Juncus kraussii* Sedgeland +/- scattered *Eucalyptus petiolaris*
- *Gahnia filum / Juncus kraussii* Sedgeland
- *Juncus kraussii* Sedgeland

This vegetation is typical of a riparian area and the presence of intact and moderately healthy Sedgeland communities indicate that they are dependent on fairly regular and reliable flows. It is unknown whether the source of this water is from underground, however a small seep was observed on the southern side of Association 15 (Photo 6), which may contribute to the ongoing robustness of these riparian communities. Certainly a proportion of the water flows originate as runoff from the surrounding catchment.

The state rare *Acacia imbricata* (Feathery Wattle) was recorded from Association 12.

Photo 6 – Water flows from seepage or natural spring on southern side of creekline (boundary of Harris / Cullen properties). Arrow shows direction of flows from seepage or natural spring.

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Appendix F

Heritage

Confidential document not for public display

Appendix G

Conceptual mine plan

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Report

Kookaburra Gully Graphite Conceptual Mine Plan
Lincoln Minerals Limited

AMC Project 813013
3 September 2014 Rev_3

Executive summary

Introduction

Lincoln Minerals Limited (LML) has identified and reported a Mineral Resource on the Kookaburra Gully graphite project, located 35 km north of Port Lincoln on the Eyre Peninsula, South Australia. Metallurgical bench-scale testing of representative drill samples of Kookaburra Gully graphite has been carried out.

LML wishes to expand the understanding of the project by undertaking a conceptual mine plan on Kookaburra Gully. The aim of this is to enable LML to quantify the potential amount of resource that could be mined, potential costs, and the size and shape of the footprint.

As part of the work on this study, AMC Consultants Pty Ltd (AMC) carried out preliminary pit optimizations on the Kookaburra Gully Resource model. LML provided the processing parameters and costs and the graphite revenue assumptions. AMC estimated the mining costs. AMC then prepared a potential waste dumps layout for Kookaburra Gully.

The Kookaburra Gully area is limited by a property fence that runs east-west on the UTM Zone 53 position, 6,192,930 mN. AMC therefore carried out two pit optimizations for comparison:

- Kookaburra Gully Base Case (limited by the property fence)
- Kookaburra Gully No Limit Case (not limited by the property fence)

The Kookaburra Gully No Limit Case optimization was performed so that the impact of the loss of that section over the project value could be compared with the Base Case.

These optimizations were performed using a slope angle of 37º and a slope angle sensitivity analysis was performed on the Base Case scenario.

This report sets out the results of AMC's preliminary pit optimizations and potential waste dumps layout for Kookaburra Gully.

All currency values in this report are in Australian Dollars.

Conclusions

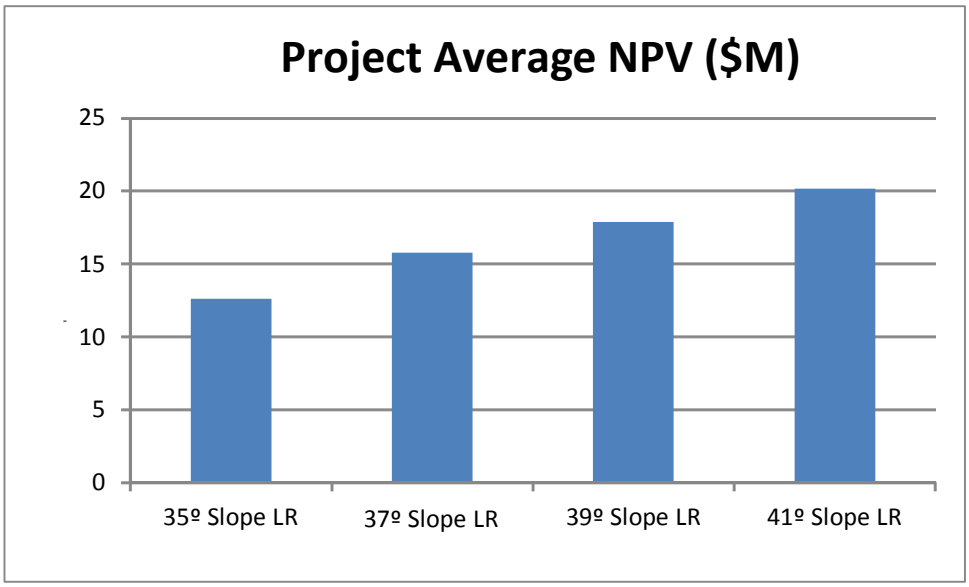
The preliminary pit optimization work indicates that the Kookaburra Gully project has a potential Base Case NPV (considering the total capital cost) of between $16 million and $52 million, for the Low Revenue (LR) and High Revenue (HR) concentrate price scenarios respectively. The possibility exists to increase those values by steepening the pit walls, as demonstrated by the slope angle sensitivity analysis (ES Figure 1) and / or including the area north of the current fence limit. Due to the short life-of-mine (less than 6 years) at a production rate of 250 ktpa, the maximum NPV pit shells are almost the same size as the pit shells from the maximum undiscounted cash flow.

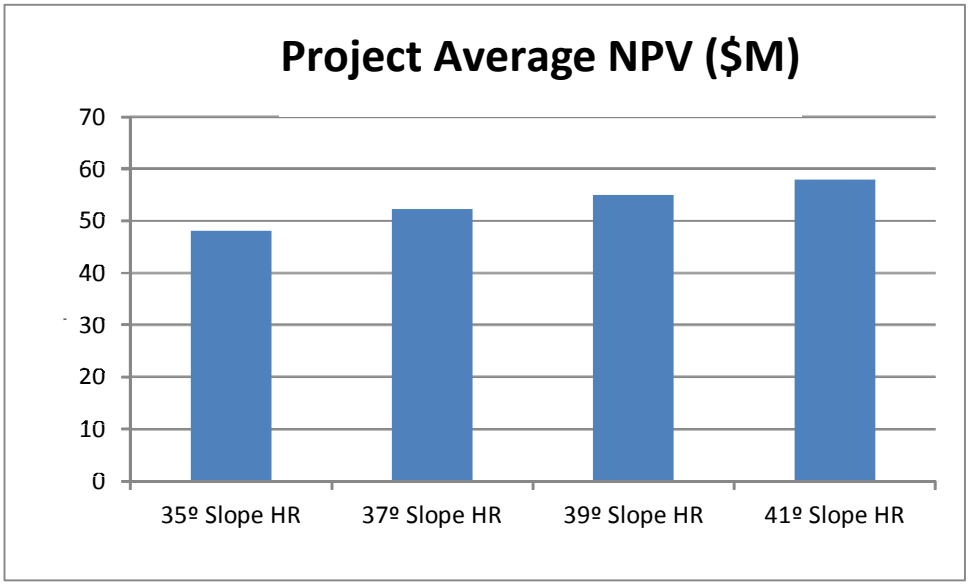
The LR scenario uses $1,077/t concentrate and the HR scenario uses $1,382/t concentrate. The calculated cut-off grade for the LR scenario is 5.24% total graphitic carbon (TGC) and for the HR scenario is 4.12% TGC. Pit optimizations were carried out and no stockpiling was assumed.

The undiscounted and maximum operating NPV results for the Kookaburra Gully Base Case and Kookaburra Gully No Limit Case are shown in ES Table 1 and ES Table 2 below.

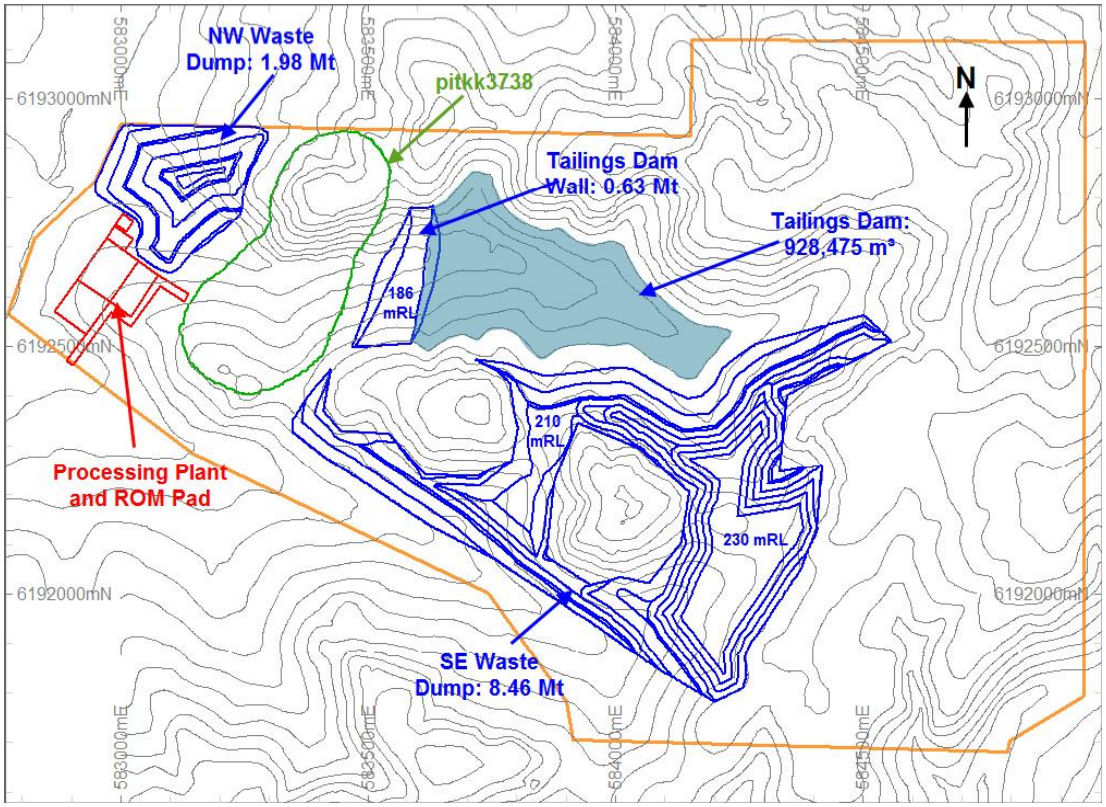
A potential site layout was prepared for Kookaburra Gully using the LR maximum operating NPV pit shell to indicate potential waste dump footprints and the fence boundary for the mining operation. The layout prepared is shown in ES Figure 2. It should be noted that this layout is not the maximum extent that may be required; it is an interim stage of the site layout.

ES Figure 1 LR and HR Base Case Project NPV slope angle sensitivity analysis





ES Figure 2 Kookaburra Gully Conceptual Layout



Recommendations

AMC recommends that LML continues with the study to identify the processing requirements, recoveries, costs and project definition parameters, before proceeding to a more detailed scale study. Analysis of geotechnical drilling and recommendations for pit designs must be prepared to allow pit designs to be prepared. AMC can assist with these investigations.

AMC recommends that after further definition of the parameters, the pit optimization be revised and mine scheduling work be undertaken. This work should examine the requirements for production using various cut-off grades.

ES Table 1 Kookaburra Gully Base Case Optimization Maximum NPV Pit Shells

Scenario Low Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/$t_{feed}$	Revenue NSR $/$t_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	31	10.75	7.47	5.08	1.27	14.60	177	94.00	73	56	32	16	93.20	150.58
Max Undiscounted	32	11.17	7.67	5.15	1.29	14.60	180	94.00	73	56	32	16	94.01	150.59

Scenario High Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/$t_{feed}$	Revenue NSR $/$t_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	38	12.47	8.07	5.50	1.37	14.35	183	97.00	122	93	82	52	95.05	184.04
Max Undiscounted	44	13.48	8.48	5.69	1.42	14.27	188	97.00	123	92	82	52	96.67	183.00

ES Table 2 Kookaburra Gully No Limit Case Optimization Maximum NPV Pit Shells

Scenario Low Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/$t_{feed}$	Revenue NSR $/$t_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	28	13.33	7.60	6.20	1.55	15.67	233	94.00	104	76	63	35	94.68	161.56
Max Undiscounted	33	15.98	8.53	6.71	1.68	15.63	251	94.00	105	75	65	35	98.44	161.16

Scenario High Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/$t_{feed}$	Revenue NSR $/$t_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	39	18.12	9.08	7.19	1.80	15.37	256	97.00	174	123	134	82	100.12	197.06
Max Undiscounted	46	20.25	9.77	7.52	1.88	15.28	267	97.00	175	122	135	82	102.86	195.98

Quality control

The signing of this statement confirms this report has been prepared and checked in accordance with the AMC Peer Review Process. AMC's Peer Review Policy can be viewed at www.amcconsultants.com.

Project Manager

The signatory has given permission to use their signature in this AMC document

Fabio Alves Rodrigues	**3 September 2014**

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Contents

1 INTRODUCTION 4
2 BASE DATA TEMPLATE 5
3 BLOCK MODEL PREPARATION 8
4 PIT OPTIMIZATION 9
4.1 Kookaburra Gully Base Case 9
4.1.1 Low Revenue Base Case 9
4.1.2 High Revenue Base Case 17
4.2 Kookaburra Gully No Limit Case 25
4.2.1 Kookaburra Gully Low Revenue Case 25
4.2.2 Kookaburra Gully High Revenue Case 29
4.3 Sensitivity to Pit Slopes 37
4.4 Waste Dump Design and Conceptual Site Layout 47
5 CONCLUSIONS AND RECOMMENDATIONS 50
5.1 Conclusions 50
5.2 Recommendations 50

Tables

Table 2.1 Summary of PB report assumptions and calculated average for 250 ktpa 5
Table 2.2 LML price assumptions 5
Table 3.1 Kookaburra Gully Mineral Resource at a nominal 5% TGC lower cut-off grade 8
Table 3.2 Kookaburra Gully Mineral Resource at a nominal 2% TGC lower cut-off grade 8
Table 4.1 Kookaburra Gully LR Base Case at 37º 10
Table 4.2 Kookaburra Gully LR Base Case at 37º Preliminary Schedule 14
Table 4.3 Kookaburra Gully HR Base Case at 37º 18
Table 4.4 Kookaburra Gully HR Base Case at 37º Preliminary Schedule 22
Table 4.5 Kookaburra Gully Pit LR No Limit Case at 37º 26
Table 4.6 Kookaburra Gully Pit HR No Limit Case at 37º 30
Table 4.7 Kookaburra Gully HR No Limit Case at 37º Preliminary Schedule 34
Table 4.8 Kookaburra Gully LR Base Case Pit Slope Sensitivity 42
Table 4.9 Kookaburra Gully HR Base Case Pit Slope Sensitivity 43
Table 4.10 NW Waste Dump Volume and Tonnes 49
Table 4.11 Tailings Dam Waste Wall Volume and Tonnes 49
Table 4.12 SE Waste Dump Volume and Tonnes 49
Table 5.1 Kookaburra Gully Base Case Optimization Maximum NPV Pit Shells 51
Table 5.2 Kookaburra Gully No Limit Case Optimization Maximum NPV Pit Shells 52

Figures

Figure 4.1 Kookaburra Gully LR Base Case at 37º – Max. Operating NPV Pit Shell Level Contours 11
Figure 4.2 Kookaburra Gully LR Base Case at 37º – Max. Operating NPV Pit Shell 12
Figure 4.3 Kookaburra Gully LR Base Case at 37º – Section A-A' 12
Figure 4.4 Kookaburra Gully LR Base Case at 37º – Section B-B' 13
Figure 4.5 Kookaburra Gully LR Base Case at 37º – Section C-C' 13
Figure 4.6 Kookaburra Gully LR Base Case at 37º Preliminary Schedule Sequence 15
Figure 4.7 Kookaburra Gully LR Base Case at 37º – Annual Production 15
Figure 4.8 Kookaburra Gully LR Base Case at 37º – Annual Production 16
Figure 4.9 Kookaburra Gully LR Base Case at 37º – Cumulative Production 16
Figure 4.10 Kookaburra Gully LR Base Case at 37º – Operating Cash Flow 17
Figure 4.11 Kookaburra Gully HR Base Case at 37º – Max. Operating NPV Pit Shell Level Contours 19

Figure 4.12 Kookaburra Gully HR Base Case at 37º – Max. Operating NPV Pit Shell 20
Figure 4.13 Kookaburra Gully HR Base Case at 37º – Section A-A' 20
Figure 4.14 Kookaburra Gully HR Base Case at 37º – Section B-B' 21
Figure 4.15 Kookaburra Gully HR Base Case at 37º – Section C-C' 21
Figure 4.16 Kookaburra Gully HR Base Case at 37º Preliminary Schedule Sequence 23
Figure 4.17 Kookaburra Gully HR Base Case at 37º – All Production 23
Figure 4.18 Kookaburra Gully HR Base Case at 37º – Process Production 24
Figure 4.19 Kookaburra Gully HR Base Case at 37º – Cumulative Production 24
Figure 4.20 Kookaburra Gully HR Base Case at 37º – Operating Cash Flow 25
Figure 4.21 Kookaburra Gully LR No Limit Case at 37º – Max. Operating NPV Pit Shell Level Contours 27
Figure 4.22 Kookaburra Gully LR No Limit Case at 37º – Max. Operating NPV Pit Shell 28
Figure 4.23 Kookaburra Gully LR No Limit Case at 37º – Section A-A' 28
Figure 4.24 Kookaburra Gully LR No Limit Case at 37º – Section B-B' 29
Figure 4.25 Kookaburra Gully LR No Limit Case at 37º – Section C-C' 29
Figure 4.26 Kookaburra Gully HR No Limit Case at 37º – Max. Operating NPV Pit Shell Level Contours 31
Figure 4.27 Kookaburra Gully HR No Limit Case at 37º – Max Operating NPV Pit Shell 32
Figure 4.28 Kookaburra Gully HR No Limit Case at 37º – Section A-A' 32
Figure 4.29 Kookaburra Gully HR No Limit Case at 37º – Section B-B' 33
Figure 4.30 Kookaburra Gully HR No Limit Case at 37º – Section C-C' 33
Figure 4.31 Kookaburra Gully HR No Limit Case at 37º Preliminary Schedule Sequence 35
Figure 4.32 Kookaburra Gully HR No Limit Case at 37º – All Production 35
Figure 4.33 Kookaburra Gully HR No Limit Case at 37º – Process Production 36
Figure 4.34 Kookaburra Gully HR No Limit Case at 37º – Cumulative Production 36
Figure 4.35 Kookaburra Gully HR No Limit Case at 37º – Operating Cash Flow 37
Figure 4.36 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Boundary Strings 37
Figure 4.37 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Section A-A' 38
Figure 4.38 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Section B-B' 38
Figure 4.39 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Section C-C' 39
Figure 4.40 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Boundary Strings 39
Figure 4.41 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Section A-A' 40
Figure 4.42 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Section B-B' 40
Figure 4.43 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Section C-C' 41
Figure 4.44 LR Base Case Max. NPV Slope Sensitivity: Plant Feed and Concentrate 44
Figure 4.45 LR Base Case Max. NPV Slope Sensitivity: Project Av. NPV and Stripping Ratio 45
Figure 4.46 HR Base Case Max. NPV Slope Sensitivity: Plant Feed and Concentrate 46
Figure 4.47 HR Base Case Max. NPV Slope Sensitivity: Av. NPV and Stripping Ratio 47
Figure 4.48 Kookaburra Gully Conceptual Site Layout 48
Figure 5.1 Kookaburra Gully Conceptual Layout 50

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1 INTRODUCTION

Lincoln Minerals Limited (LML) has identified and reported a Mineral Resource on the Kookaburra Gully graphite project, located 35 km north of Port Lincoln on the Eyre Peninsula, South Australia. Metallurgical bench-scale testing of representative drill samples of Kookaburra Gully graphite has been carried out.

LML wishes to expand the understanding of the project by undertaking a conceptual mine plan on Kookaburra Gully. The aim of this is to enable LML to quantify the potential amount of resource that could be mined, potential costs, and the size and shape of the footprint.

As part of the work on this study, AMC Consultants Pty Ltd (AMC) carried out preliminary pit optimizations on the Kookaburra Gully Resource model. LML provided the processing parameters and costs and the graphite revenue assumptions. AMC estimated the mining costs. AMC then prepared a potential waste dumps layout for Kookaburra Gully.

The Kookaburra Gully area is limited by a property fence that runs east-west on the UTM Zone 53 position, 6,192,930 mN. AMC therefore carried out two pit optimizations for comparison:

- Kookaburra Gully Base Case (limited by the property fence)
- Kookaburra Gully No Limit Case (not limited by the property fence)

The Kookaburra Gully No Limit Case optimization was performed so that the impact of the loss of that section over the project value could be compared with the Base Case.

These optimizations were performed using a slope angle of 37º and a slope angle sensitivity analysis was performed on the Base Case scenario.

This report sets out the results of AMC's preliminary pit optimizations and potential waste dumps layout for Kookaburra Gully.

All currency values in this report are in Australian Dollars.

2 BASE DATA TEMPLATE

The Base Data Template (BDT) lists the key parameters used to define the cost and revenue of each block mined. The mining costs were estimated by AMC, based on equipment hourly rates obtained from small contractors in the Eyre Peninsula region and key personnel wages obtained from the Hay's Salary Guide 2012.

The total Capital Cost and Processing Cost for the 250 ktpa scenario was obtained as an average between the 200 ktpa and 400 ktpa scenarios in the reports "Kookaburra Gully Graphite Project - Infrastructure scoping study" and "Kookaburra Gully Graphite Project - Infrastructure scoping study - Increased resource grade", from Parsons Brinckerhoff (PB). These are summarized in Table 2.1.

Table 2.1 Summary of PB report assumptions and calculated average for 250 ktpa

Nameplate Capacity at 85% availability	**Unit**	**Case**	**Base Case**	**Case**
Annual Treatment Rate	dmt/a	200,000	250,000	300,000
Total Capital Cost	$M	37.9	40.4	42.9
Availability	%	85	85	85
Treatment Rate	dmt/h	26.9	33.6	40.3
Ore Head Grade	%	14.3	14.3	14.3
Concentrate Recovery	%	90	90	90
Concentrate Grade	**%**	**94**	**94**	**94**
Hours per Annum	h/a	7,446	7,446	7,446
Shift Hours	h/a	12	12	12
Processing Shifts per day	Shift/d	2	2	2
Days per Annum	d/a	365	365	365
Total Carbon on ROM	dmt/a	28,600	35,750	42,900
Carbon in Concentrate	dmt/a	25,740	32,175	38,610
Concentrate	**dmt/a**	**27,383**	**34,229**	**41,074**
Process Plant Operating Cost	$/t feed	46.30	43.20	41.14

The price assumptions provided by LML were based on Industrial Minerals data to end of August 2013. The prices were in US$ and an exchange rate of 0.92 (A$/US$) was assumed to get the A$ prices. The product selling price was obtained as a weighted average of the price assumptions and the range of product expected to be produced in Kookaburra Gully project, provided by LML. This is shown in Table 2.2.

Table 2.2 LML price assumptions

Style	**Grade**	**Size Range (mesh size)**	**Size Range (microns)**	**LML Price assumption Low ($/t)**	**LML Price assumption High ($/t)**	**Kookaburra Gully Product (%)**
Large Flake	94-97% C	+80	>177	1,500	1,778	9.5
Medium Flake	94-97% C	-80 +100	149-177	1,222	1,444	14.6
Medium Flake	85-87% C	-80 +100	149-177	889	1,111	0.0
Fine Flake	94-97% C	-100	-149	1,000	1,333	70.3
Fine Flake	90% C	-100	-149	944	1,167	5.7
Average Price ($/t)				1,077	1,382	100

All other parameters and assumptions were provided by LML.

The BDT assumptions are:

- Total Capital Cost: $40.4 million
- Plant Throughput: 250 ktpa
- Recovery: 90%
- Concentrate grade:
  - 94%C (low revenue scenario)
  - 97%C (high revenue scenario)
- Processing cost: $43.20/$t_{Feed}$
- Total mining cost (excluding drill-and-blast):
  - Plant feed: $8.91/t
  - Waste: $3.06/t
- Drill-and-blast cost (below 30 m): $1.39/t
- Revenue:
  - $1,077/t (low revenue scenario)
  - $1,382/t (high revenue scenario)
- Transport of concentrate: $100/t, assuming trucked to Port Lincoln then sea freight to Asia

2.1 Preliminary Mining Cost Estimate

The mining scenario for the cost estimation assumes that a contractor would be engaged to carry out the pit excavation. The small-size equipment required is readily available in the region. It has been assumed that to increase production, bringing in additional equipment over short periods will be possible.

The assumptions used for the mining costs are:

- Shift roster:
  - 12 working hours per day (single shift)
  - 5 working days per week
  - 240 production days per year (including public holidays)
- Transport of ROM feed: less than 1 km
- Contractor's Costs:
  - Truck (11 m³): $100/h, usage factor = 1
  - 25 t excavator (1.2 m³ bucket): $150/h, usage factor = 1
  - Grader: $150/h, usage factor = 3/8
  - Dozer: $240/h, usage factor = 1
  - Water Cart: $120/h, usage factor = 1
  - Supervisor: $100/h, usage factor = 1
- Load, haul, and dump:
  - Plant feed: $1.63/t
  - Waste: $1.60/t
- Mine Personnel (salary based on Hay's Salary Guide 2012):
  - Pit Superintendent: 240 h/month – $43.40/h

  - Geologist: 120 h/month – $36.46/h
  - Surveyor: 24 h/month – $36.46/h
- Drill-and-blast (below 40 m):
  - Blasting unit cost: $0.71/t
  - Drilling unit cost: $0.50/t
  - Blasting Miscellaneous: 25% extra
  - Total drill-and-blast unit cost: $1.39/t
- Ancillary and supervision cost:
  - Plant feed: $7.29/t
  - Waste: $1.46/t

3 BLOCK MODEL PREPARATION

The resource model (grademod_131127.dm) was supplied by AMC and then prepared for use in the optimization process. Table 3.1 and Table 3.2 summarize the resource model at 5% and 2% Total Graphitic Carbon respectively.

Table 3.1 Kookaburra Gully Mineral Resource at a nominal 5% TGC lower cut-off grade

Mineral Resource Classification	Tonnage (Mt)	Average Grade (% TGC)	Contained Graphite (tonnes)	Density (g/cc)
Indicated	1.47	13.9	204,352	2.57
Inferred	0.73	17.3	127,425	2.52
TOTAL (>5% TGC)	**2.20**	**15.1**	**331,778**	**2.55**

Mt = million tonnes TGC = Total Graphitic Carbon

Table 3.2 Kookaburra Gully Mineral Resource at a nominal 2% TGC lower cut-off grade

Mineral Resource Classification	Tonnage (Mt)	Average Grade (% TGC)	Contained Graphite (tonnes)	Density (g/cc)
Indicated	2.10	10.6	223,349	2.56
Inferred	1.13	12.2	137,370	2.52
TOTAL (>2% TGC)	**3.23**	**11.2**	**360,719**	**2.54**

Mt = million tonnes TGC = Total Graphitic Carbon

Waste blocks were added to the resource model. A 30 metre deep oxide zone was assumed, based on information provided by LML. This oxide zone was treated as a free-dig when applying costs—that is, no blasting being required.

The mining costs were then applied to the model to create value models for input into the optimization process. Two models were created during this process: One for the “Base Case”, limited by the property fence, and one for the “No Limit Case”, which considers the whole area as mineable.

The resulting Kookaburra Gully Base Case value model was named *kkow_fx.dm* and the Kookaburra Gully No Limit Case value model was named *kkownl_fx.dm*.

4 PIT OPTIMIZATION

The ultimate pit limit and stages were determined using Whittle™ software (Whittle). Whittle software is provided by Dassault Systèmes GEOVIA. Whittle software is an implementation of the Lerchs-Grossman algorithm.

Whittle optimizations were conducted on the following two cases:

- Kookaburra Gully Base Case (Limited to 6,192,930 mN)
- Kookaburra Gully No Limit Case

Four different pit slopes scenarios (35°, 37°, 39°, and 41°) were created for each case.

In addition, two price scenarios were created: Low Revenue (LR) and High Revenue (HR) scenarios, both assuming a constant feed of 250 ktpa throughout the life-of-mine.

4.1 Kookaburra Gully Base Case

The Kookaburra Gully Base Case takes into account the property fence limit, by preventing any block north of that limit, from mining.

The two price scenarios (LR and HR) use 37° slopes.

4.1.1 Low Revenue Base Case

The LR Base Case is based on the production of a concentrate with grade of 94%C and a price of $1,077/t Concentrate.

The optimization results for the Kookaburra Gully LR Base Case are shown in Table 4.1.

Table 4.1 Kookaburra Gully LR Base Case at 37°

Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cashflow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
				Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
4	0.53	2.45	0.62	0.15	17.22	25	94.00	16	15	-25	-26	76.25	177.53
6	1.11	2.83	1.16	0.29	17.13	47	94.00	29	26	-12	-14	77.73	176.65
10	1.95	3.58	1.71	0.43	16.79	69	94.00	40	35	-1	-5	80.18	173.11
14	3.25	3.84	2.69	0.67	15.22	98	94.00	52	44	12	4	79.51	156.93
17	4.98	4.72	3.48	0.87	14.85	124	94.00	62	50	21	10	82.38	153.09
24	8.44	6.44	4.54	1.13	14.69	160	94.00	71	56	30	15	89.17	151.52
28	9.74	7.03	4.85	1.21	14.65	170	94.00	72	56	32	16	91.49	151.10
31	10.75	7.47	5.08	1.27	14.60	177	94.00	73	56	32	16	93.20	150.58
32	11.17	7.67	5.15	1.29	14.60	180	94.00	73	56	32	16	94.01	150.59
Max Undiscounted and Max Operating NPV Pit Shells													
31	10.75	7.47	5.08	1.27	14.60	177	94.00	73	56	32	16	93.20	150.58
32	11.17	7.67	5.15	1.29	14.60	180	94.00	73	56	32	16	94.01	150.59

The maximum operating NPV pit shell for this scenario is Pit Shell 31, which is shown on Figure 4.1 and Figure 4.2, with a pit NPV of $56 million and a concentrate production of 177 kt. The project NPV is $16 million.

Figure 4.3, Figure 4.4 and Figure 4.5 show the pit sections A-A', B-B' and C-C', respectively.

Figure 4.1 Kookaburra Gully LR Base Case at 37° – Max. Operating NPV Pit Shell Level Contours

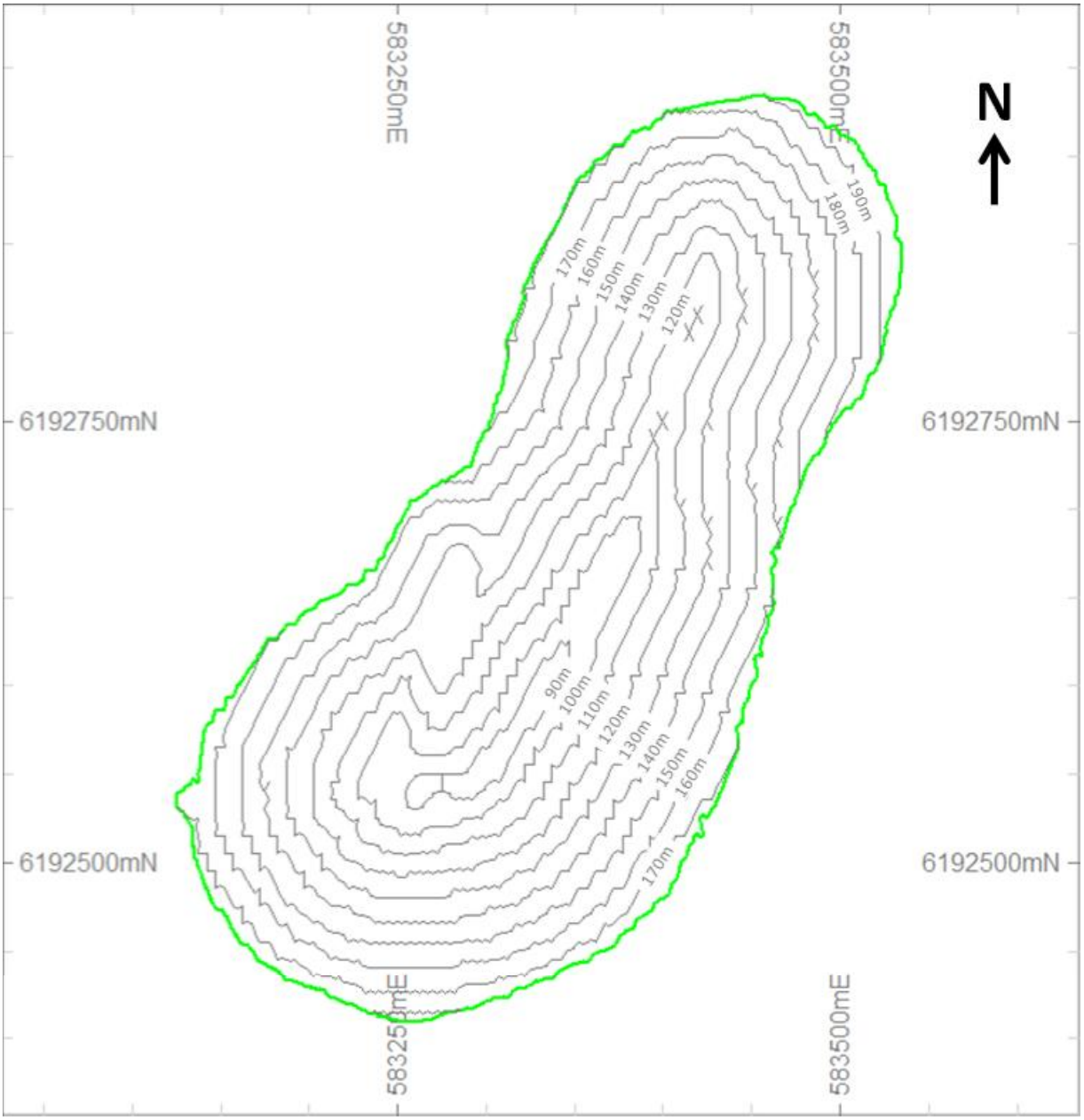


Figure 4.2 Kookaburra Gully LR Base Case at 37º – Max. Operating NPV Pit Shell

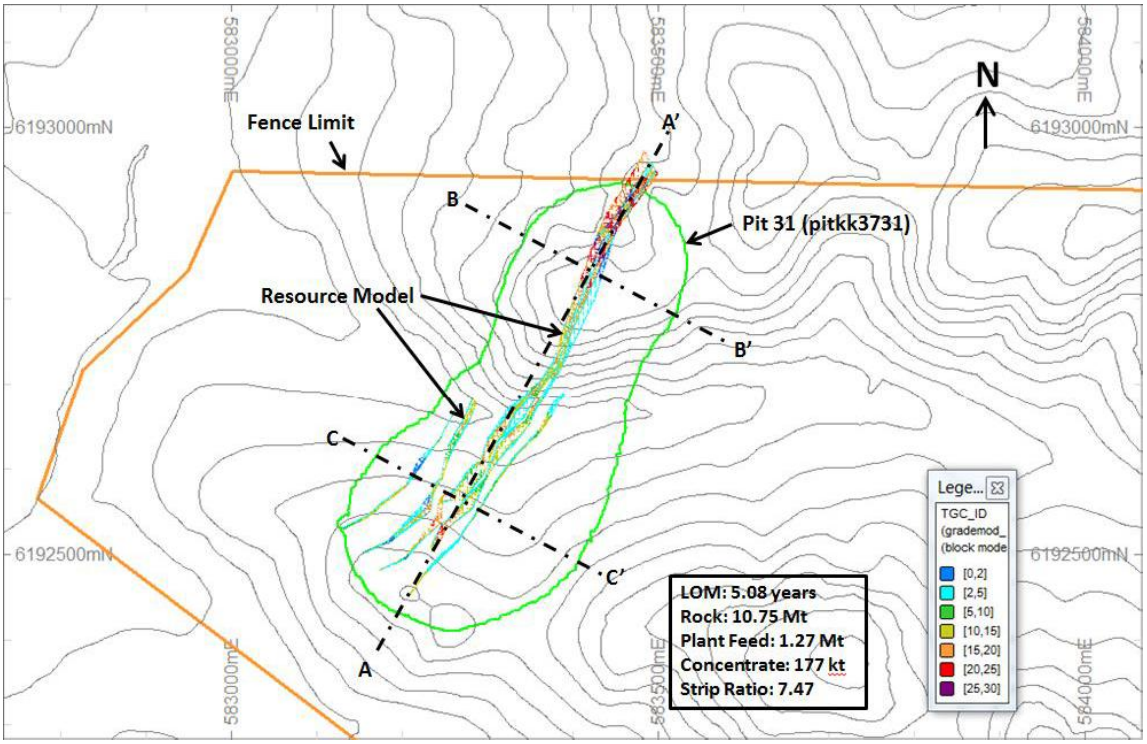


Figure 4.3 Kookaburra Gully LR Base Case at 37º – Section A-A'

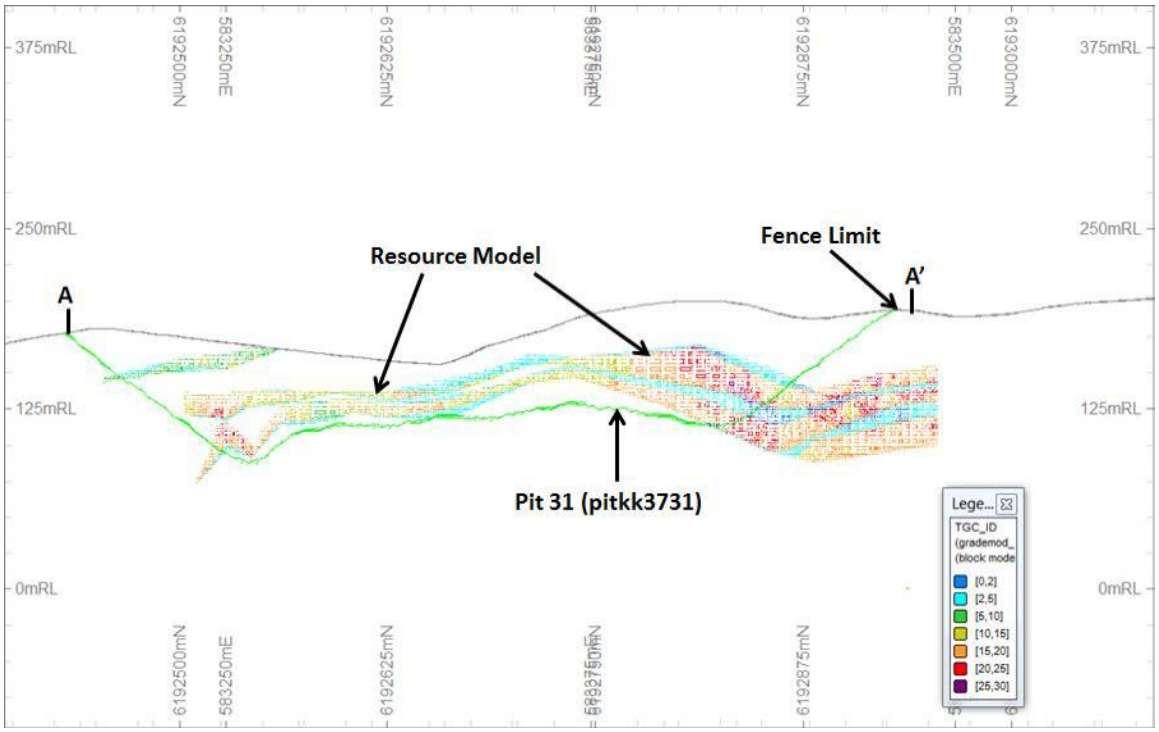


Figure 4.4 Kookaburra Gully LR Base Case at 37º – Section B-B'

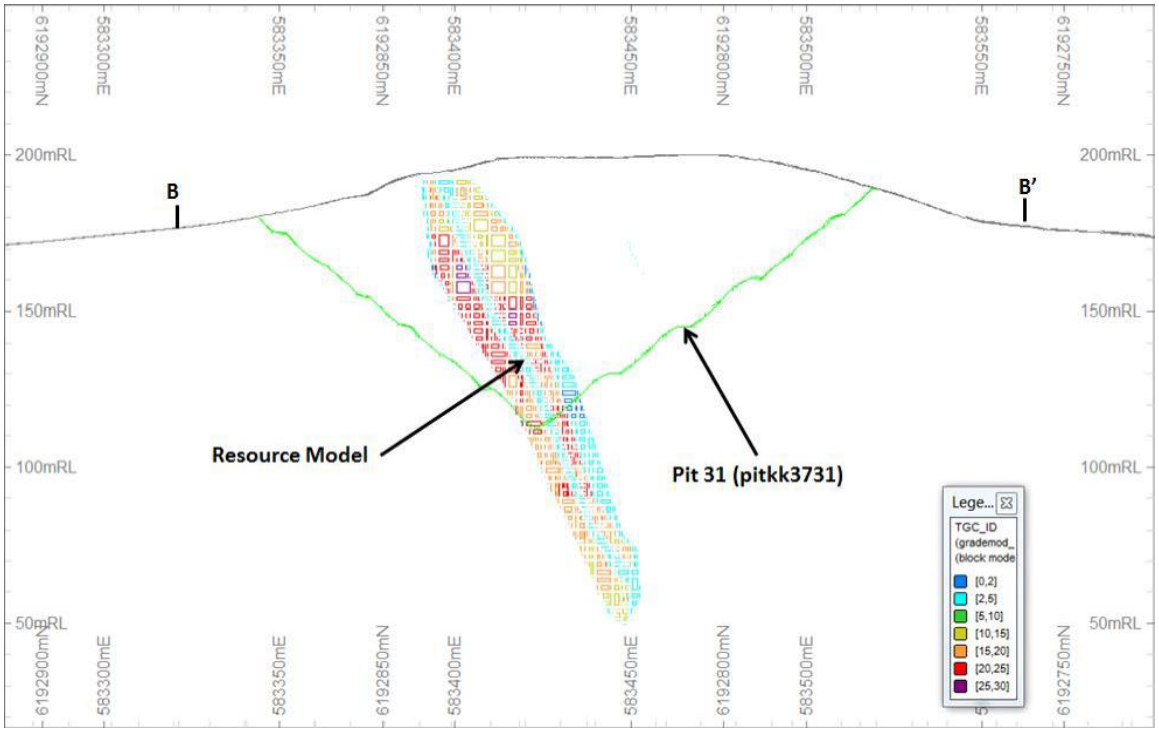
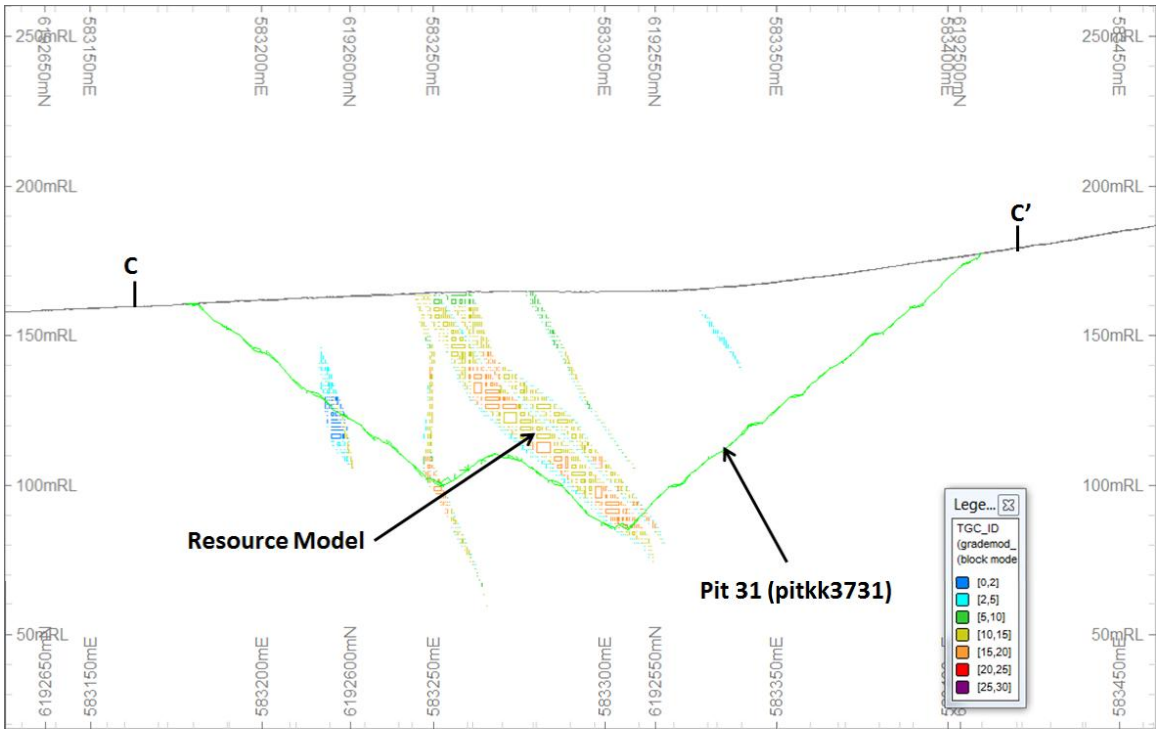


Figure 4.5 Kookaburra Gully LR Base Case at 37º – Section C-C'



A summary of the preliminary mine schedule for the Kookaburra Gully LR Base Case Scenario is shown in Table 4.2.

Figure 4.6 shows outlines of the final pits for each stage of the schedule sequencing.

Table 4.2 Kookaburra Gully LR Base Case at 37º Preliminary Schedule

Period Year No.	Initial Pit No.	Final Pit No.	Period Rock Mt	Period SR W:O	Production and Grade per Period				Period Operating Cash Flow		Period Cost Total $/$t_{feed}$	Period Revenue NSR $/$t_{feed}$
					Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	AvNPV $M		
1	1	4	1.03	3.14	0.25	16.91	40.47	94.00	24.00	21.82	78.35	174.34
2	5	6	1.69	5.76	0.25	14.58	34.89	94.00	16.22	13.40	85.44	150.31
3	11	14	1.97	6.88	0.25	13.22	31.64	94.00	12.11	9.10	87.85	136.28
4	15	17	3.42	12.67	0.25	14.20	33.99	94.00	8.30	5.67	113.24	146.44
5	18	24	2.61	9.42	0.25	14.12	33.80	94.00	10.69	6.64	102.85	145.62
6	29	31	0.04	0.81	0.02	14.45	2.70	94.00	1.52	0.94	70.94	149.00

Figure 4.6 Kookaburra Gully LR Base Case at 37º Preliminary Schedule Sequence

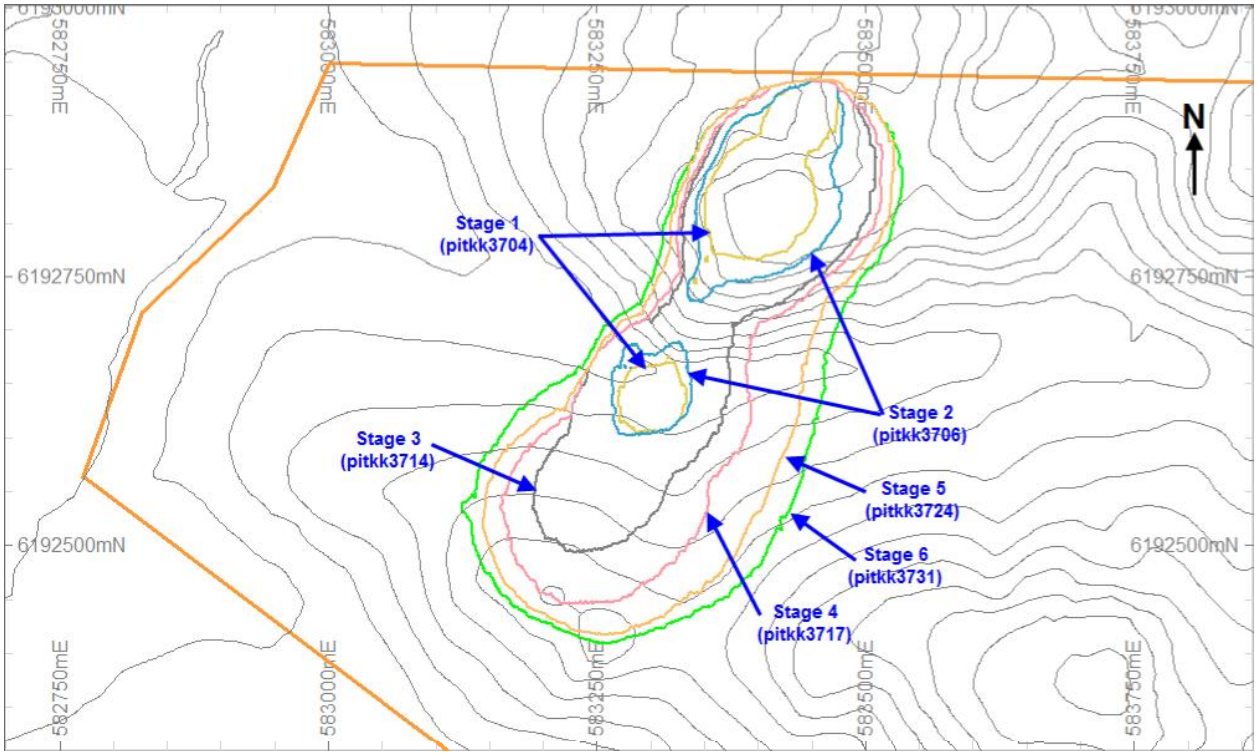


Figure 4.7 shows the quantities of rock and plant feed mined and the concentrate produced per year. Figure 4.8 shows the annual production and average grade of the feed.

More detailed mine planning is likely to result in the smoothing of production. The peak in waste mining indicates the relative timing for significant cutback. The average feed carbon grade in the first year is 16.91% TGC, but it is maintained between 13% TGC and 15% TGC throughout the remaining life-of-mine.

Figure 4.7 Kookaburra Gully LR Base Case at 37º – Annual Production

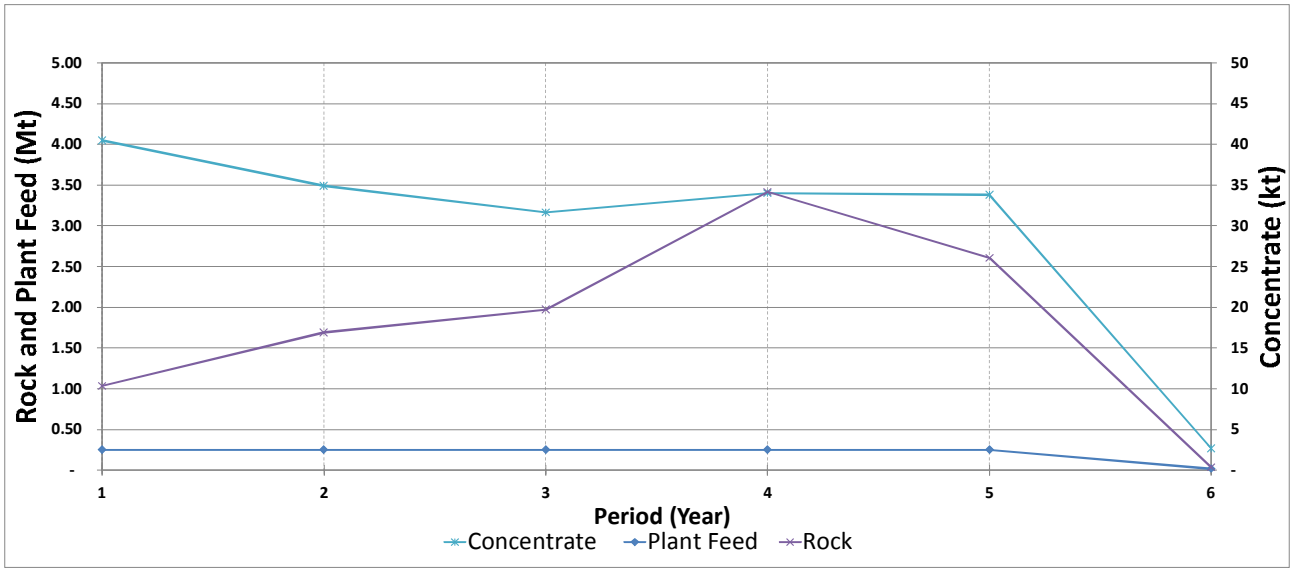


Figure 4.8 Kookaburra Gully LR Base Case at 37º – Annual Production

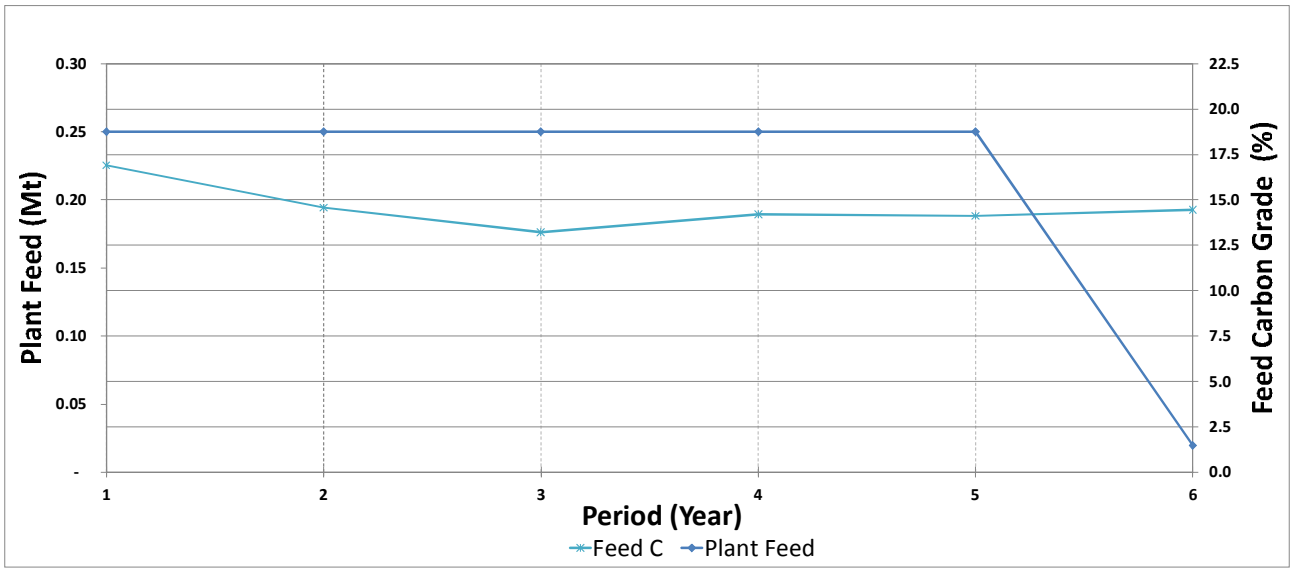


Figure 4.9 shows the cumulative rock and plant feed movement and concentrate production per year.

Figure 4.9 Kookaburra Gully LR Base Case at 37º – Cumulative Production

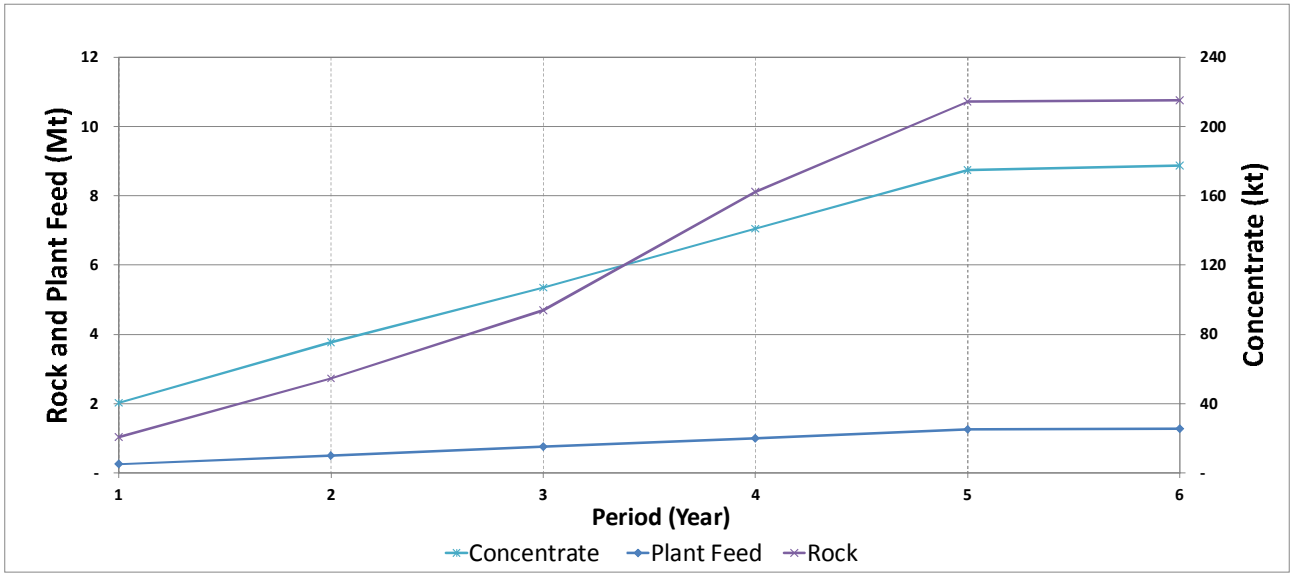
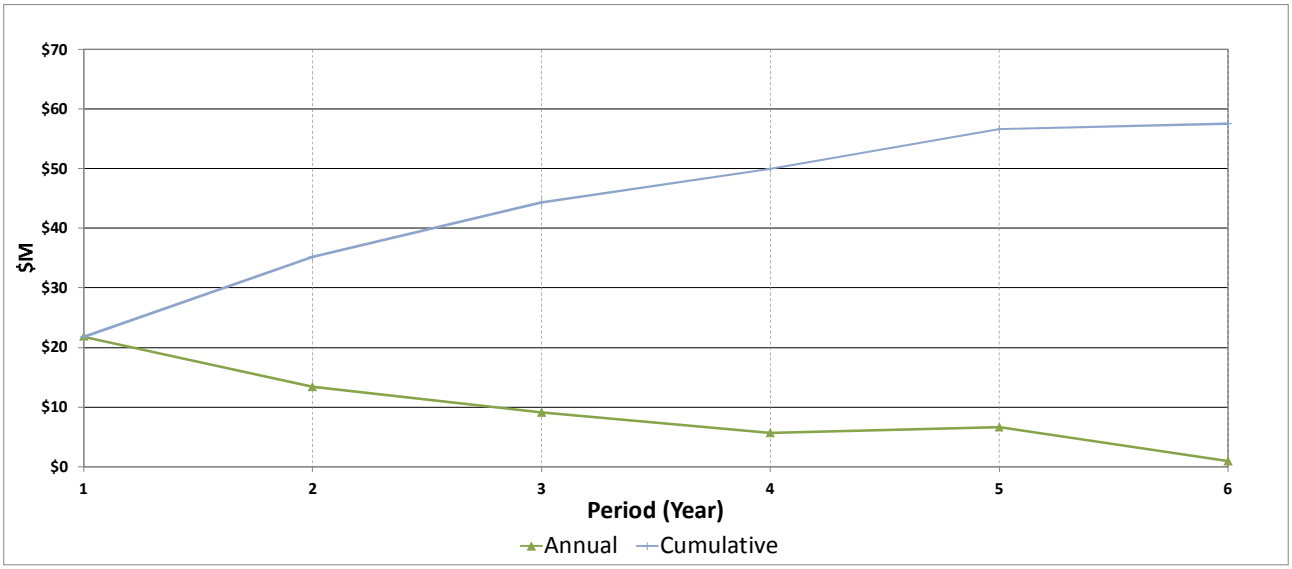


Figure 4.10 shows the yearly operating cash flow and the cumulative cash flow respectively. The cash flow decreases throughout the years due to the increase in the volume of waste being mined.

Figure 4.10 Kookaburra Gully LR Base Case at 37º – Operating Cash Flow



4.1.2 High Revenue Base Case

The HR Base Case is based on the production of a concentrate with 97%C and with a market value of $1,382/t Concentrate.

The optimization results for the Kookaburra Gully HR Base Case with 37º slopes are shown in Table 4.3.

Table 4.3 Kookaburra Gully HR Base Case at 37°

Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
				Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
4	0.53	2.45	0.62	0.15	17.21	25	97.00	22	21	-18	-19	75.74	220.73
6	1.11	2.82	1.16	0.29	17.12	46	97.00	41	37	1	-3	77.20	219.58
10	1.95	3.57	1.71	0.43	16.76	66	97.00	58	51	17	11	79.64	214.96
14	3.25	3.81	2.70	0.68	15.15	95	97.00	78	66	38	26	78.90	194.32
17	4.98	4.67	3.51	0.88	14.76	120	97.00	94	77	54	37	81.70	189.25
24	8.44	6.30	4.63	1.16	14.49	156	97.00	113	88	73	48	88.03	185.83
28	9.74	6.86	4.96	1.24	14.44	166	97.00	118	91	77	50	90.27	185.20
38	12.47	8.07	5.50	1.37	14.35	183	97.00	122	93	82	52	95.05	184.04
44	13.48	8.48	5.69	1.42	14.27	188	97.00	123	92	82	52	96.67	183.00
Max Undiscounted and Max Operating NPV Pit Shells													
38	12.47	8.07	5.50	1.37	14.35	183	97.00	122	93	82	52	95.05	184.04
44	13.48	8.48	5.69	1.42	14.27	188	97.00	123	92	82	52	96.67	183.00

The maximum operating NPV pit shell for the HR Base Case scenario is Pit Shell 38, which is shown on Figure 4.11 and Figure 4.12, with a pit NPV of $93 million and a Concentrate production of 183 kt. The project NPV is $52 million.

Figure 4.13, Figure 4.14 and Figure 4.15 show the pit sections A-A', B-B' and C-C', respectively.

Figure 4.11 Kookaburra Gully HR Base Case at 37º – Max. Operating NPV Pit Shell Level Contours

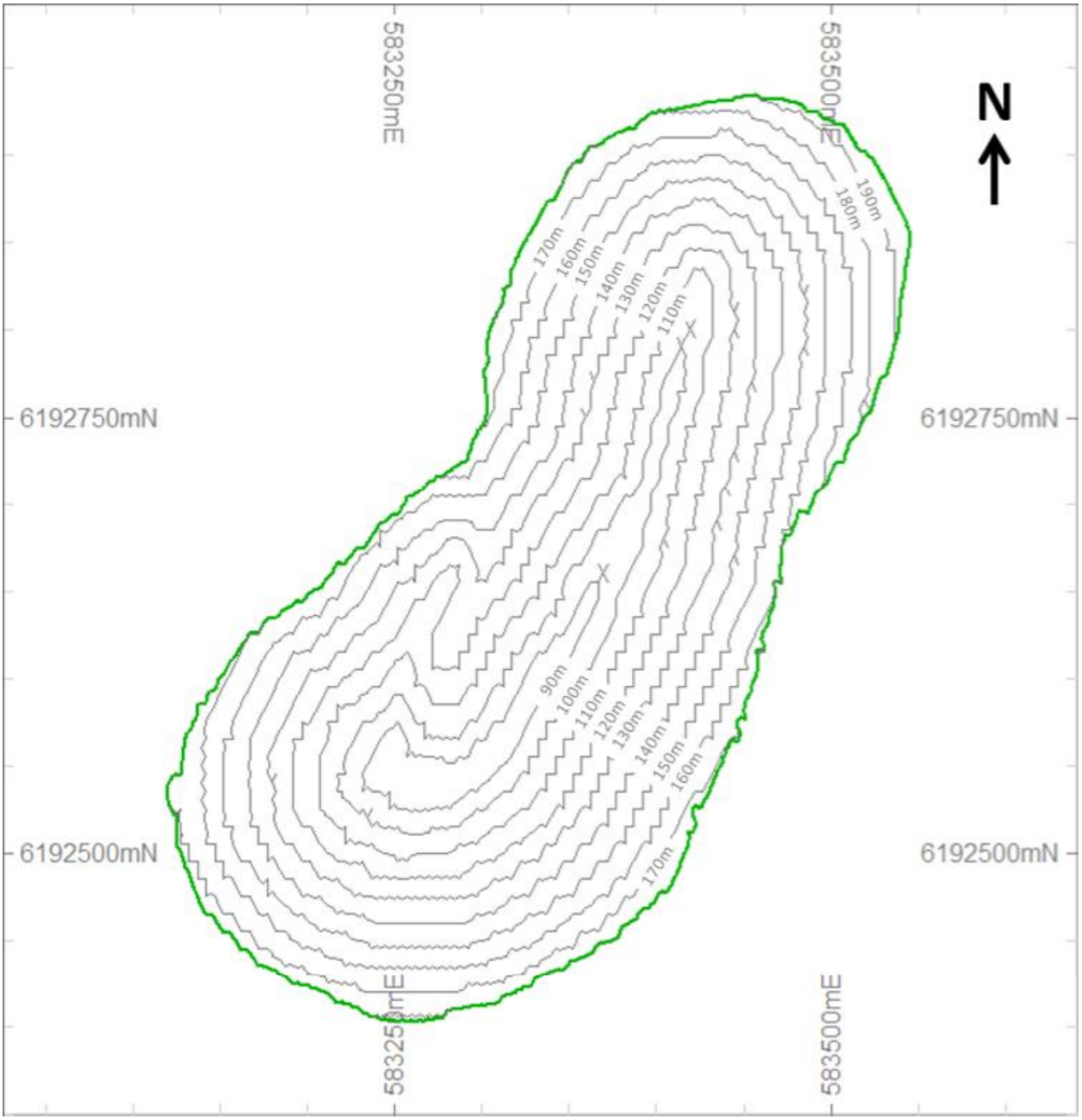


Figure 4.12 Kookaburra Gully HR Base Case at 37º – Max. Operating NPV Pit Shell

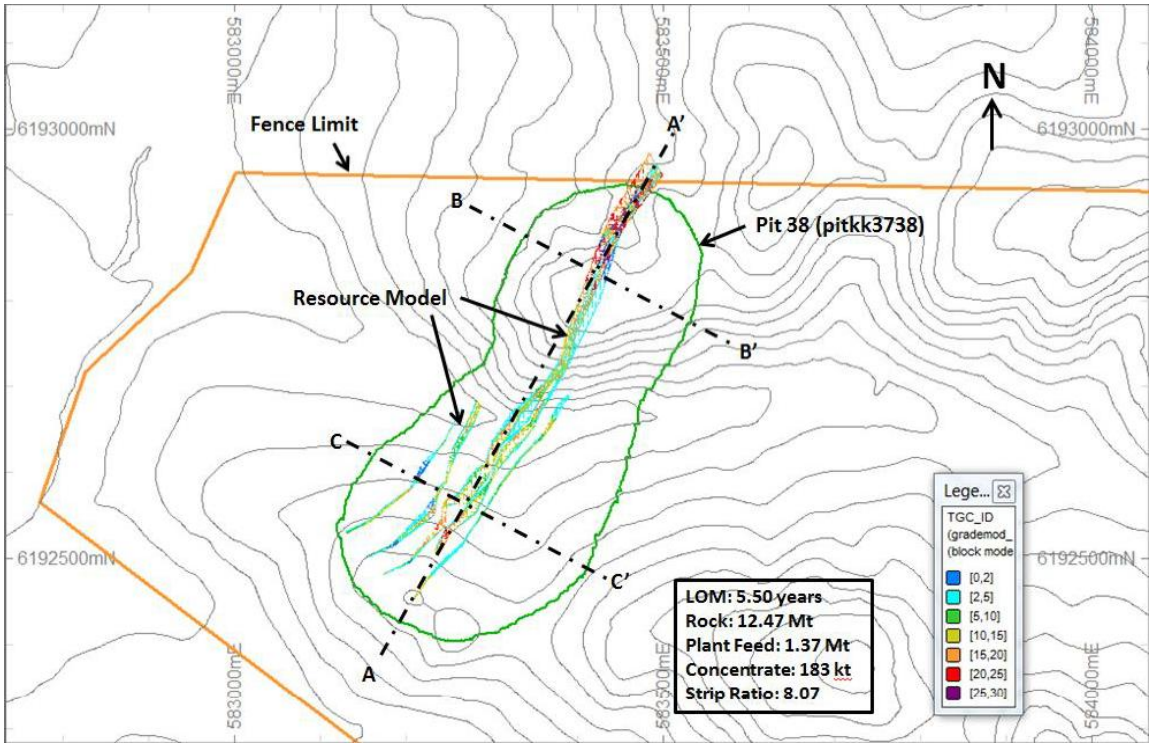


Figure 4.13 Kookaburra Gully HR Base Case at 37º – Section A-A'

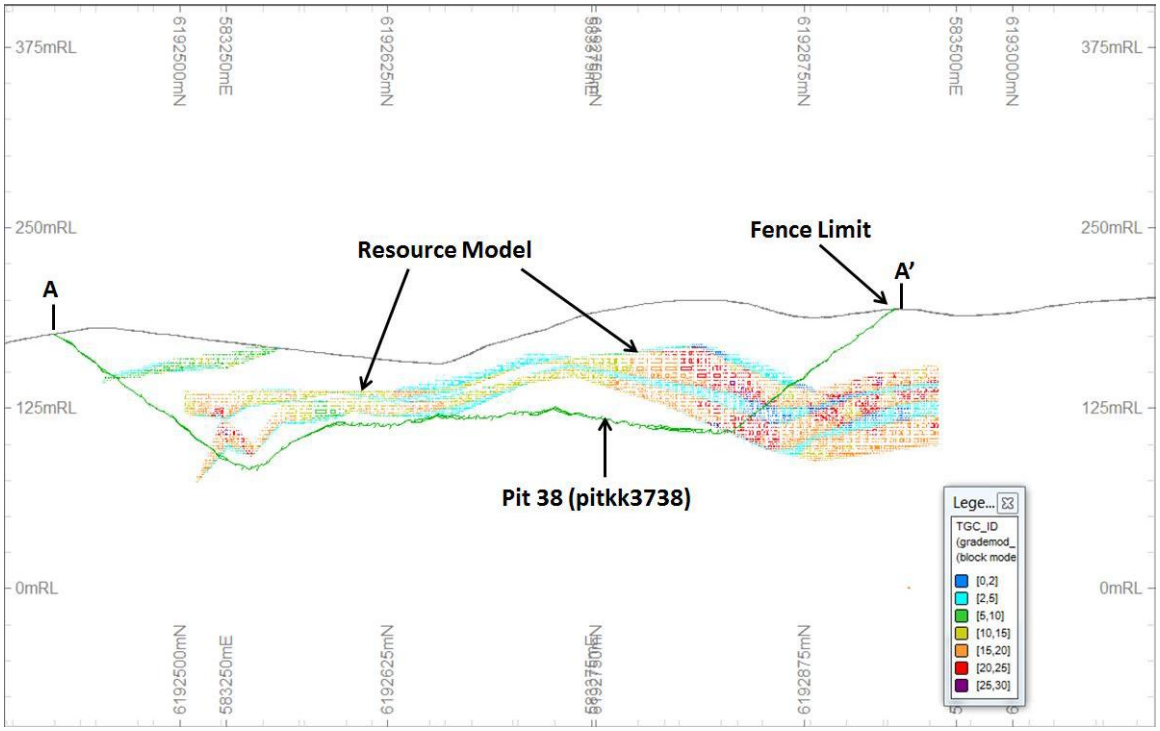


Figure 4.14 Kookaburra Gully HR Base Case at 37º – Section B-B'

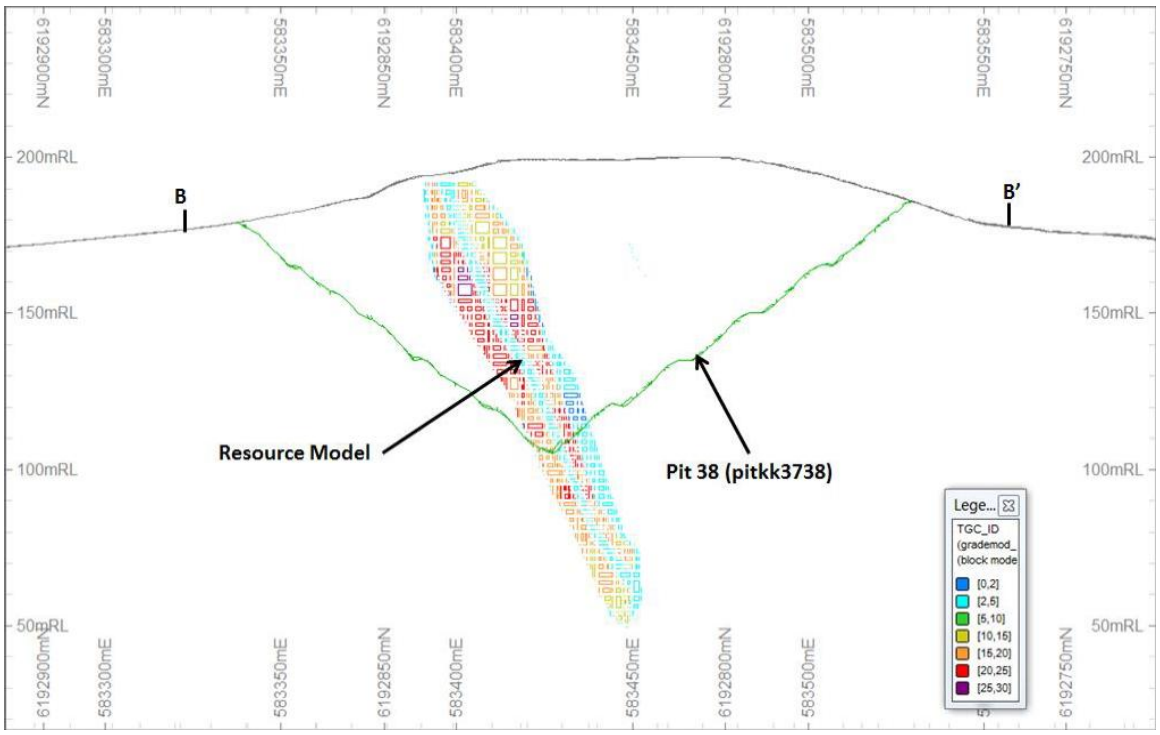
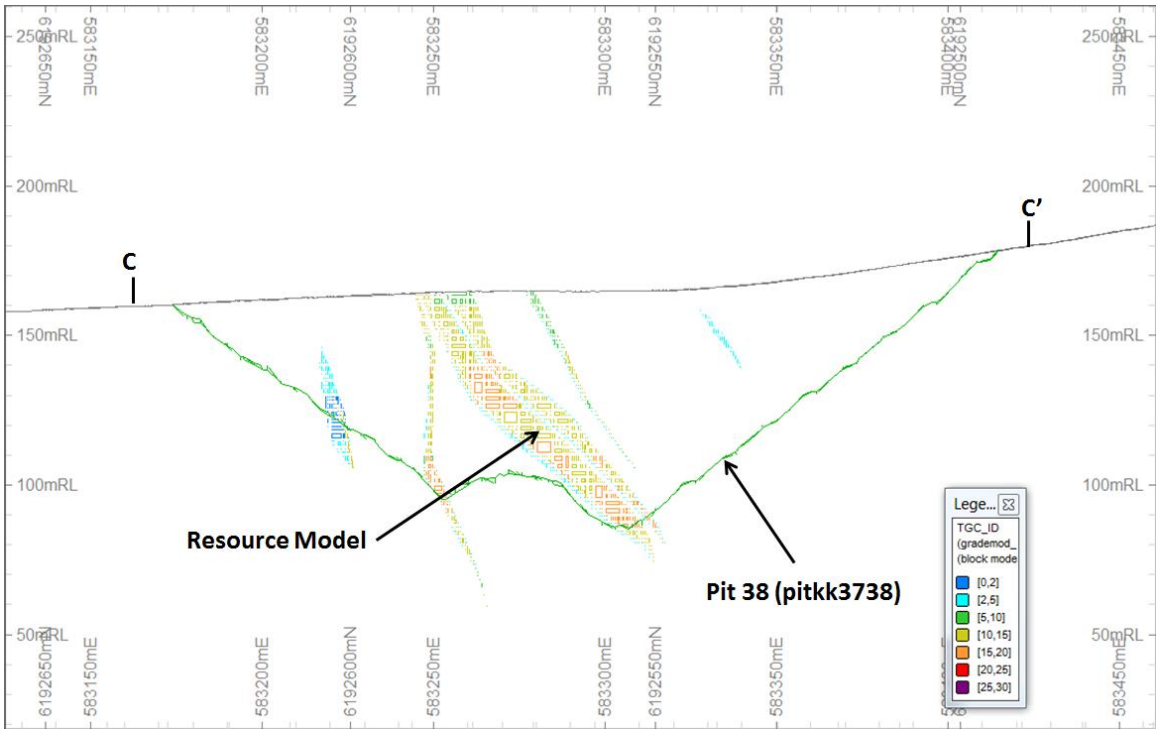


Figure 4.15 Kookaburra Gully HR Base Case at 37º – Section C-C'



A summary of the preliminary mine schedule for the Kookaburra Gully HR Base Case Scenario is shown in Table 4.4.

Figure 4.16 shows outlines of the final pits for each stage of the schedule sequencing.

Table 4.4 Kookaburra Gully HR Base Case at 37° Preliminary Schedule

Period Year No.	Initial Pit No.	Final Pit No.	Period Rock Mt	Period SR W:O	Production and Grade per Period				Period Operating Cash Flow		Period Cost Total $/$t_{feed}$	Period Revenue NSR $/$t_{feed}$
					Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	AvNPV $M		
1	1	4	1.03	3.14	0.25	16.90	39.21	97.00	34.72	31.57	77.84	216.73
2	5	6	1.68	5.70	0.25	14.51	33.66	97.00	25.32	20.93	84.76	186.05
3	11	14	1.96	6.85	0.25	13.04	30.24	97.00	20.02	15.04	87.11	167.19
4	15	17	3.37	12.49	0.25	13.86	32.16	97.00	16.52	11.29	111.68	177.78
5	18	24	3.64	13.58	0.25	13.74	31.87	97.00	14.91	9.26	116.58	176.20
6	29	38	0.78	5.23	0.12	13.77	15.95	97.00	10.86	6.43	89.56	176.52

Figure 4.16 Kookaburra Gully HR Base Case at 37º Preliminary Schedule Sequence

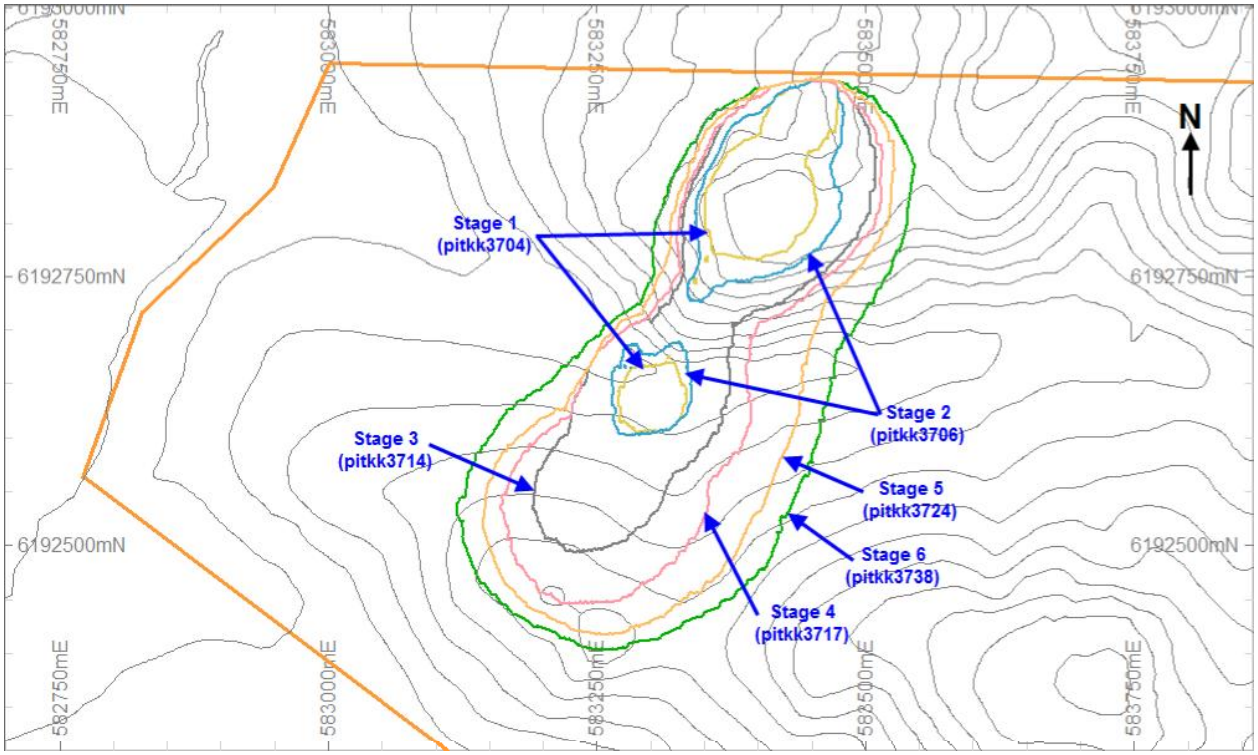


Figure 4.17 shows the quantities of rock and plant feed mined and the concentrate produced per year. Figure 4.18 shows the annual production and average grade.

As with the Kookaburra Gully LR Base Case, the peaks in waste production indicate the timing required for large cutbacks and more detailed mine planning is likely to result in the smoothing of production.

The average feed carbon grade in the first year is 16.90% TGC and 14.51% TGC in the second year. It is maintained between 13% TGC and 14% TGC throughout the remaining life-of-mine.

Figure 4.17 Kookaburra Gully HR Base Case at 37º – All Production

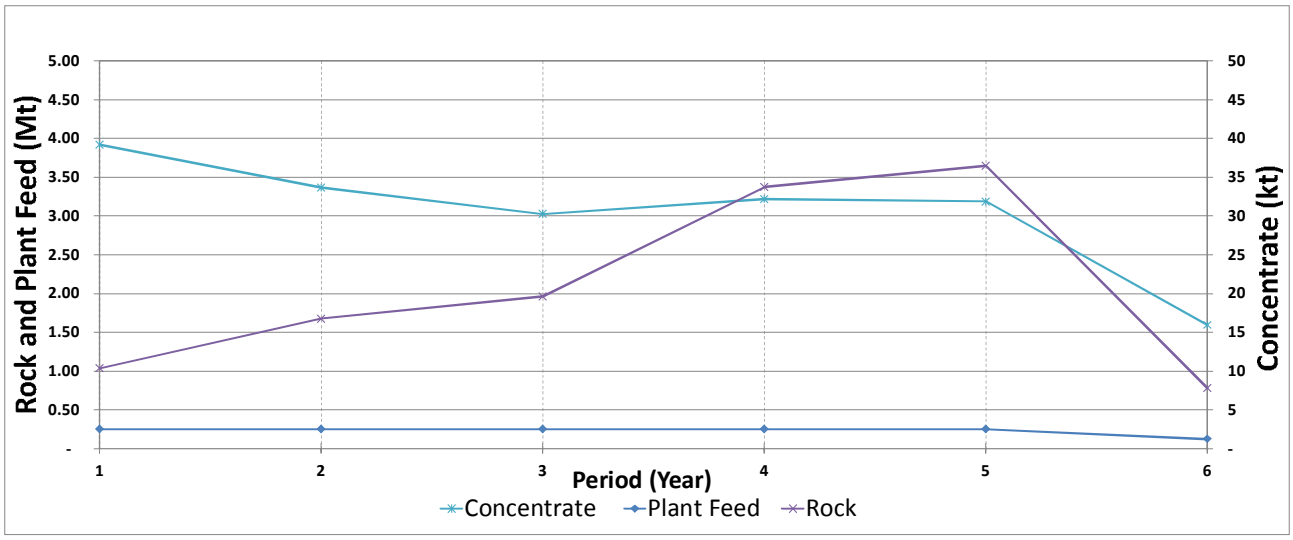


Figure 4.18 Kookaburra Gully HR Base Case at 37º – Process Production

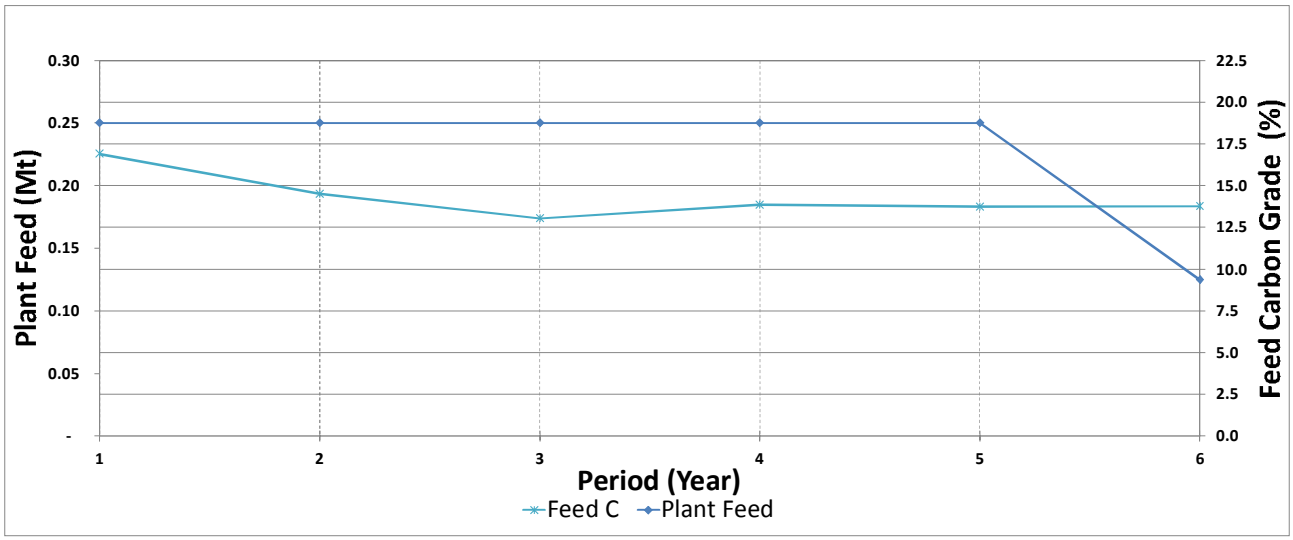


Figure 4.19 shows the cumulative rock and plant feed movements and concentrate production per year.

Figure 4.19 Kookaburra Gully HR Base Case at 37º – Cumulative Production

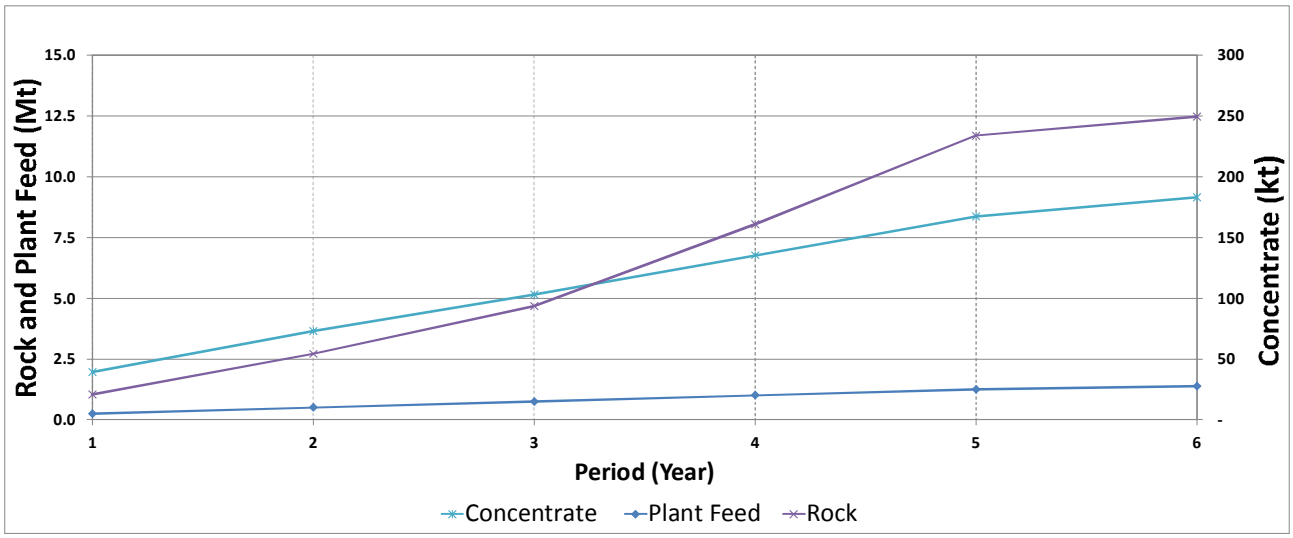
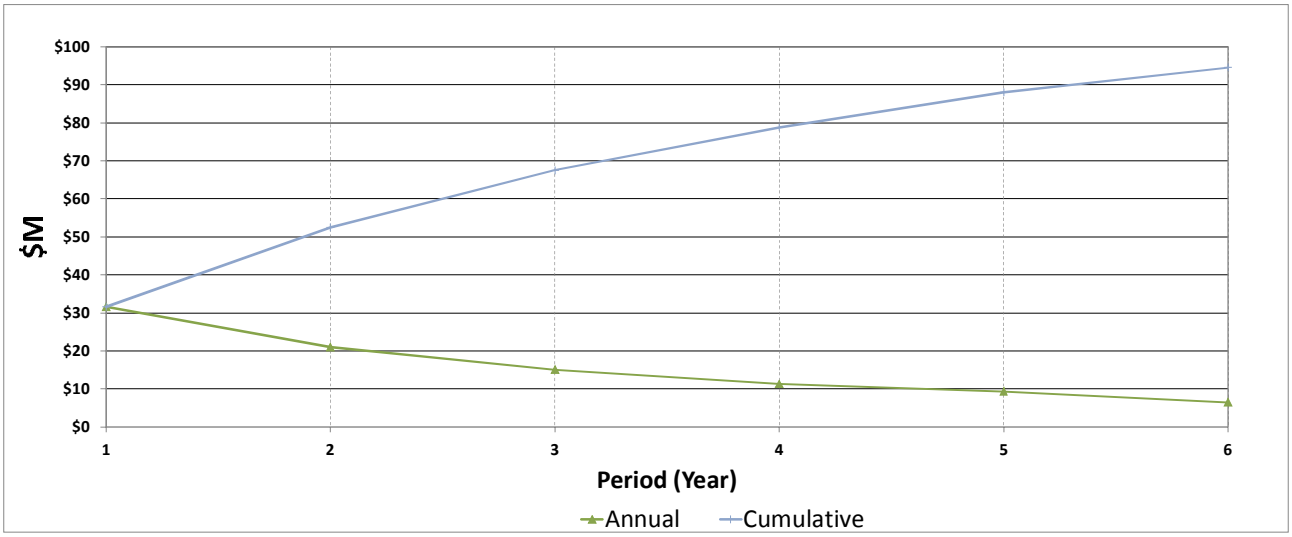


Figure 4.20 shows the yearly operating cash flow and the cumulative cash flow respectively. As in the LR Base Case, the cash flow decreases throughout the years due to the increase in volume of waste being mined.

Figure 4.20 Kookaburra Gully HR Base Case at 37º – Operating Cash Flow



4.2 Kookaburra Gully No Limit Case

The No Limit Case considers the whole resource as mineable, disregarding the northern fence limit. Two optimizations (LR and HR scenarios) were also performed for this case, but no schedule was produced.

In both scenarios, the final pit limit extends around 110 m north of the fence limit.

4.2.1 Kookaburra Gully Low Revenue Case

The LR Base Case is based on the production of a concentrate with 94%C and with a market value of $1,077/t Concentrate.

The optimization results for the Kookaburra Gully Resource Model Optimization LR Case with 37º slopes are shown in Table 4.5.

Table 4.5 Kookaburra Gully Pit LR No Limit Case at 37°

Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
				Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
4	0.37	2.57	0.41	0.10	18.87	19	94.00	12	12	-28	-29	78.05	194.55
6	1.30	2.88	1.34	0.33	17.81	57	94.00	35	32	-5	-9	78.40	183.64
10	3.29	4.45	2.42	0.60	17.71	102	94.00	59	51	19	10	84.29	182.62
14	5.50	5.13	3.59	0.90	16.75	144	94.00	78	63	37	23	86.05	172.72
17	7.59	5.62	4.58	1.15	16.07	176	94.00	90	70	50	29	87.22	165.68
24	11.88	7.16	5.82	1.45	15.81	220	94.00	102	75	61	35	93.06	163.02
28	13.33	7.60	6.20	1.55	15.67	233	94.00	104	76	63	35	94.68	161.56
31	15.74	8.44	6.67	1.67	15.63	249	94.00	105	76	65	35	98.11	161.20
33	15.98	8.53	6.71	1.68	15.63	251	94.00	105	75	65	35	98.44	161.16
Max Undiscounted and Max Operating NPV Pit Shells													
28	13.33	7.60	6.20	1.55	15.67	233	94.00	104	76	63	35	94.68	161.56
33	15.98	8.53	6.71	1.68	15.63	251	94.00	105	75	65	35	98.44	161.16

The maximum operating NPV pit shell for this scenario is the Pit Shell 28, which is shown on Figure 4.21 and Figure 4.22, with a pit NPV of $76 million and a Concentrate production of 233 kt.

The project NPV is $35 million, which is $19 million higher than the Base Case LR scenario and produces an extra 56 Mt of concentrate.

Figure 4.23 shows the pit section A-A' and the maximum operating NPV pit shell for the Base Case LR (pitkk3731) as a comparison. Figure 4.24 and Figure 4.25 show the pit sections B-B' and C-C', respectively.

Figure 4.21 Kookaburra Gully LR No Limit Case at 37º – Max. Operating NPV Pit Shell Level Contours

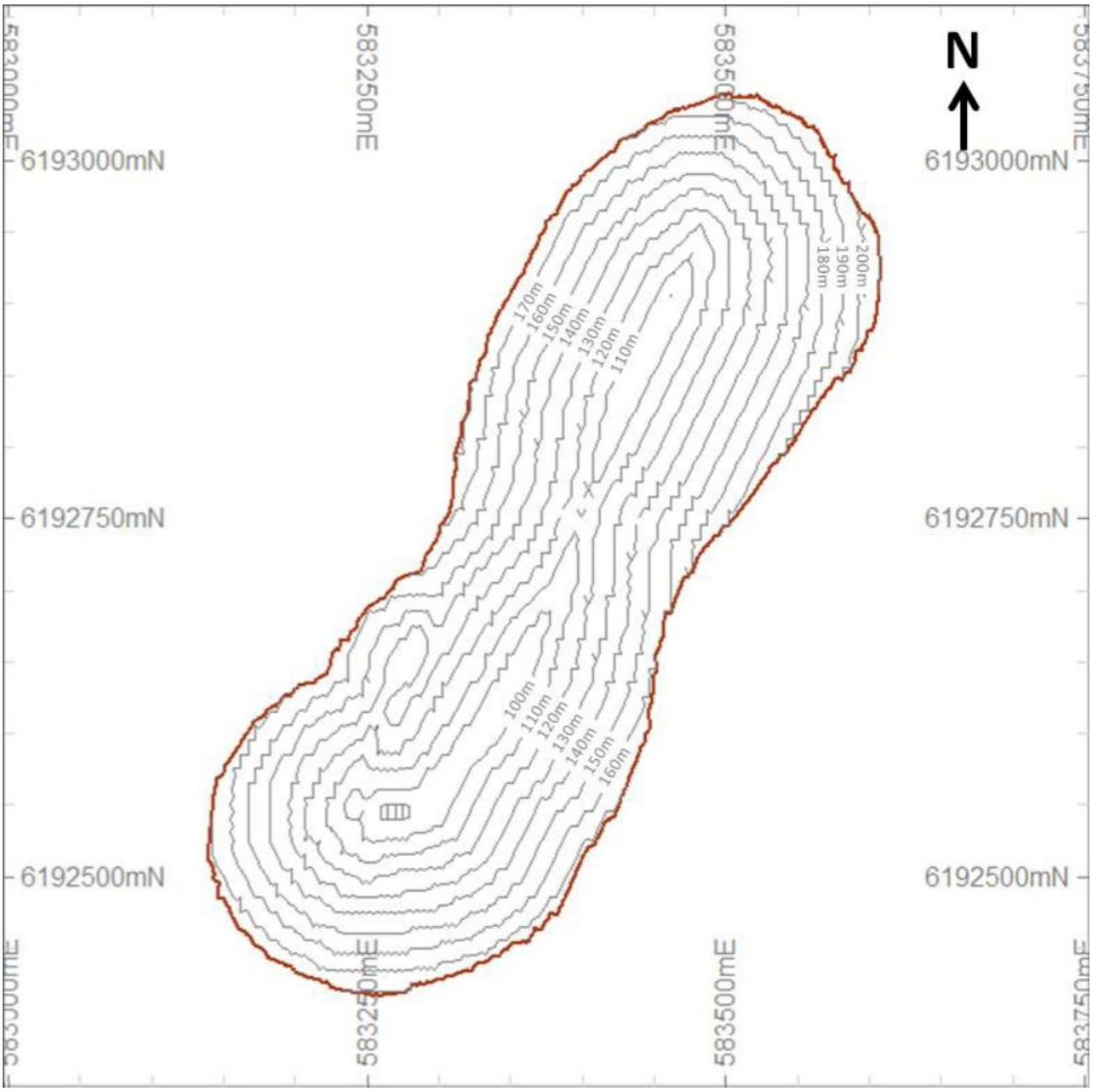


Figure 4.22 Kookaburra Gully LR No Limit Case at 37º – Max. Operating NPV Pit Shell

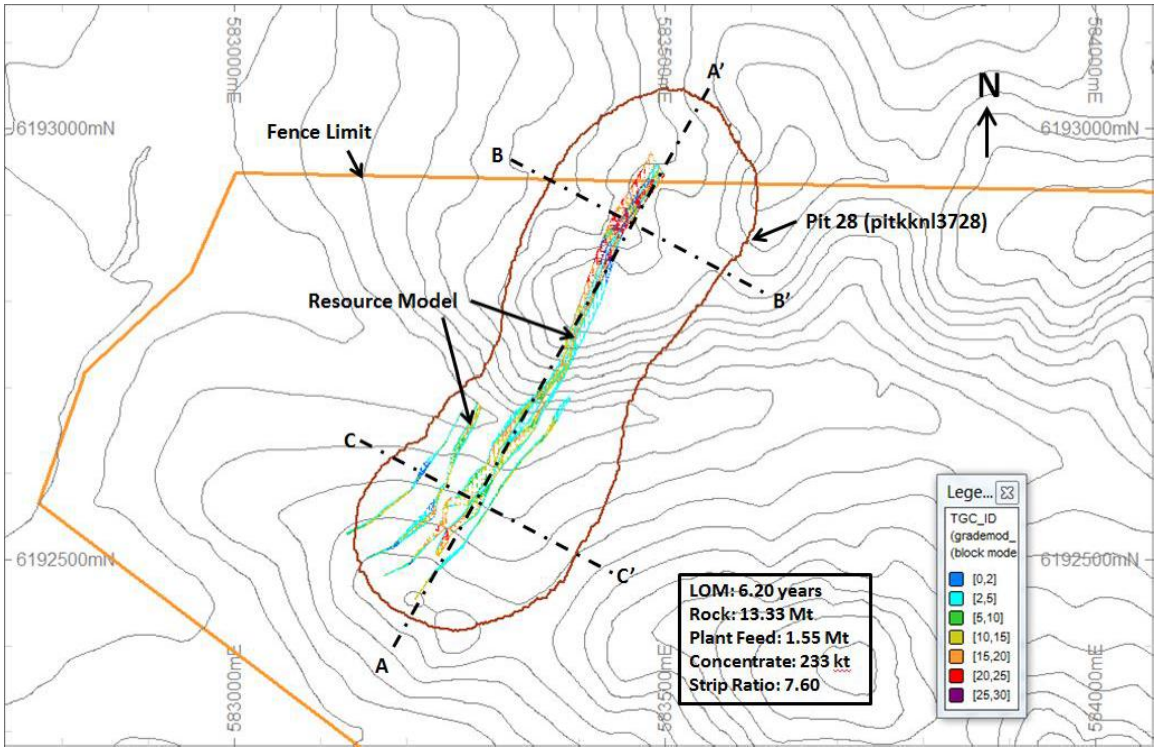


Figure 4.23 Kookaburra Gully LR No Limit Case at 37º – Section A-A'

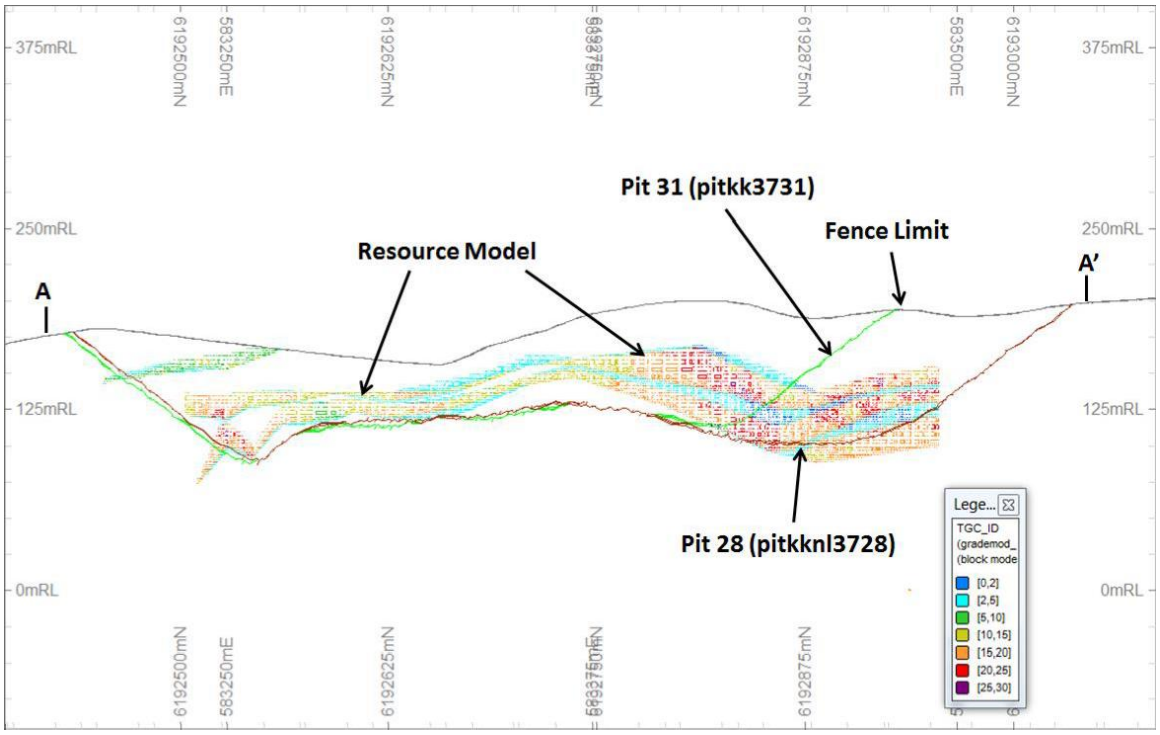


Figure 4.24 Kookaburra Gully LR No Limit Case at 37º – Section B-B'

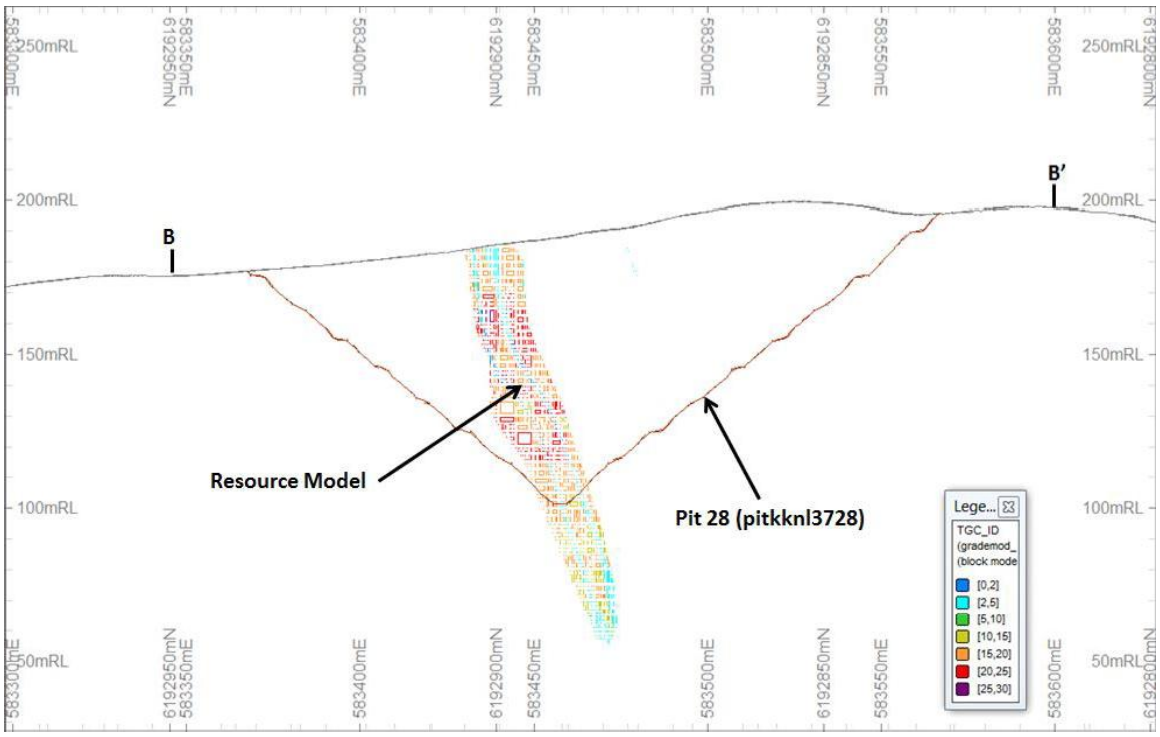
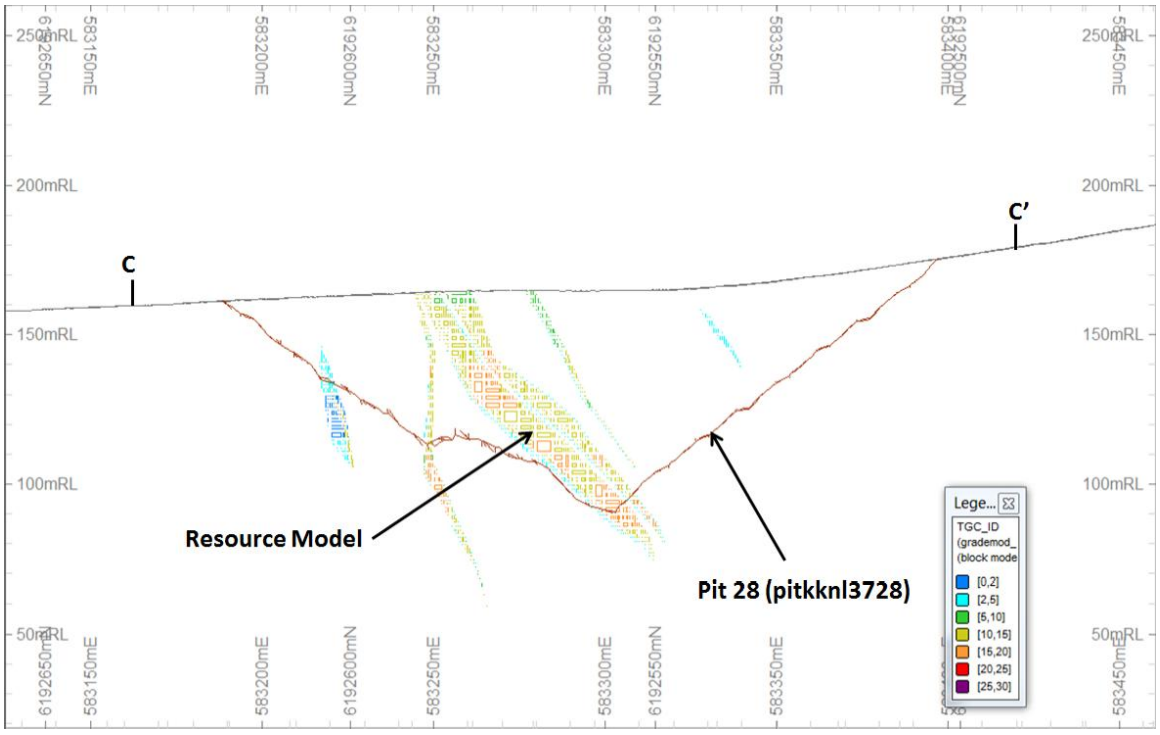


Figure 4.25 Kookaburra Gully LR No Limit Case at 37º – Section C-C'



4.2.2 Kookaburra Gully High Revenue Case

The HR No Limit Case is based on the production of a concentrate with 97%C and with a market value of $1,382/t Concentrate.

The optimization results for the Kookaburra Gully HR No Limit Case with 37º slopes are shown in Table 4.6.

Table 4.6 Kookaburra Gully Pit HR No Limit Case at 37°

Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
				Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
4	0.37	2.57	0.41	0.10	18.86	18	97.00	17	16	-23	-24	77.48	241.88
6	1.30	2.88	1.34	0.33	17.81	55	97.00	50	45	10	5	77.87	228.33
10	3.29	4.44	2.42	0.60	17.69	99	97.00	87	74	46	33	83.73	226.85
14	5.50	5.11	3.61	0.90	16.70	140	97.00	116	94	76	54	85.42	214.15
17	7.59	5.58	4.61	1.15	16.00	171	97.00	137	106	96	66	86.55	205.16
24	11.88	7.04	5.91	1.48	15.63	214	97.00	160	118	120	78	91.99	200.48
28	13.33	7.46	6.31	1.58	15.49	227	97.00	166	120	125	80	93.54	198.56
39	18.12	9.08	7.19	1.80	15.37	256	97.00	174	123	134	82	100.12	197.06
46	20.25	9.77	7.52	1.88	15.28	267	97.00	175	122	135	82	102.86	195.98
Max Undiscounted and Max Operating NPV Pit Shells													
39	18.12	9.08	7.19	1.80	15.37	256	97.00	174	123	134	82	100.12	197.06
46	20.25	9.77	7.52	1.88	15.28	267	97.00	175	122	135	82	102.86	195.98

The maximum operating NPV pit shell for this scenario is the number 39, which is shown on Figure 4.26 and Figure 4.27, with a pit NPV of $123 million and a Concentrate production of 256 kt.

The project NPV is $82 million, which is $30 million higher than the Base Case High HR scenario and produces an extra 73 Mt of concentrate.

Figure 4.28 shows the pit section A-A' and the maximum operating NPV pit shell for the Base Case HR (pitkk3738) as a comparison. Figure 4.29 and Figure 4.30 show the pit sections B-B' and C-C', respectively.

Figure 4.26 Kookaburra Gully HR No Limit Case at 37º – Max. Operating NPV Pit Shell Level Contours

Figure 4.27 Kookaburra Gully HR No Limit Case at 37º – Max Operating NPV Pit Shell

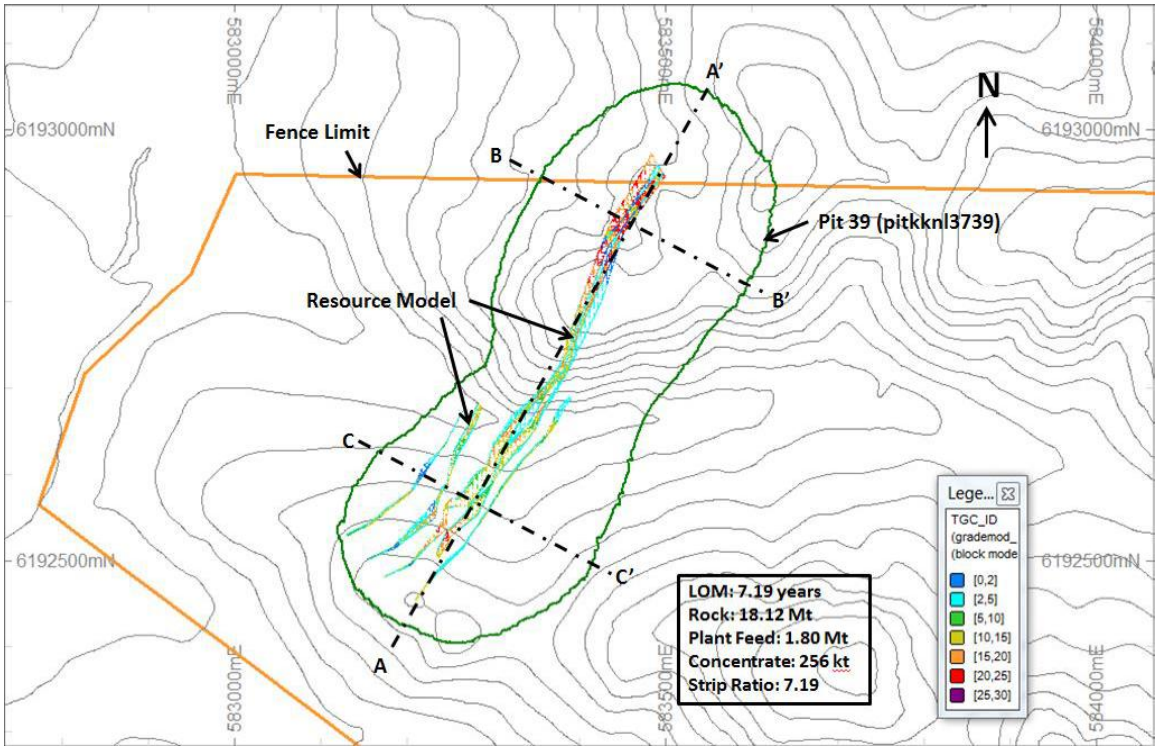


Figure 4.28 Kookaburra Gully HR No Limit Case at 37º – Section A-A'

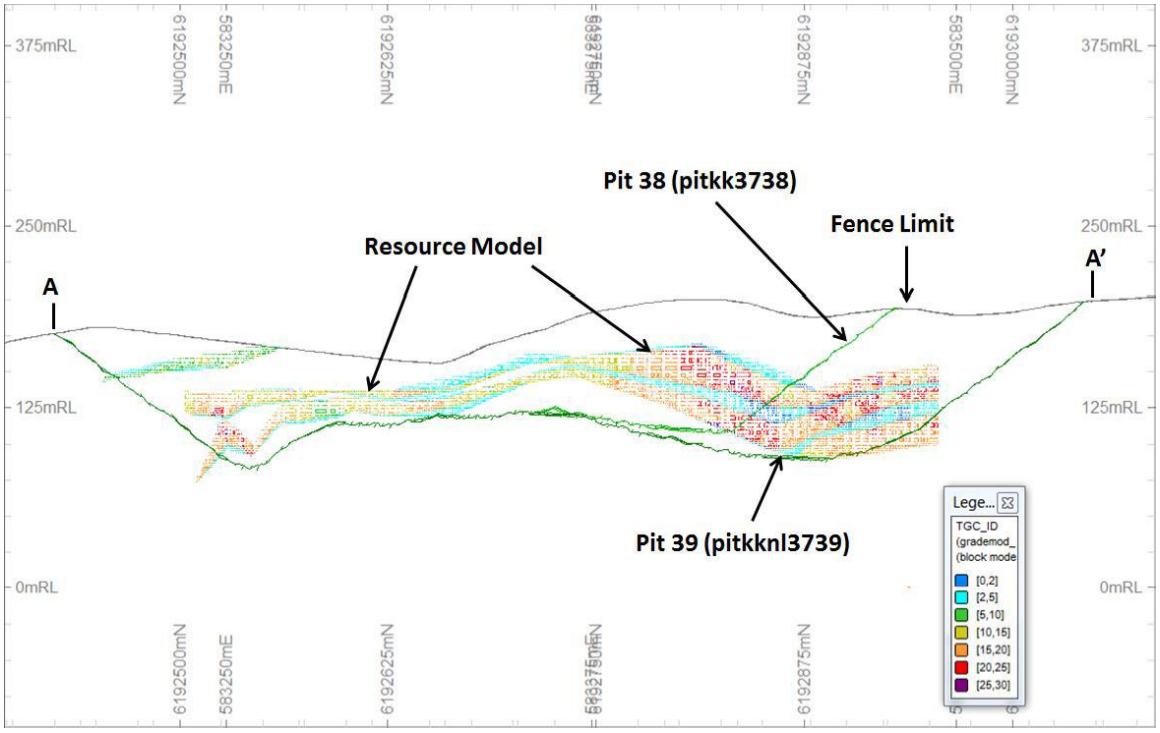


Figure 4.29 Kookaburra Gully HR No Limit Case at 37º – Section B-B'

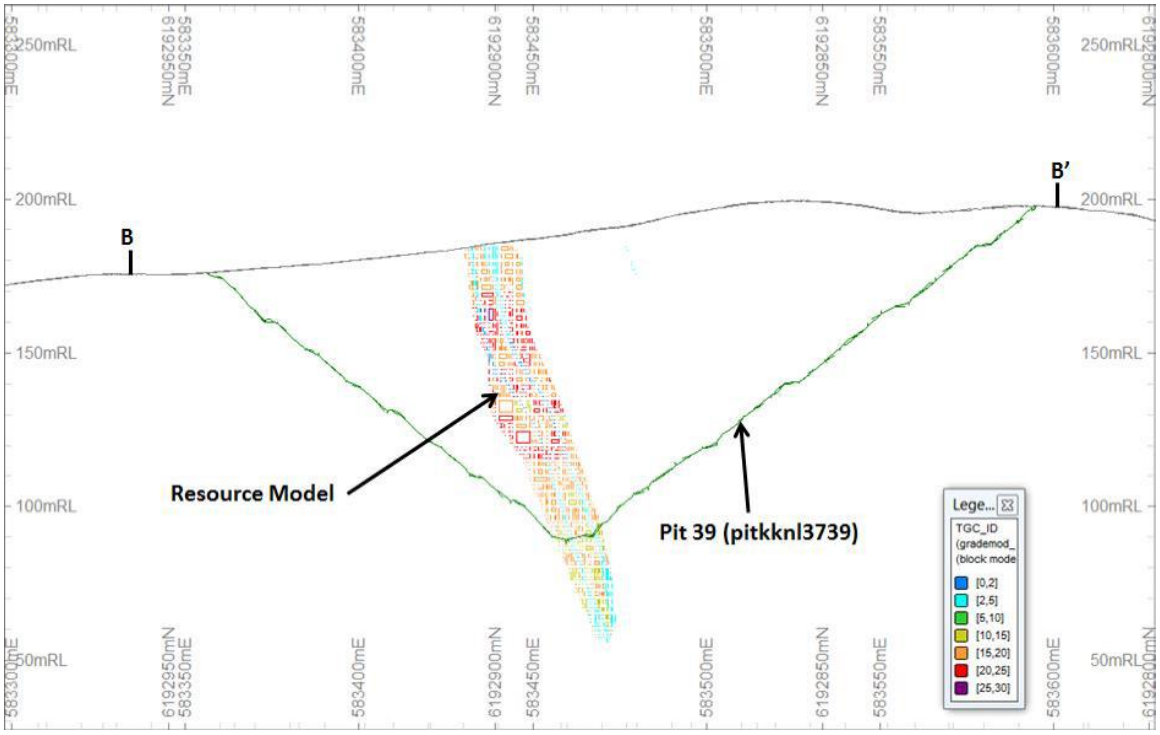
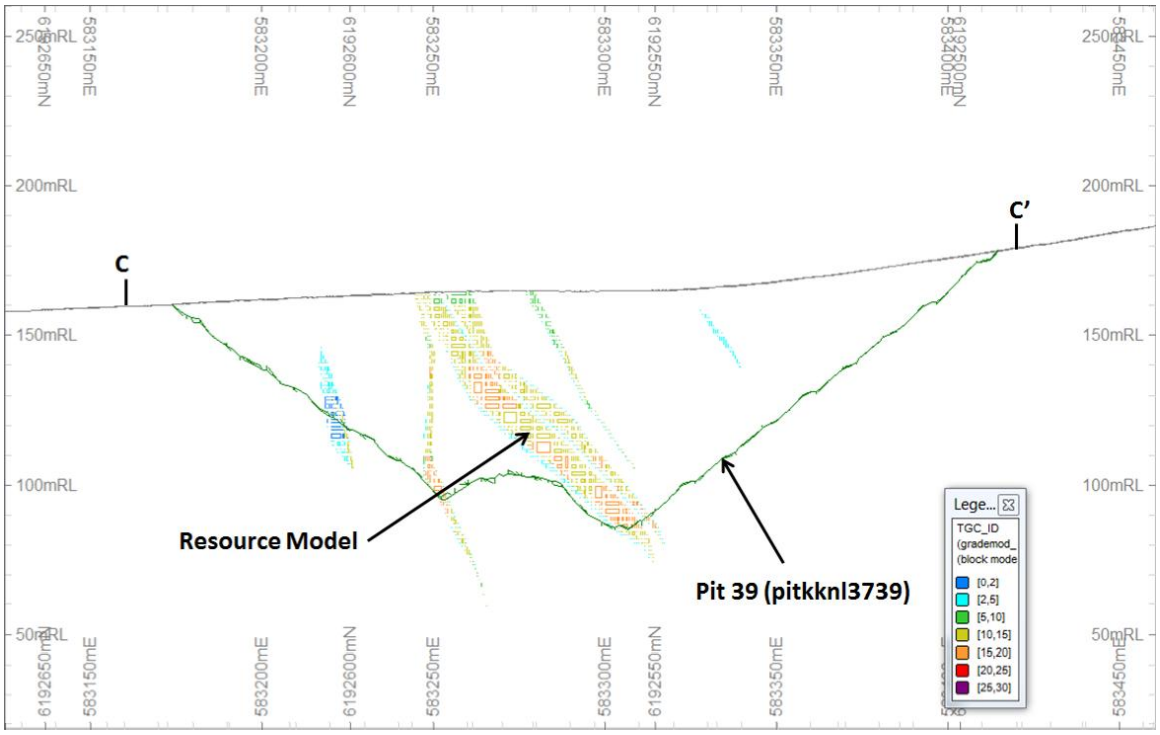


Figure 4.30 Kookaburra Gully HR No Limit Case at 37º – Section C-C'



A summary of the preliminary mine schedule for the Kookaburra Gully HR No Limit Case Scenario is shown in Table 4.7.

Figure 4.31 shows outlines of the final pits for each stage of the schedule sequencing.

Table 4.7 Kookaburra Gully HR No Limit Case at 37° Preliminary Schedule

Period Year no	Initial Pit no	Final Pit no	Period Rock Mt	Period SR W:O	Production and Grade per Period				Period Operating Cash Flow		Period Cost Total $/$t_{feed}$	Period Revenue NSR $/$t_{feed}$
					Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	AvNPV $M		
1	1	4	1.13	3.54	0.25	17.49	40.57	97.00	36.23	32.94	79.35	224.28
2	5	6	1.97	6.90	0.25	17.26	40.04	97.00	32.29	26.69	92.16	221.33
3	7	10	2.05	7.21	0.25	14.82	34.39	97.00	24.70	18.55	91.30	190.09
4	11	14	2.03	7.13	0.25	14.97	34.73	97.00	25.25	17.25	91.00	192.01
5	15	17	4.07	15.30	0.25	14.15	32.83	97.00	14.96	9.29	121.64	181.50
6	18	24	1.84	6.37	0.25	14.77	34.25	97.00	24.43	13.79	91.62	189.34
7	25	28	4.91	18.65	0.25	14.07	32.63	97.00	10.33	5.30	139.02	180.36
8	29	39	0.09	0.97	0.05	15.60	6.90	97.00	6.09	3.07	72.31	199.98

Figure 4.31 Kookaburra Gully HR No Limit Case at 37º Preliminary Schedule Sequence

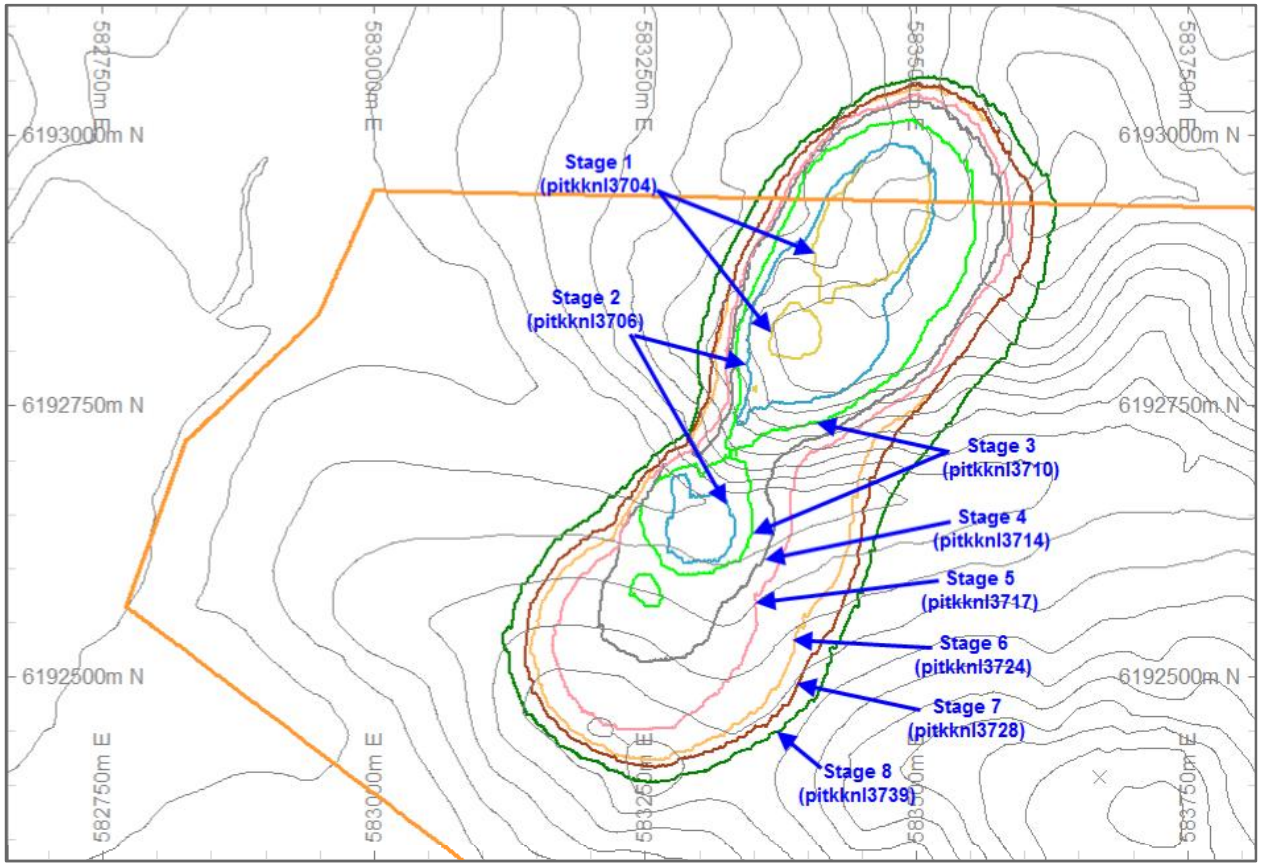


Figure 4.32 shows the quantities of rock and plant feed mined and the concentrate produced per year.

Figure 4.33 shows the annual production and average grade.

As with the Kookaburra Gully HR Base Case, the peaks in waste production indicate the timing required for large cutbacks and more detailed mine planning is likely to result in the smoothing of production.

The average feed carbon grade in the first and second year is above 17% TGC then it drops to 14.82% on the third year and stays between 14% and 15% TGC until the seventh year. In the last year (year 8), for 4 months of production, the average carbon grade increases to 15.60%.

Figure 4.32 Kookaburra Gully HR No Limit Case at 37º – All Production

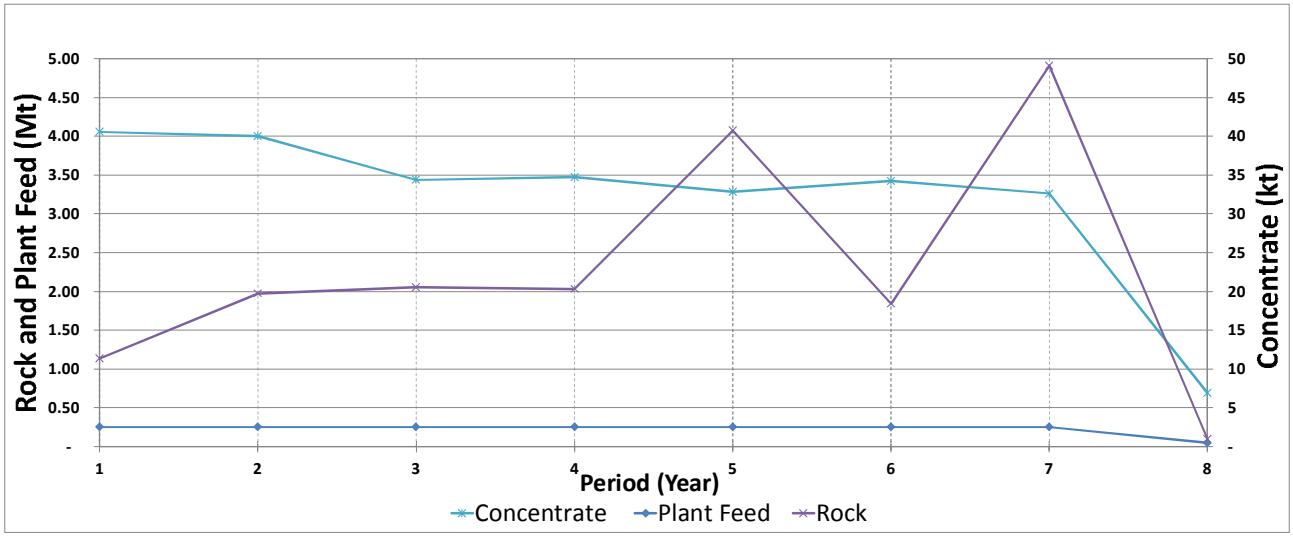


Figure 4.33 Kookaburra Gully HR No Limit Case at 37º – Process Production

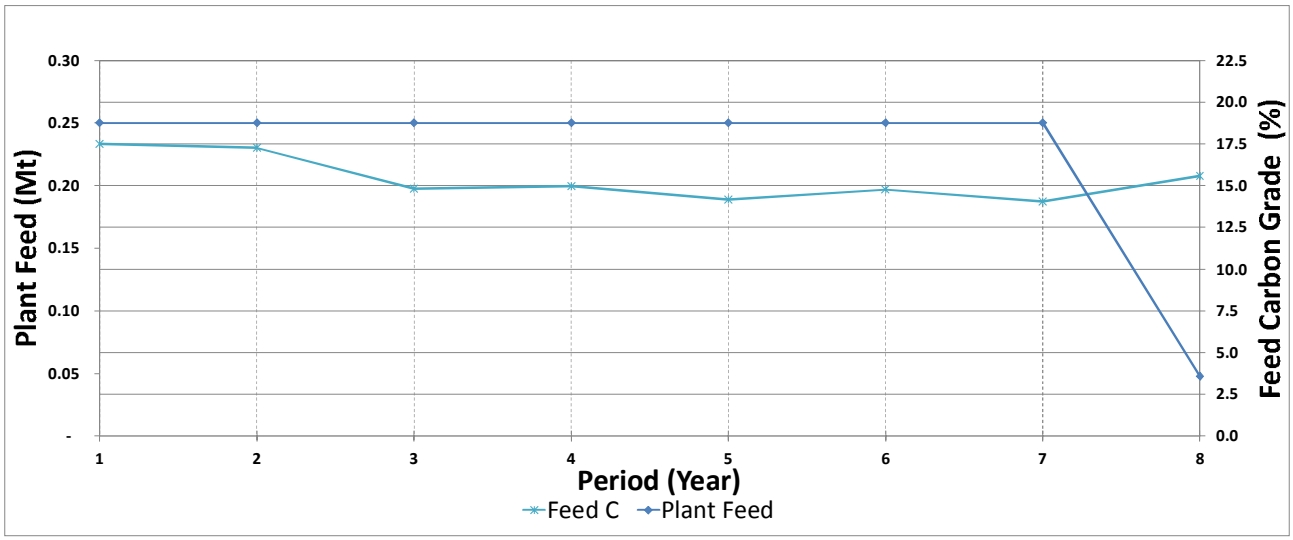


Figure 4.34 shows the cumulative rock and plant feed movements and concentrate production per year.

Figure 4.34 Kookaburra Gully HR No Limit Case at 37º – Cumulative Production

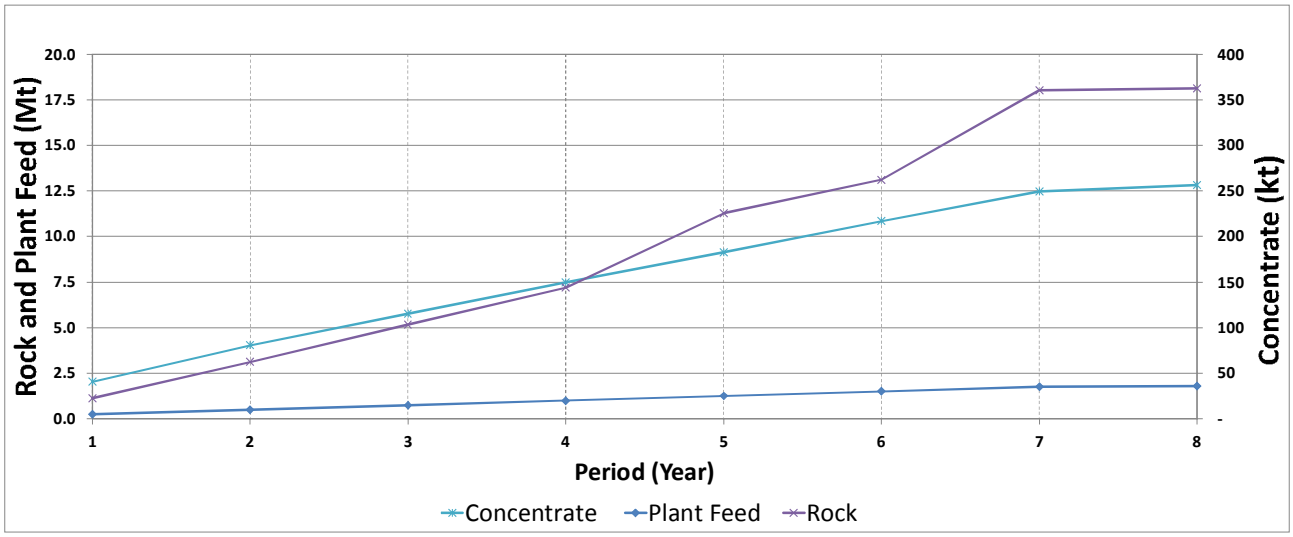
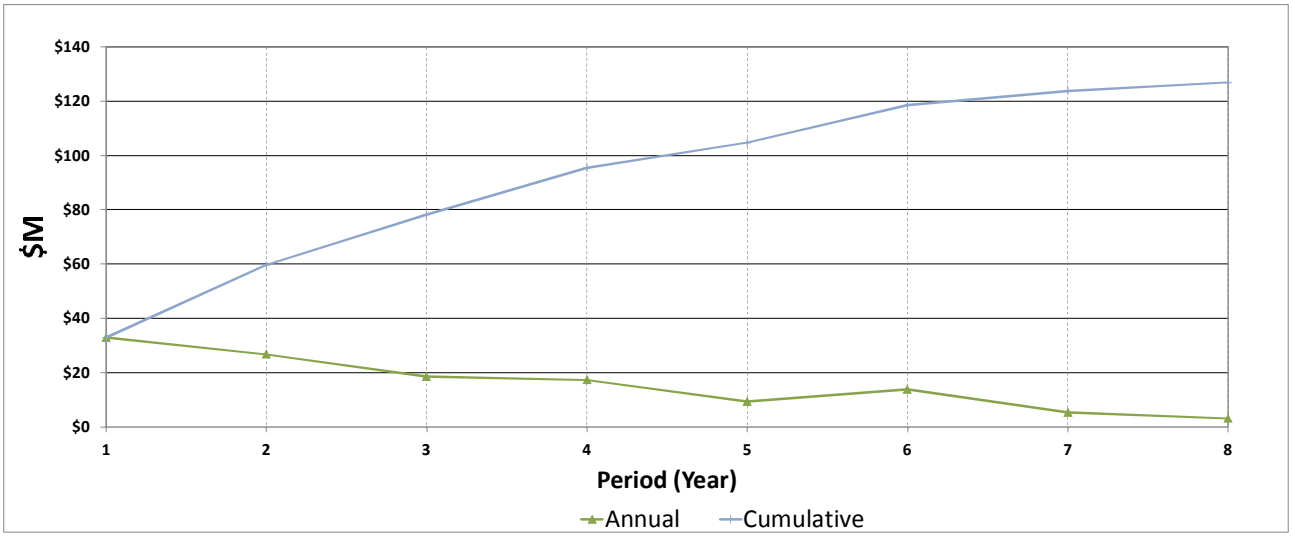


Figure 4.35 shows the yearly operating cash flow and the cumulative cash flow respectively. As in the HR Base Case, the cash flow decreases throughout the years due to the increase in volume of waste being mined.

Figure 4.35 Kookaburra Gully HR No Limit Case at 37º – Operating Cash Flow



4.3 Sensitivity to Pit Slopes

A sensitivity to the initial Base Case assumption of 37 degrees was carried out using 35, 39 and 41 degree overall slopes.

The effect of the slope variation on the geometry of the pit is not the same in all regions of the pit. In the northern region of the pit, it appears to have more impact on the depth of the pit, with not much impact on the footprint area of that region. However, in the southern region, it seems to have more impact on the footprint of the pit than the depth.

Figure 4.36 to Figure 4.43 show the sensitivities to the different slope angles in plan and section for the Kookaburra Gully LR and Kookaburra Gully HR scenarios.

Figure 4.36 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Boundary Strings

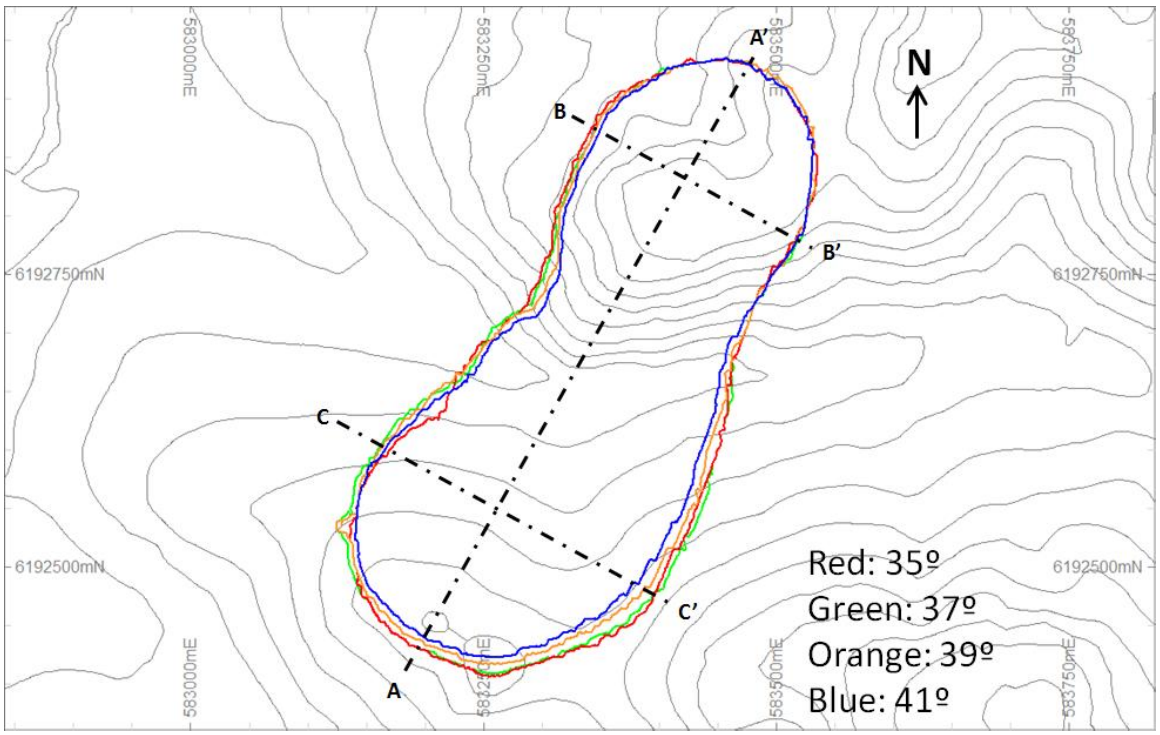


Figure 4.37 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Section A-A'

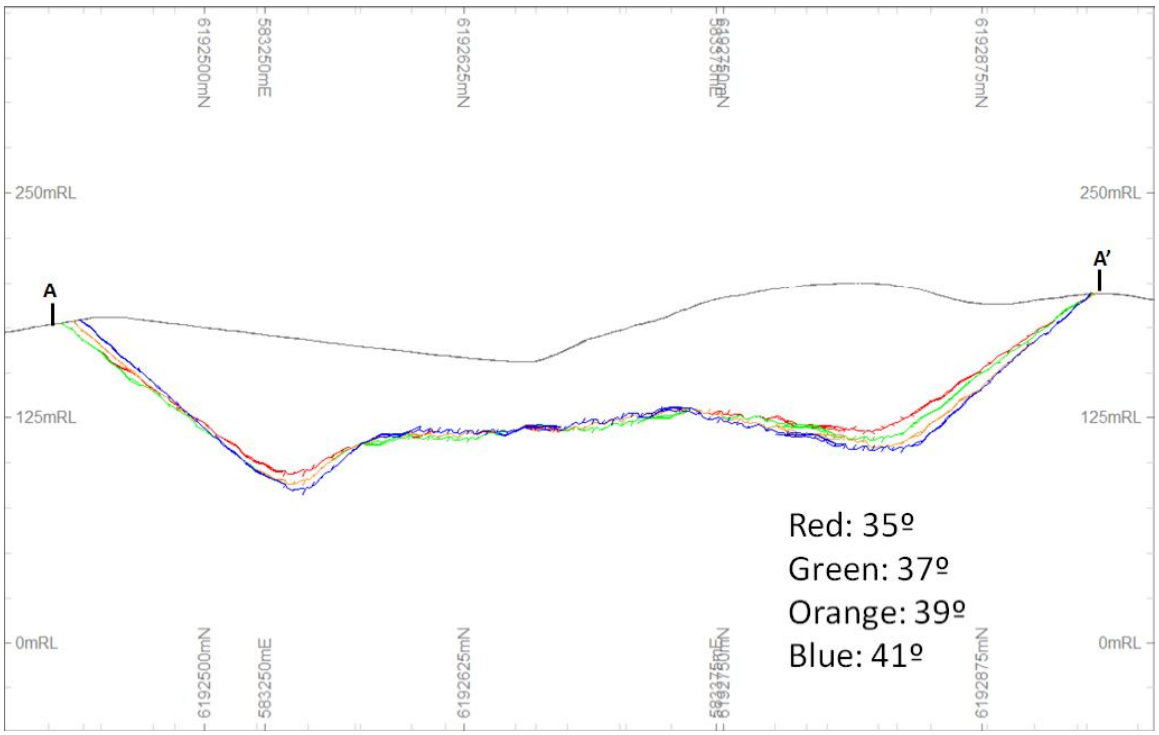


Figure 4.38 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Section B-B'

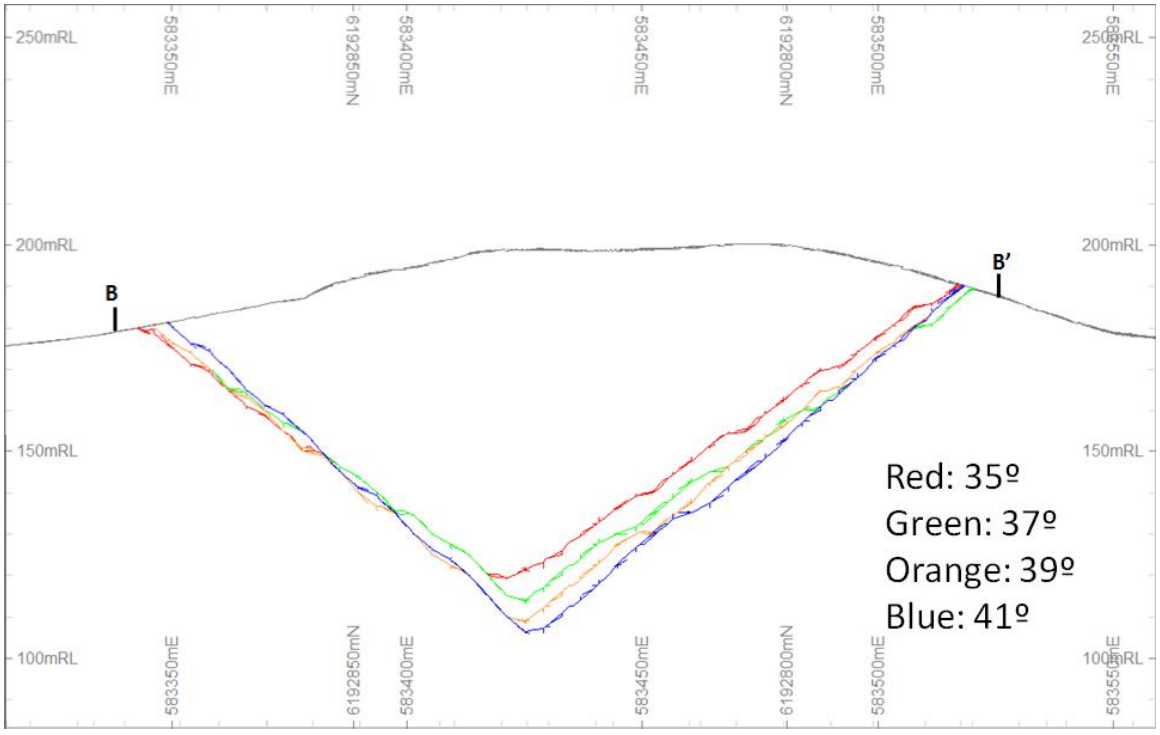


Figure 4.39 Kookaburra Gully LR Base Case Max NPV Slope Sensitivity Section C-C'

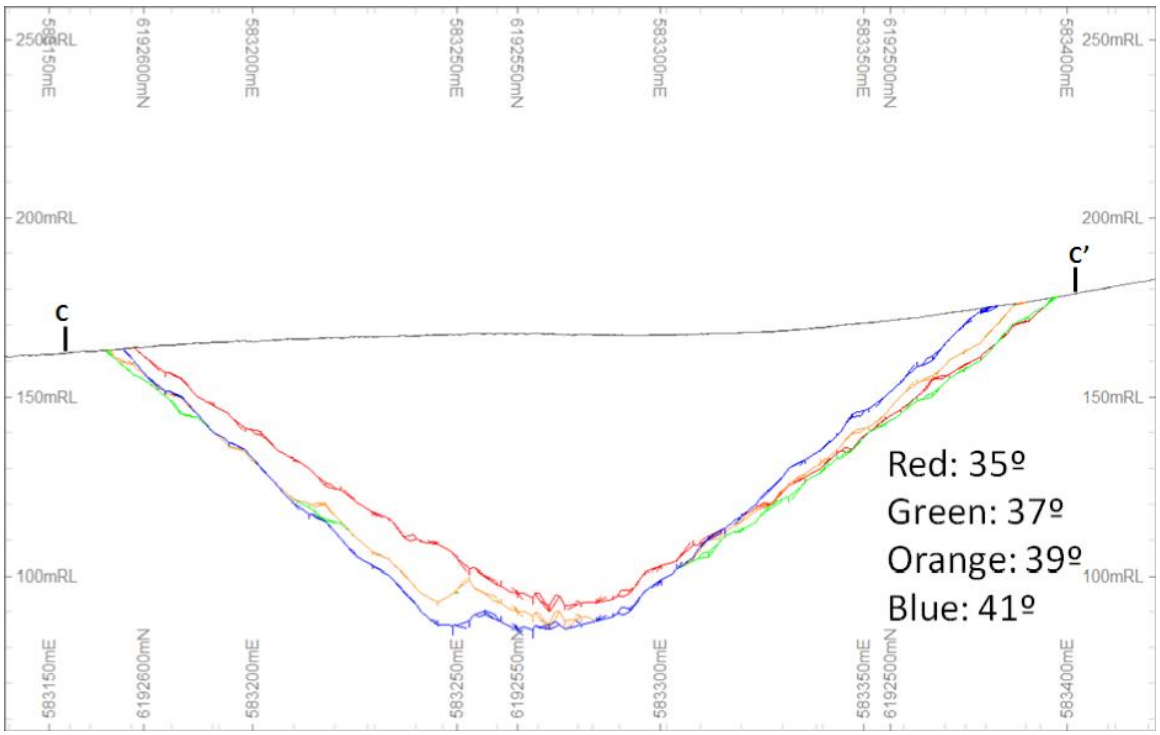


Figure 4.40 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Boundary Strings

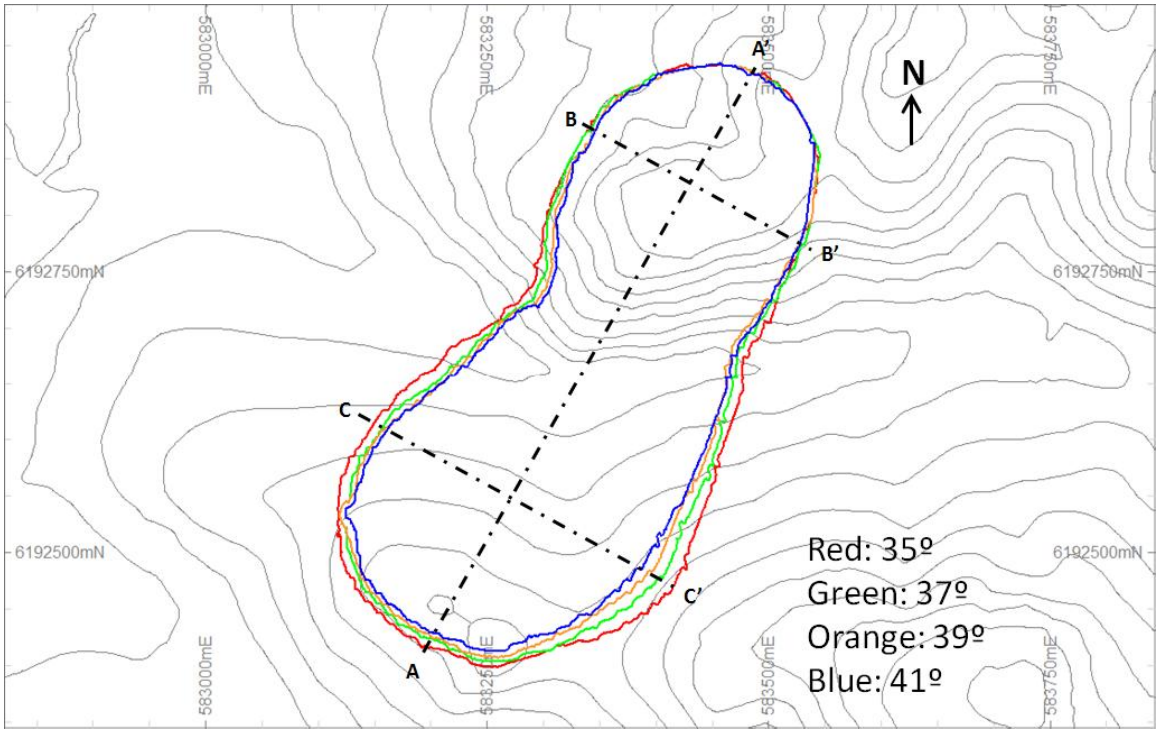


Figure 4.41 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Section A-A’

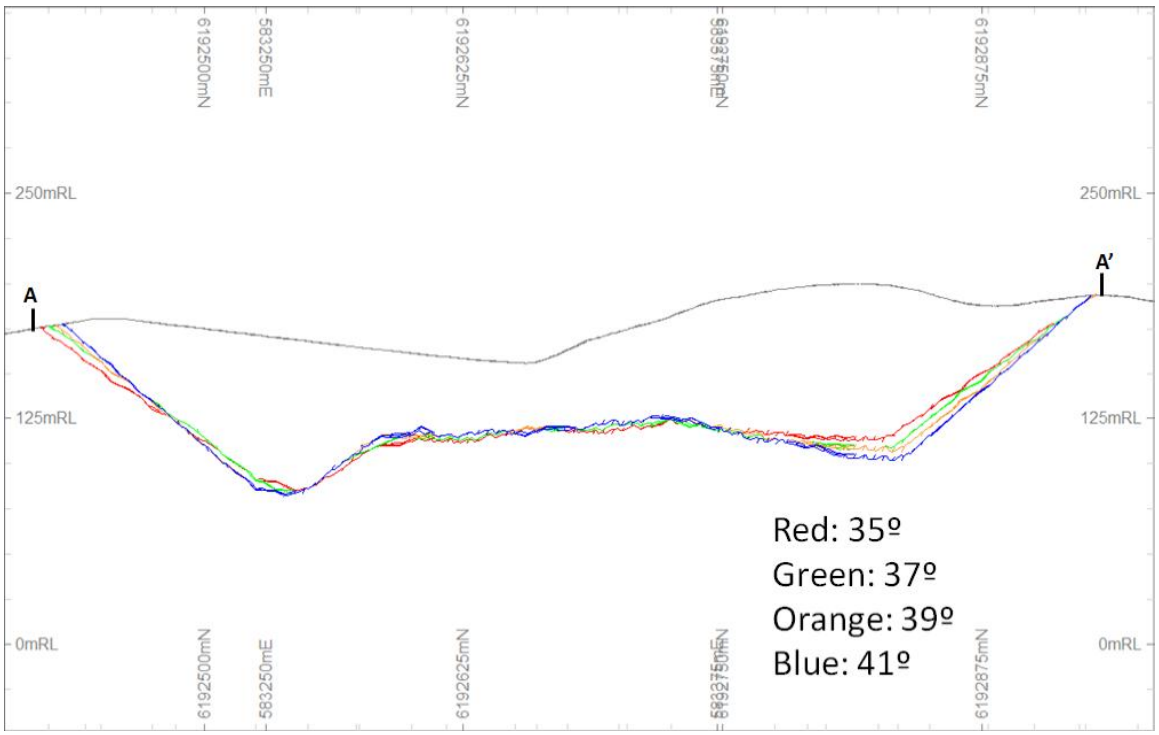


Figure 4.42 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Section B-B’

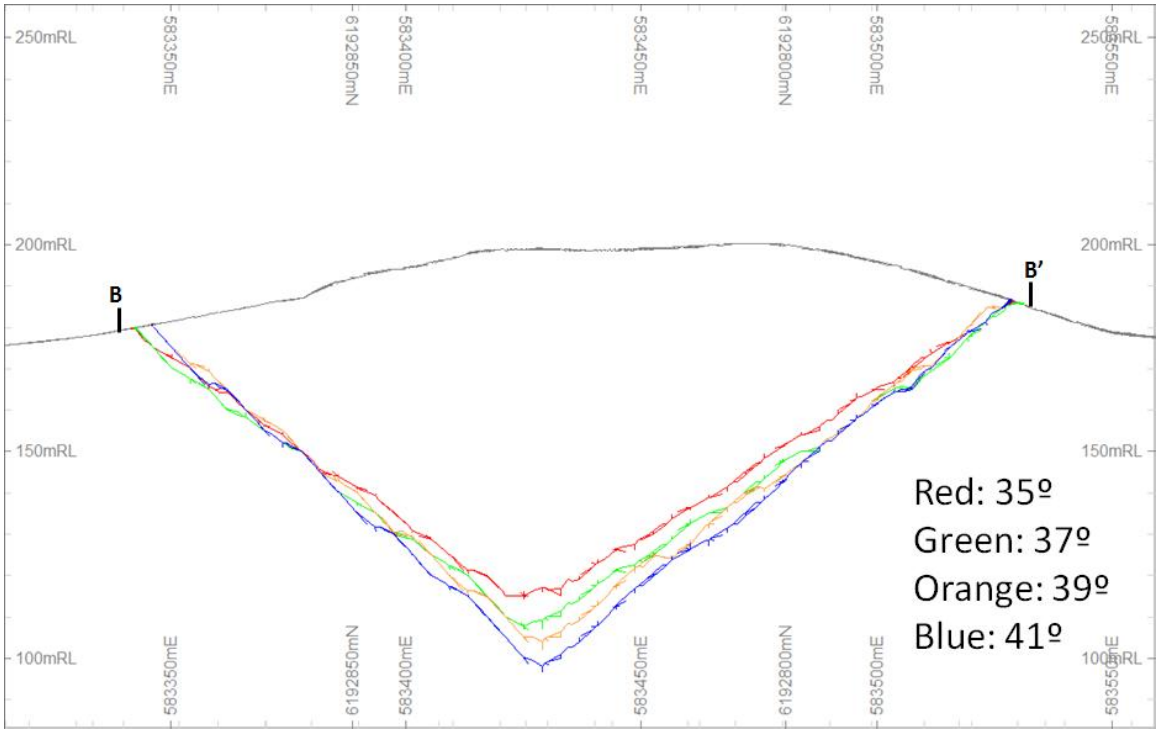


Figure 4.43 Kookaburra Gully HR Base Case Max NPV Slope Sensitivity Section C-C'

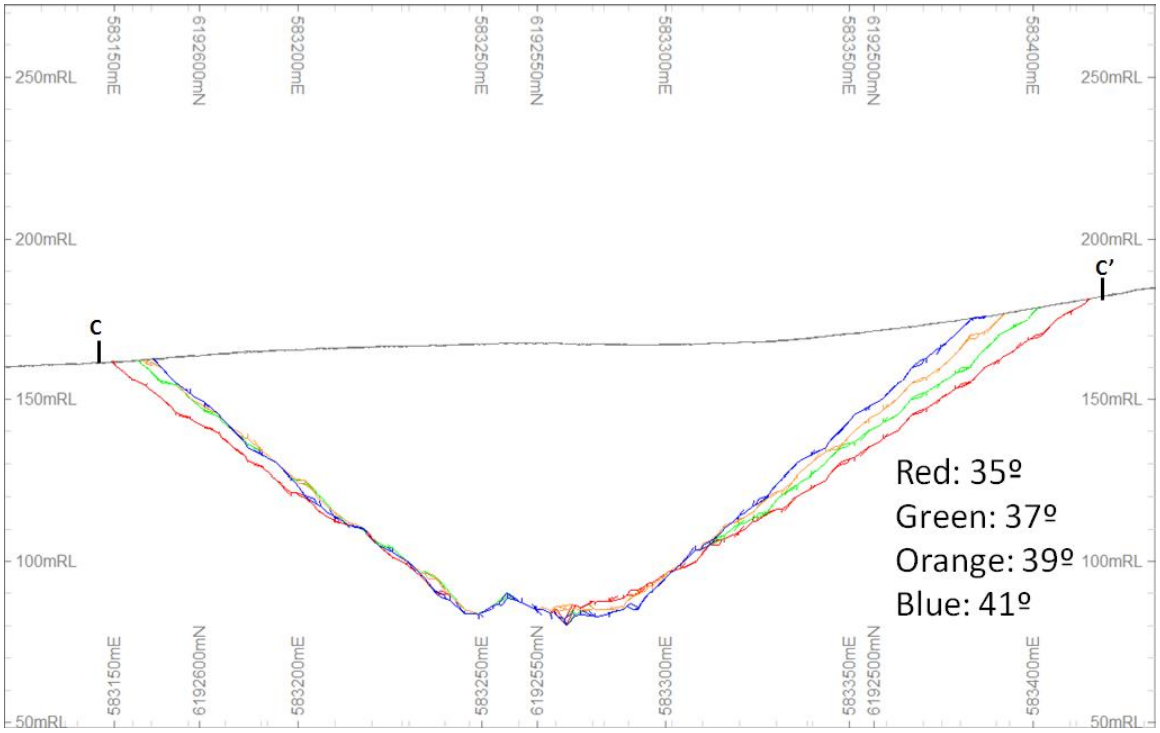


Table 4.8 and Table 4.9 show the comparative summary for the different scenarios. Figure 4.44 to Figure 4.47 show the variation in Plant Feed, Concentrate Production, Average NPV and Stripping Ratio for each slope variation in different scenarios.

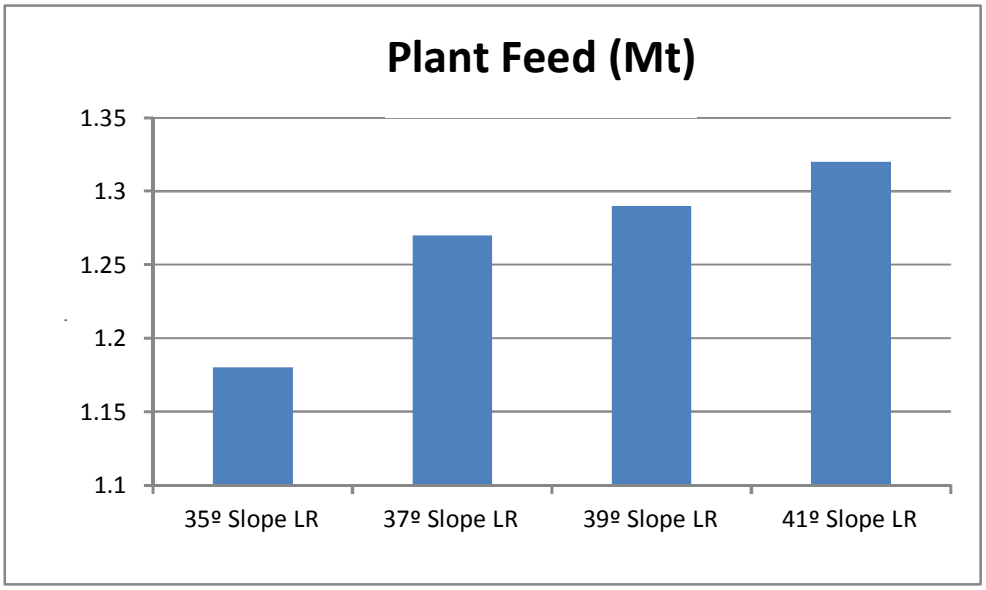
Table 4.8 Kookaburra Gully LR Base Case Pit Slope Sensitivity

Scenario	Cash Flow	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
						Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
35° Slope LR	Max NPV	28	9.86	7.39	4.7	1.18	14.57	164	94	68	53	27	13	92.53	150.28
	Max Undisc	31	11.5	8.18	5.01	1.25	14.56	175	94	68	53	28	12	95.65	150.17
37° Slope LR	Max NPV	31	10.75	7.47	5.08	1.27	14.6	177	94	73	56	32	16	93.2	150.58
	Max Undisc	32	11.17	7.67	5.15	1.29	14.6	180	94	73	56	32	16	94.01	150.59
39° Slope LR	Max NPV	30	10.59	7.18	5.18	1.29	14.65	182	94	76	58	36	18	92.38	151.07
	Max Undisc	32	11.27	7.5	5.3	1.33	14.65	186	94	76	58	36	18	93.64	151.03
41° Slope LR	Max NPV	29	10.37	6.89	5.26	1.32	14.72	185	94	79	61	39	20	91.55	151.8
	Max Undisc	32	10.93	7.14	5.37	1.34	14.7	189	94	79	60	39	20	92.49	151.6

Table 4.9 Kookaburra Gully HR Base Case Pit Slope Sensitivity

Scenario	Cash Flow	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
						Plant Feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
35° Slope HR	Max NPV	39	12.88	8.55	5.39	1.35	14.27	179	97.00	116	89	76	48	96.55	182.93
	Max Undisc	43	13.69	8.93	5.52	1.38	14.24	182	97	117	88	76	48	98.06	182.61
37° Slope HR	Max NPV	38	12.47	8.07	5.5	1.37	14.35	183	97	122	93	82	52	95.05	184.04
	Max Undisc	44	13.48	8.48	5.69	1.42	14.27	188	97	123	92	82	52	96.67	183
39° Slope HR	Max NPV	37	12.09	7.68	5.57	1.39	14.4	186	97	127	95	86	55	93.82	184.65
	Max Undisc	44	13.45	8.24	5.82	1.45	14.3	193	97	127	95	87	55	96.02	183.34
41° Slope HR	Max NPV	38	12.24	7.51	5.75	1.44	14.41	192	97	131	98	91	58	93.42	184.73
	Max Undisc	44	13.94	8.21	6.05	1.51	14.29	201	97	132	98	91	58	96.16	183.29

Figure 4.44 LR Base Case Max. NPV Slope Sensitivity: Plant Feed and Concentrate



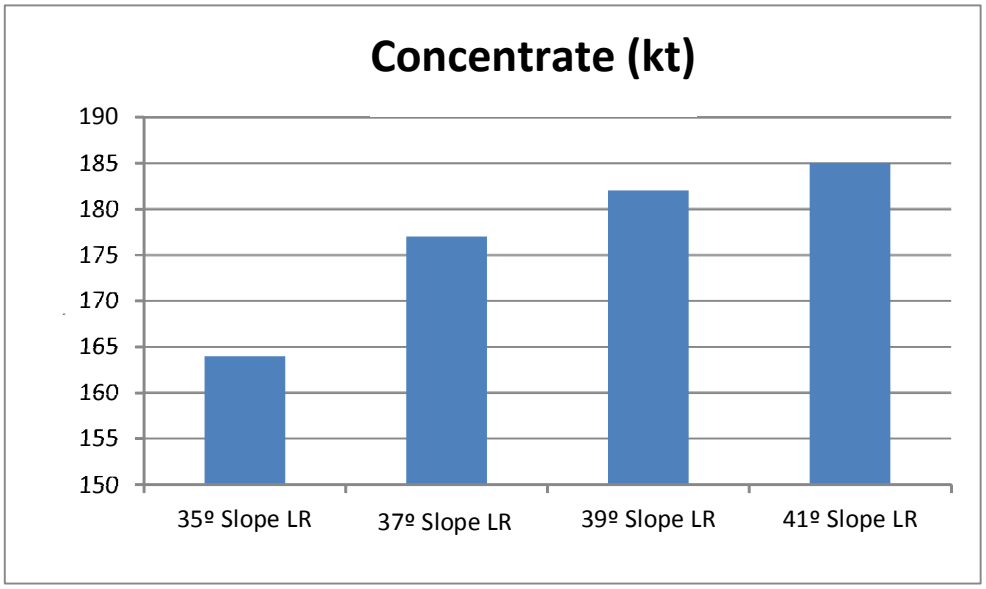
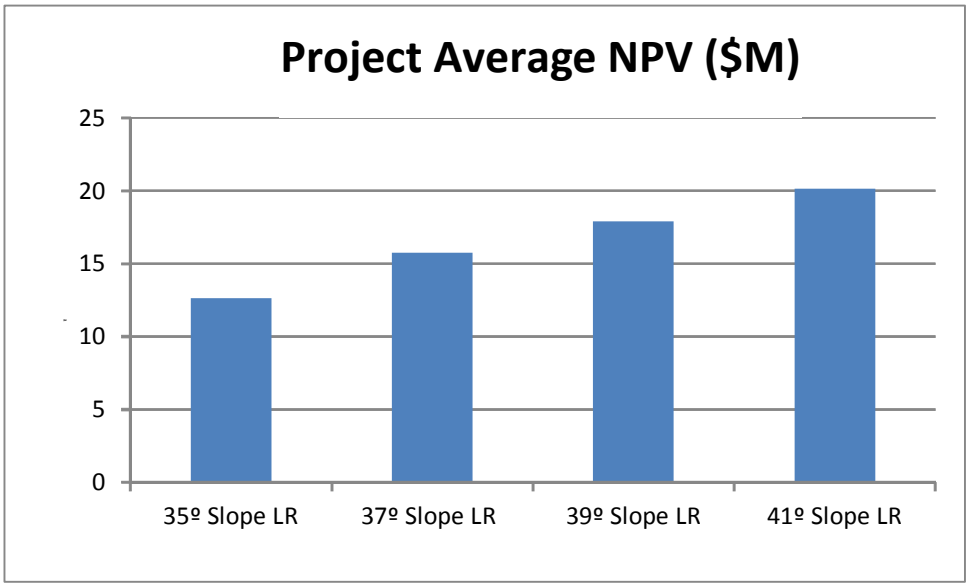


Figure 4.45 LR Base Case Max. NPV Slope Sensitivity: Project Av. NPV and Stripping Ratio



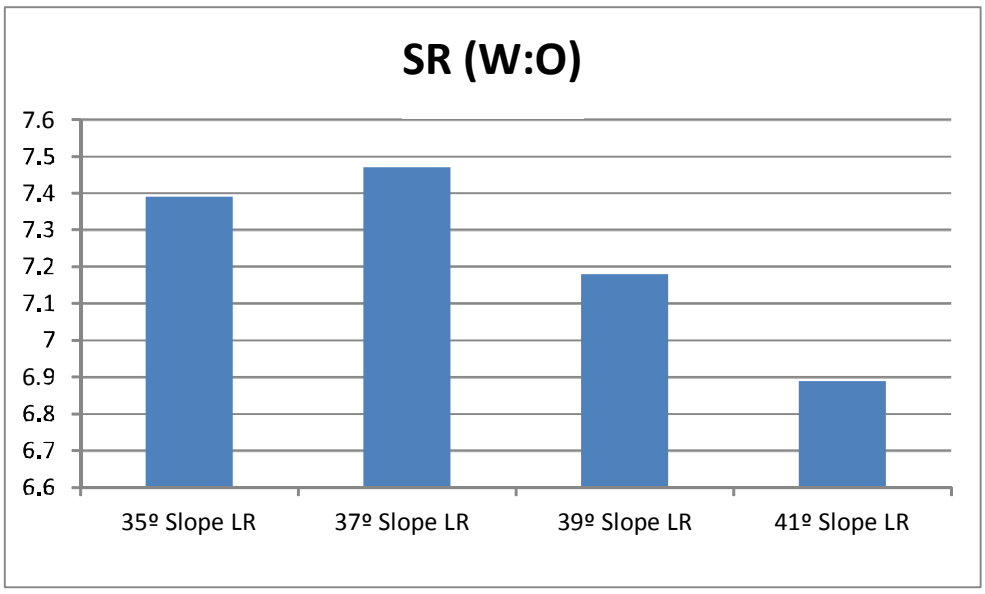
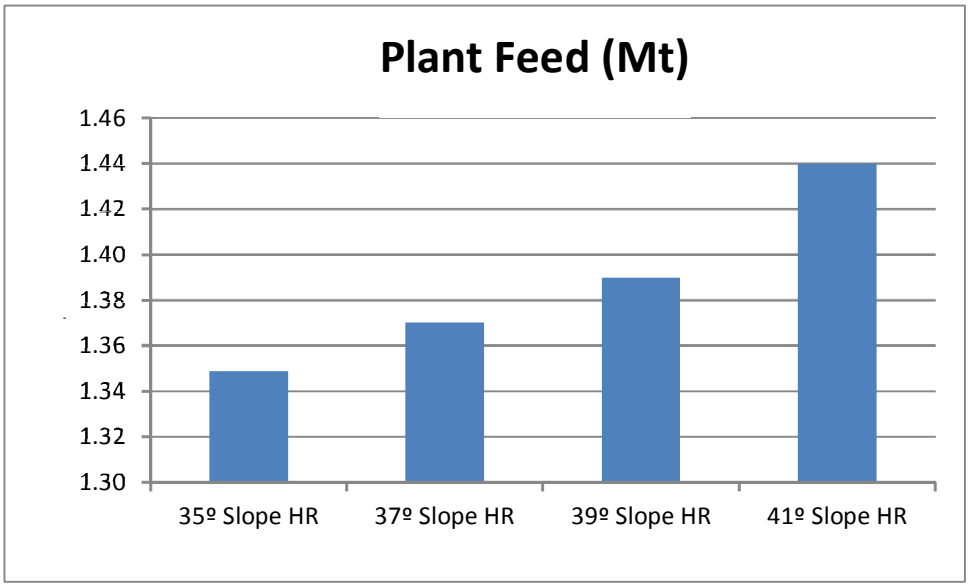


Figure 4.46 HR Base Case Max. NPV Slope Sensitivity: Plant Feed and Concentrate



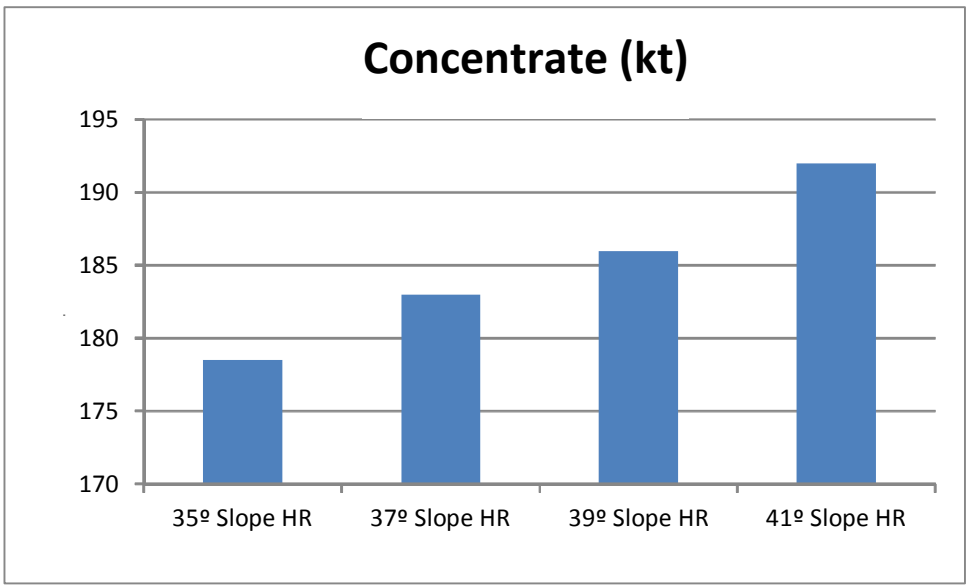
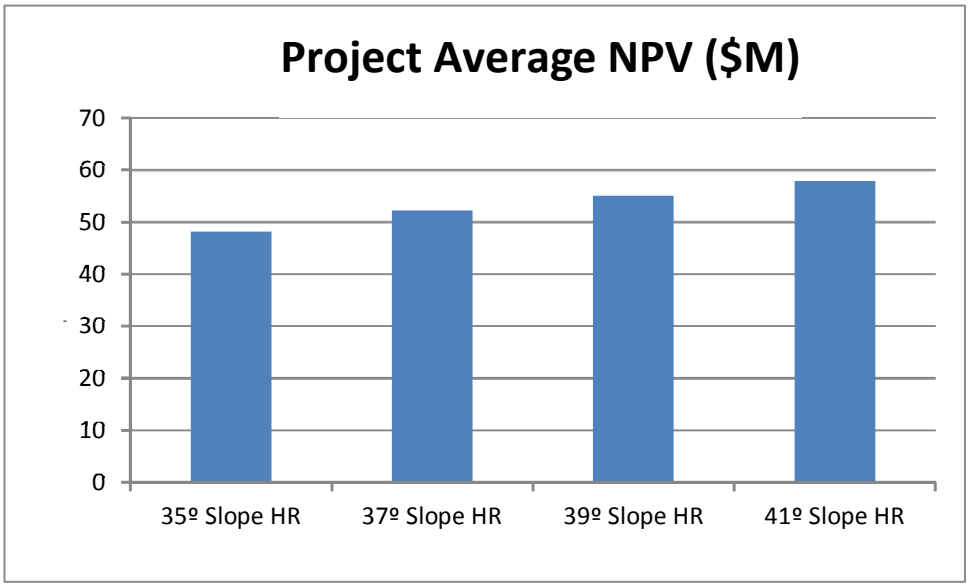
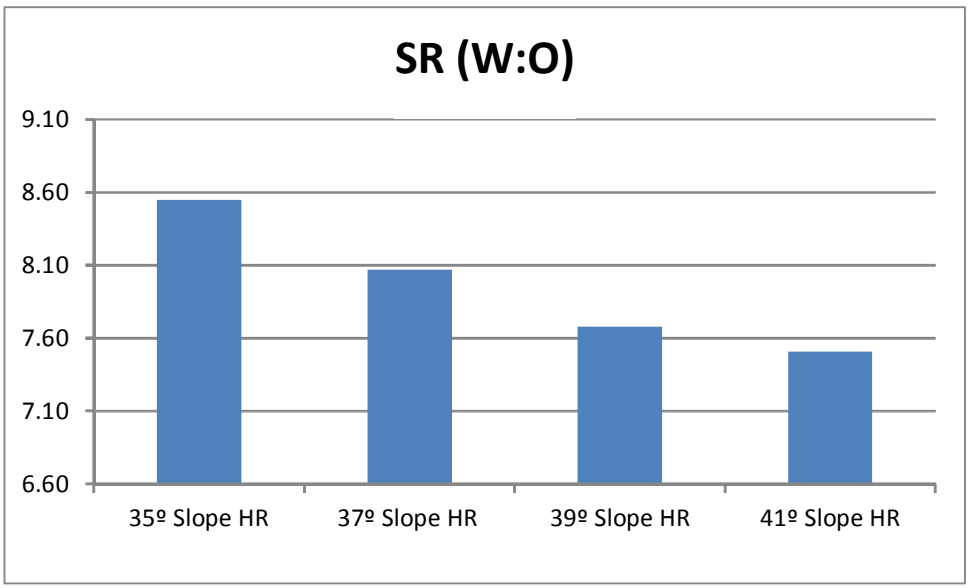


Figure 4.47 HR Base Case Max. NPV Slope Sensitivity: Av. NPV and Stripping Ratio





4.4 Waste Dump Design and Conceptual Site Layout

A waste dump design was created for the Kookaburra Gully HR Base Case, using the maximum operating NPV pit shell (pitkk3738). The HR Base Case was chosen because it generates more waste rock than the LR Base Case (11.1 Mt against 9.5 Mt).

The waste dump design was made not as an operational dump design, but as a final design after rehabilitation, with all slope angles battered down. This is to ensure that there is enough area available to accommodate all the waste rock within the tenement after rehabilitation.

Three waste dumps were designed in the area—one located north-west (NW) of the pit, a tailings dam wall located east of the pit, and a big waste dump south-east (SE) of the pit.

The assumptions made for the waste dumps designs are:

- Combined capacity to hold approximately 11.1 Mt of waste rock
- Wall angle: 20º (just the tailings dam wall used a 37º angle, which is the repose angle of graphite ore)
- Bench height: 20 m
- Berm width: 5 m
- Waste rock loose density: 2 t/m³

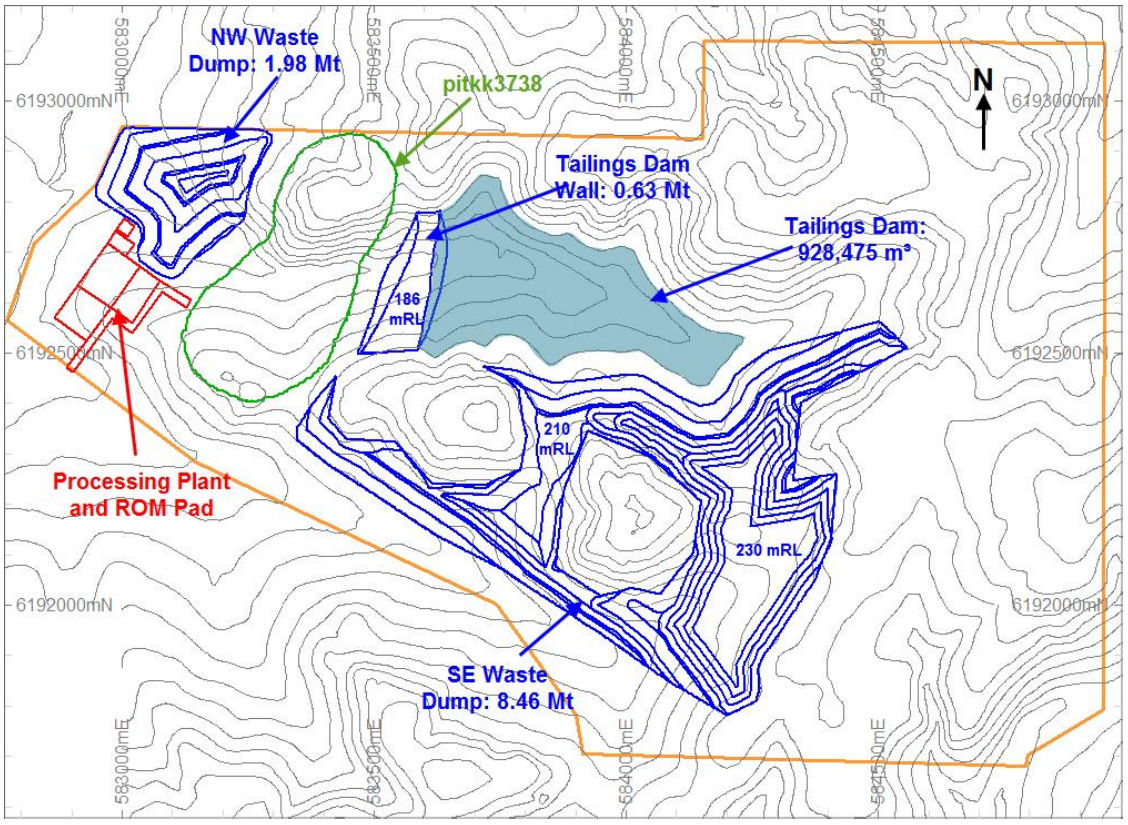
The SE waste dump was designed avoiding the suppression of existing vegetation in the region and avoiding filling the existing valley creeks.

The proposed tailings dam wall is not based on a tailings dam design, so it may differ when the design is done. With the proposed tailings dam wall, and assuming the tailings dam to be filled up to the 185 m RL, the capacity of the tailings dam would be 928,475 m³.

Figure 4.48 is a conceptual site layout showing the position of the waste dumps, the outline of the HR Base Case maximum operating NPV pit shell (pitkk3738), the process plant location proposed by PB, and the tailings dam.

The combined capacity of the waste dumps is 11.07 Mt of waste rock.

Figure 4.48 Kookaburra Gully Conceptual Site Layout



A detailed capacity of each waste dump, in increments of 5 m, can be seen in Table 4.10 to Table 4.12.

Table 4.10 NW Waste Dump Volume and Tonnes

From (mRL)	To (mRL)	Volume (m³)	Tonnes	Cumulative Volume (m³)	Cumulative Tonnes
145	150	33,739	67,478	33,739	67,478
150	155	142,681	285,362	176,420	352,840
155	160	188,733	377,466	365,153	730,306
160	165	185,270	370,540	550,423	1,100,846
165	170	148,867	297,734	699,290	1,398,580
170	175	132,489	264,978	831,779	1,663,558
175	180	89,261	178,522	921,040	1,842,080
180	185	53,585	107,170	974,625	1,949,250
185	190	15,646	31,292	990,271	1,980,542
Total		990,271	1,980,542		

Table 4.11 Tailings Dam Waste Wall Volume and Tonnes

From (mRL)	To (mRL)	Volume (m³)	Tonnes	Cumulative Volume (m³)	Cumulative Tonnes
160	165	5,127	10,254	5,127	10,254
165	170	42,782	85,564	47,909	95,818
170	175	71,043	142,086	118,952	237,904
175	180	85,888	171,776	204,840	409,680
180	185	92,530	185,060	297,370	594,740
185	186	18,326	36,652	315,696	631,392
Total		315,696	631,392		

Table 4.12 SE Waste Dump Volume and Tonnes

From (mRL)	To (mRL)	Volume (m³)	Tonnes	Cumulative Volume (m³)	Cumulative Tonnes
165	170	87	174	87	174
170	175	18,672	37,344	18,759	37,518
175	180	62,303	124,606	81,062	162,124
180	185	109,239	218,478	190,301	380,602
185	190	158,670	317,340	348,971	697,942
190	195	256,586	513,172	605,557	1,211,114
195	200	444,839	889,678	1,050,396	2,100,792
200	205	607,752	1,215,504	1,658,148	3,316,296
205	210	721,106	1,442,212	2,379,254	4,758,508
210	215	635,146	1,270,292	3,014,400	6,028,800
215	220	526,942	1,053,884	3,541,342	7,082,684
220	225	397,718	795,436	3,939,060	7,878,120
225	230	291,331	582,662	4,230,391	8,460,782
Total		4,230,391	8,460,782		

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The preliminary pit optimization work indicates that Kookaburra Gully project has a potential Base Case NPV (considering the total capital cost) of between $16 million and $52 million, for the LR and HR concentrate price scenarios respectively. The possibility exists to increase those values by steepening the pit walls and / or including the area north of the current fence limit. Due to the short life-of-mine (less than 6 years) at a production rate of 250 ktpa, the maximum NPV pit shells are almost the same size as the pit shells from the maximum undiscounted cash flow.

The LR scenario uses $1,077/t concentrate and the HR scenario uses $1,382/t concentrate. The calculated cut-off grade for the LR scenario is 5.24% TGC and for the HR case is 4.12% TGC. Pit optimizations were carried out and no stockpiling was assumed. The undiscounted and maximum operating NPV results for the Kookaburra Gully Base Case and Kookaburra Gully No Limit Case are shown in Table 5.1 and Table 5.2 below.

A potential site layout was prepared for Kookaburra Gully using the LR maximum operating NPV pit shell to indicate potential waste dump foot prints and the fence boundary for the mining operation. The layout prepared is shown in Figure 5.1. It should be noted that this layout is not the maximum extent that might be required; it is an interim stage of the site layout.

5.2 Recommendations

AMC recommends that LML continues with the study to identify the processing requirements, recoveries, costs and project definition parameters, before proceeding to a more detailed scale study. Analysis of geotechnical drilling and recommendations for pit designs must be prepared to allow pit designs to be prepared. AMC can assist with these investigations.

AMC recommends that after further definition of the parameters, the pit optimization be revised and mine scheduling work be undertaken. This work should examine the requirements for production using various cut-off grades.

Figure 5.1 Kookaburra Gully Conceptual Layout

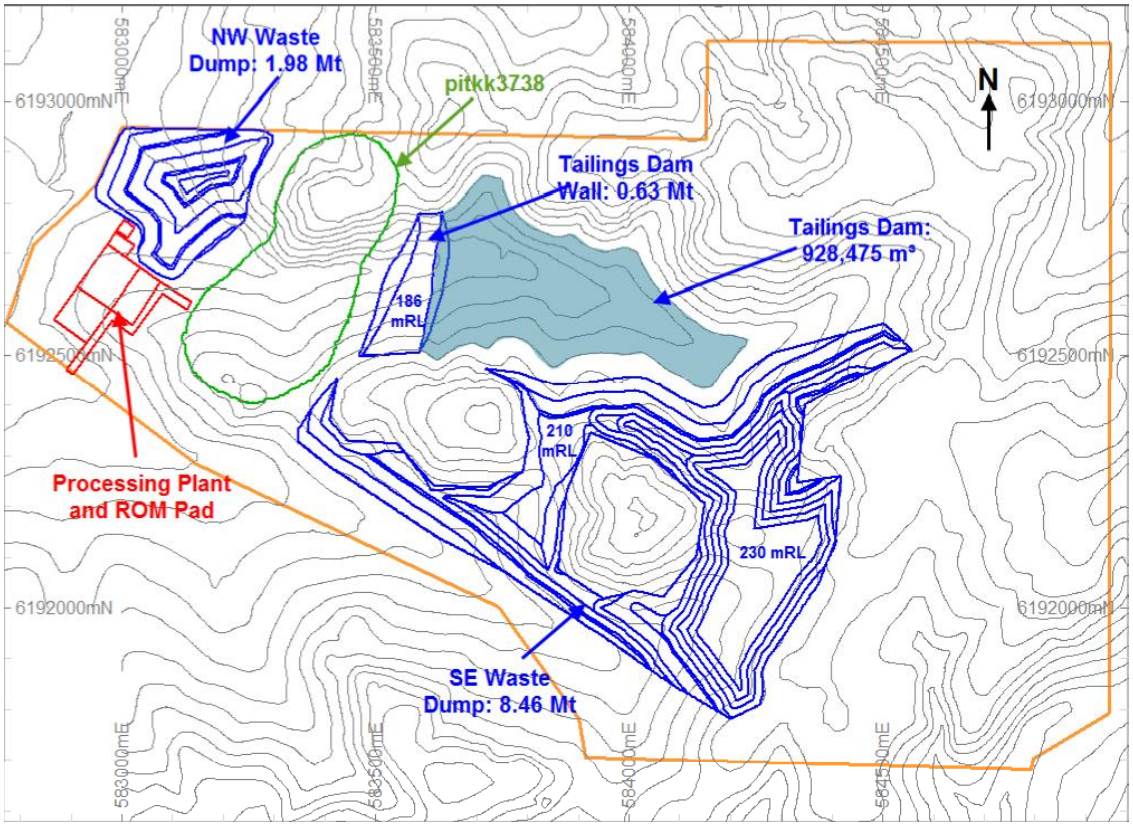


Table 5.1 Kookaburra Gully Base Case Optimization Maximum NPV Pit Shells

Scenario Low Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/$t_{feed}$	Revenue NSR $/$t_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	31	10.75	7.47	5.08	1.27	14.60	177	94.00	73	56	32	16	93.20	150.58
Max Undiscounted	32	11.17	7.67	5.15	1.29	14.60	180	94.00	73	56	32	16	94.01	150.59

Scenario High Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/$t_{feed}$	Revenue NSR $/$t_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	38	12.47	8.07	5.50	1.37	14.35	183	97.00	122	93	82	52	95.05	184.04
Max Undiscounted	44	13.48	8.48	5.69	1.42	14.27	188	97.00	123	92	82	52	96.67	183.00

Table 5.2 Kookaburra Gully No Limit Case Optimization Maximum NPV Pit Shells

Scenario Low Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	28	13.33	7.60	6.20	1.55	15.67	233	94.00	104	76	63	35	94.68	161.56
Max Undiscounted	33	15.98	8.53	6.71	1.68	15.63	251	94.00	105	75	65	35	98.44	161.16

Scenario High Revenue	Pit Shell no	Rock Mt	SR W:O	Life Yrs	Cumulative Production and Grade				Pit Operating Cash Flow		Project Operating Cash Flow (Incl. Cap. Cost)		Cost Total $/t$_{feed}$	Revenue NSR $/t$_{feed}$
					Plant feed Mt	Feed %TGC	Conc kt	Conc %C	Undisc $M	Average NPV $M	Undisc $M	Average NPV $M		
Max Operating NPV	39	18.12	9.08	7.19	1.80	15.37	256	97.00	174	123	134	82	100.12	197.06
Max Undiscounted	46	20.25	9.77	7.52	1.88	15.28	267	97.00	175	122	135	82	102.86	195.98

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Appendix H

Tailings and waste rock storage facility design

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Report

Kookaburra Gully Tailings and Waste Rock Storage Facility Design

Lincoln Minerals Limited

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Review of AMC Project 814004
13 August 2014

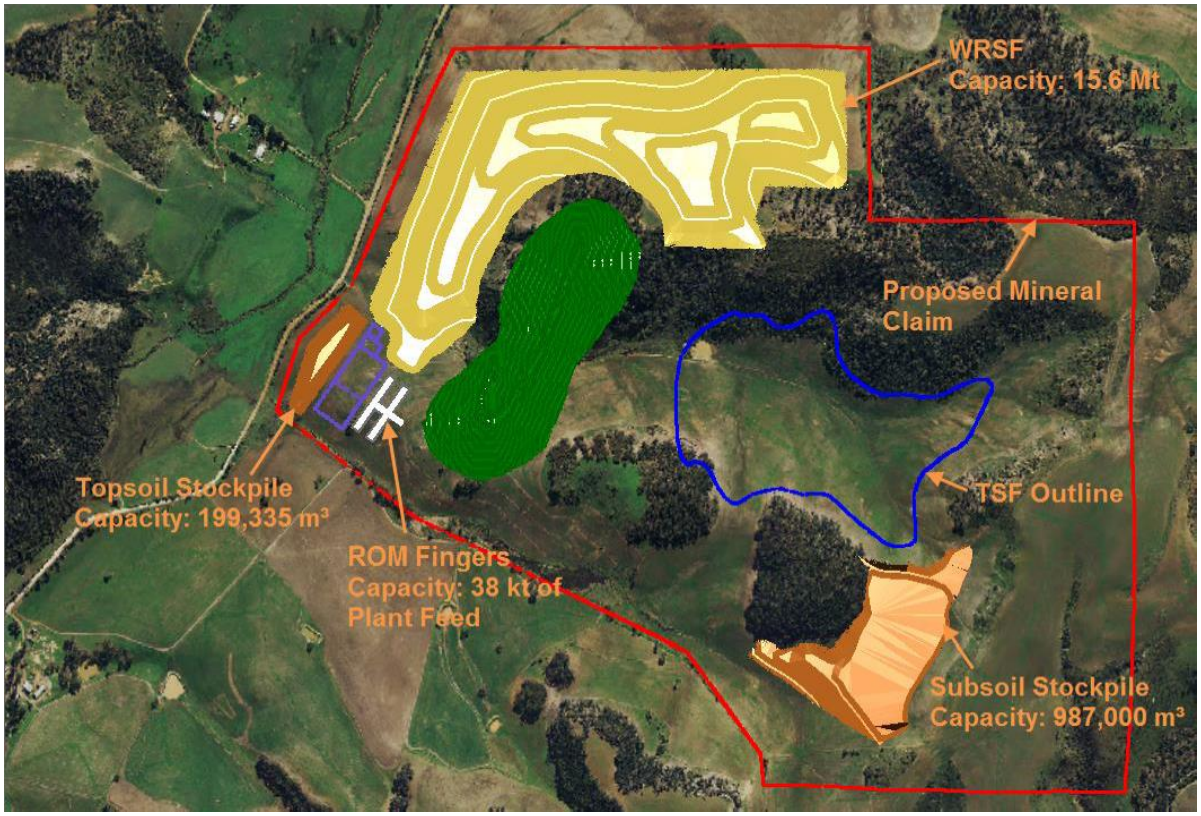
Executive summary

The Kookaburra Gully Project is a graphite deposit located near the historic Koppio Graphite Mine on the Eyre Peninsula in South Australia. The deposit will be mined using open-pit methods with a nominal mill throughput of 0.25 Mt per year. The project owner, Lincoln Minerals Limited (LML), requested that AMC Consultants Pty Ltd (AMC) provides design details for the waste rock storage facility (WRSF), the tailings storage facility (TSF), and the soil stockpiles.

The WRSF is located in the north-west of the project site and will contain approximately 16 million tonnes of material. There are two soil stockpiles: the topsoil stockpile (TSSP) and the subsoil stockpile (SSSP). The TSSP is located to the west of the proposed process plant while the SSSP is located in the south-east of the project site. These stockpiles contain 200,000 m^3 and 900,000 m^3 of material respectively. The WRSF, TSSP, and SSSP were designed with a final face slope angle of 20º, 20 m high benches and 5 m berms in between. The final slope angle of 20° for the WRSF is similar to the steeper slopes of the surrounding topography. The SSSP and the TSSP will be reclaimed after mining is complete and the material will be used for rehabilitation of the WRSF and tailings storage facility (TSF). Potentially acid forming material (PAF) will not be dumped on the WRSF, but will be encapsulated in the TSF. A preliminary dump stability rating assessment of the WRSF and the stockpiles indicated that the WRSF needed further stability assessment while the stockpiles did not. Subsequent slope stability modelling of the WRSF indicated that it was stable under the given design criteria.

The TSF is proposed to be located within the central valley of the project site and was designed for the secure and permanent storage of approximately 1.8 Mt of tailings, 1 Mt of PAF waste rock, plus 30% of supernatant water from the proposed mining operations. The TSF was designed as an approximate 30 m high valley impoundment structure, which consists of a rockfill embankment built using a downstream construction method. The design incorporates a high density polyethylene (HDPE) liner on the upstream face of the TSF embankment, which is keyed into the foundation and abutment material. The preliminary TSF design includes the embankment, the general layout of the tailings delivery and distribution pipework, a seepage collection system, and a tailings water reclaim system. No PAF will be used in the construction of the TSF embankment. The embankment was given a high hazard rating for slope stability using the ANCOLD guidelines (1999). Subsequent slope stability modelling of the TSF indicated that it was stable under the given design criteria.

ES1 Conceptual layout of the project



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Contents

1 Introduction 1

2 Material Schedules 2
2.1 Waste Rock Production 2
2.2 Tailings Production 2

3 Site Characteristics 3
3.1 Topography 3
3.2 Vegetation 3
3.3 Climate and Hydrometeorology 3
3.3.1 Design Storm Event 4
3.4 Geology and Hydrogeology 5
3.5 Seismicity 5
3.5.1 Design Seismic Event 5

4 Waste Rock and Soil Stockpiles Design 6
4.1 Introduction 6
4.1.1 Waste Rock and Soil Stockpile Stability Assessment 9
4.2 WRSF Design 10
4.2.1 Waste Rock Parameters 10
4.2.1.1 Particle Size Distribution 10
4.2.1.2 Specific Gravity 10
4.2.1.3 Density 10
4.2.1.4 Permeability 10
4.2.2 Site Preparation 10
4.2.3 Embankment Details 10
4.2.4 Stability Analysis 11
4.3 Soil Stockpile Design 12
4.4 Water Management and Sediment Control 13
4.5 Rehabilitation 13

5 Tailings Storage Facility Design 14
5.1 General 14
5.2 Tailings Parameters 14
5.2.1 Particle Size Distribution 15
5.2.2 Specific Gravity 15
5.2.3 Density 15
5.2.4 Permeability 15
5.2.5 Strength 15
5.3 Embankment Classification 15
5.4 Design Basis 16
5.5 Layout and Operating Strategy 18
5.5.1 General 18
5.5.2 Water Management 18
5.5.3 Tailings Distribution 19
5.5.4 PAF Waste Storage Area Development 19
5.6 Embankment Construction 19
5.6.1 Site Preparation 19
5.6.2 Embankments 21
5.6.3 Embankment Details 23
5.6.4 Liner 23
5.6.5 Stability Analysis 24
5.7 Water Management 25
5.7.1 Tailings Water 26
5.7.2 Rainfall 26
5.7.3 Evaporation/Evapotranspiration 26
5.7.4 Runoff 26
5.7.5 Seepage 26
5.7.5.1 Seepage Collection System 26
5.7.5.2 Seepage Analysis 27

5.7.6 Freeboard 28
5.7.7 Water Recovery 28
5.8 Pipework 28
5.8.1 Tailings Discharge System 28
5.8.2 Reclaim Water System 28
5.9 Instrumentation, Closure Plan, and Monitoring 28
5.9.1 Instrumentation 28
5.9.2 Closure Plan 28
5.9.3 Monitoring 30
6 Recommendations 31
7 References 32

Tables

Table 4.1 Waste rock schedule 6
Table 4.2 WRSF capacity in 10 m intervals 6
Table 4.3 Cumulative topsoil and subsoil schedule 7
Table 4.4 Dump stability ratings for the WRSF and soil stockpiles 10
Table 4.5 Estimated material properties for in situ clay and waste rock 11
Table 4.6 Estimated material properties for bedrock 11
Table 4.7 WRSF stability analysis results 12
Table 5.1 Estimated tailings parameters 15
Table 5.2 Hazard categorization of the TSF 16
Table 5.3 Preliminary design and operation criteria for the TSF 18
Table 5.4 Approximate volumes of excavated soil and clay from TSF footprint 20
Table 5.5 Waste rock volume and tonnage required for the TSF embankment 22
Table 5.6 HPDE liner area by stage 24
Table 5.7 Estimated material properties for soils and waste rock 24
Table 5.8 Estimated material properties for bedrock 24
Table 5.9 TSF Embankment stability analysis results 25
Table 5.10 Estimate permeability values for embankment materials 27

Figures

Figure 1.1 Location of the Kookaburra Gully Project 1
Figure 2.1 Waste rock production schedule 2
Figure 2.2 Tailings production schedule 2
Figure 3.1 Monthly evaporation, evapotranspiration, and rainfall rates for the White Flat and Koppio meteorological stations 3
Figure 3.2 Effective rainfall for the Koppio and White Flat meteorological stations 4
Figure 3.3 Design storm for TSF (from Australian Bureau of Meteorology) 5
Figure 4.1 Topsoil schedule 8
Figure 4.2 Subsoil schedule 8
Figure 4.3 Conceptual layout of WRSF, topsoil, subsoil and ROM stockpiles 9
Figure 4.4 Typical cross section of the WRSF face 11
Figure 5.1 Ultimate configuration of TSF 14
Figure 5.2 TSF depth area capacity relationship 16
Figure 5.3 TSF filling schedule 17
Figure 5.4 Approximate limits of soil excavation for TSF 20
Figure 5.5 TSF configuration for the starter dam 21
Figure 5.6 TSF configuration for Stage 2 22

Figure 5.7 Material balance of waste rock 23
Figure 5.8 Preliminary ultimate embankment design schematic....23
Figure 5.9 Preliminary yearly water balance for TSF 25
Figure 5.10 Movement of water between the mill, the SCP system, and the TSF 26
Figure 5.11 Conceptual TSF closure configuration....29

Appendices

Appendix A Typical Shear Strength of Rock Dumps (LEPS, 1970)
Appendix B Waste Rock Storage Facility Stability Assessment
Appendix C Tailings Storage Facility Seepage Assessment
Appendix D Tailings Storage Facility Stability Assessment
Appendix E Tailings Storage Facility Preliminary Yearly Water Balance

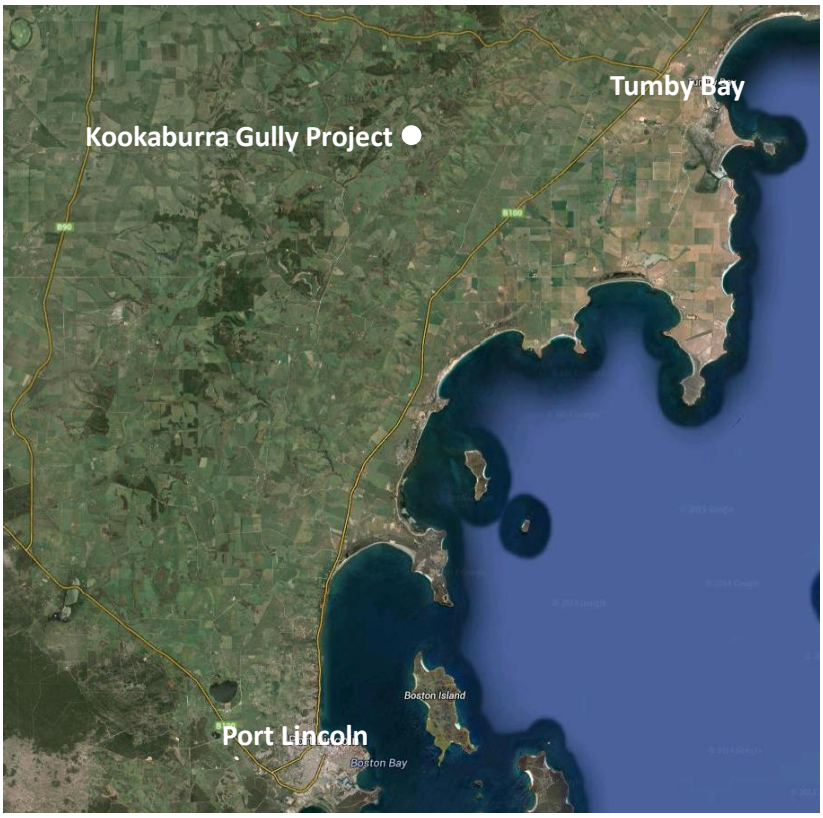
Distribution list

1 e-copy to Dr John Parker, Lincoln Minerals Limited
1 e-copy to AMC Adelaide office

1 Introduction

The Kookaburra Gully project is focused on the exploration and development of a graphite deposit, located near the historic Koppio Graphite Mine, north of Port Lincoln and west of Tumby Bay on the Eyre Peninsula in South Australia. The project is owned by Australian Graphite Limited (AGL), a fully-owned subsidiary of Lincoln Minerals Limited (LML). Figure 1.1 shows the location of the project.

Figure 1.1 Location of the Kookaburra Gully Project



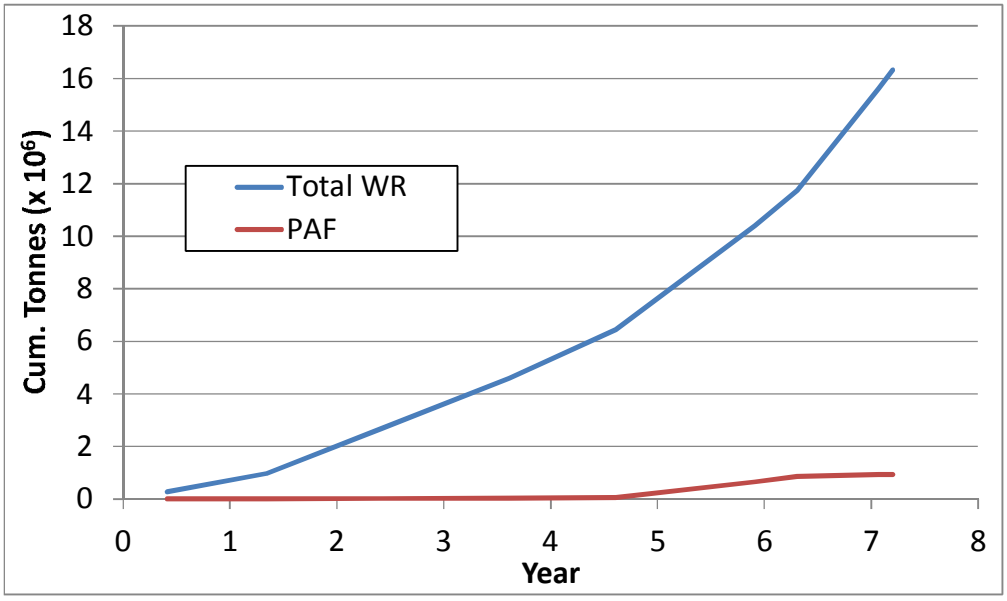
As part of a mining lease application (MLA), LML requested that AMC Consultants Pty Ltd (AMC) provides design details for the waste rock storage facilities (WRSF), the tailings storage facility (TSF), and the soil stockpiles.

2 Material Schedules

2.1 Waste Rock Production

A conceptual design for Kookaburra Gully indicates that an estimated 16.3 million tonnes of waste rock will be produced over the life-of-mine. Figure 2.1 shows the waste rock production schedule. LML estimates that approximately one million tonnes of the waste rock is potentially acid forming (PAF). The exact production schedule of the PAF material is unknown but AMC estimated a production schedule based on wireframes provided by LML. This estimated schedule for PAF waste rock is also shown on Figure 2.1. Note that this schedule indicates that the majority of the PAF material will be removed during the 6th year of mine life.

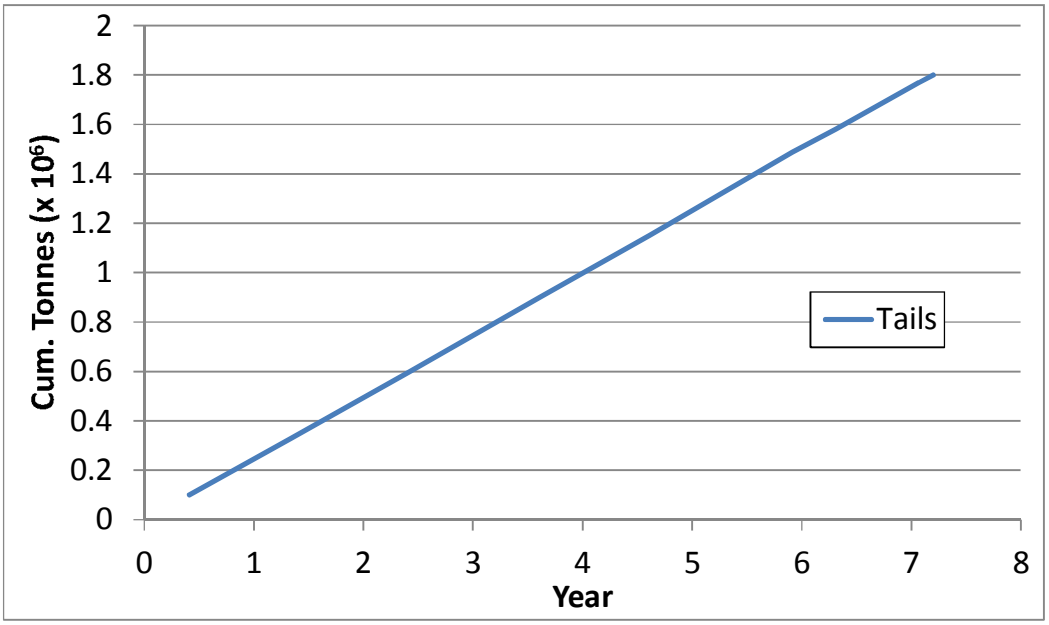
Figure 2.1 Waste rock production schedule



2.2 Tailings Production

Approximately 1.8 million tonnes of tailings will be produced over the life-of-mine. Figure 2.2 shows the tailings production schedule. The average annual production rate is approximately 0.25 Mtpa.

Figure 2.2 Tailings production schedule



3 Site Characteristics

3.1 Topography

The topography of the area consists of gently rising hills and valleys with elevations between 140 m and 250 m above sea level.

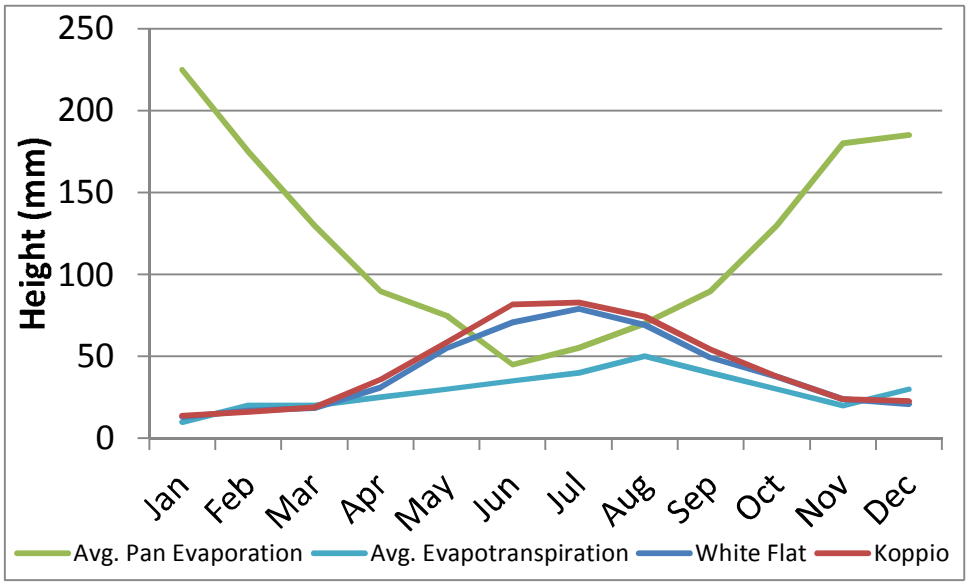
3.2 Vegetation

The vegetation consists of cropland, pastureland, and trees. The cropland tends to be on the gentler slopes, whereas the pastureland is on the steeper slopes or hilltops. Trees are generally found on the steepest slopes and on hilltops.

3.3 Climate and Hydrometeorology

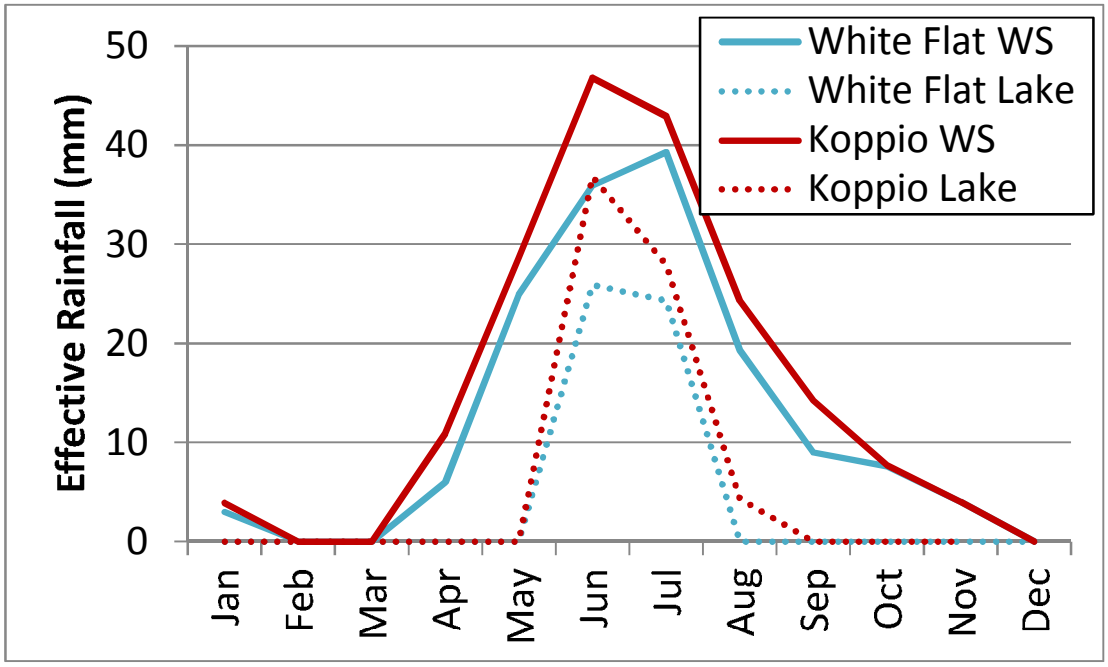
AMC obtained rainfall data from the White Flat and Koppio meteorological stations, and evaporation and evapotranspiration data from maps generated by the Australian Bureau of Meteorology (BOM). Rainfall data from the Koppio and White Flat stations is available from 1897 and 1903 respectively. Although local rainfall data is available, the data has not been verified and the data from the BOM has been used in this study. A brief review of the local rainfall data indicated that application of the data from the Koppio station is somewhat conservative. Figure 3.1 presents the average evaporation, evapotranspiration, and the rainfall from the White Flat and Koppio stations. The Koppio station recorded more rainfall than the White Flat station. Note that during the summer months the evaporation and evapotranspiration rates exceed or equal the rainfall.

Figure 3.1 Monthly evaporation, evapotranspiration, and rainfall rates for the White Flat and Koppio meteorological stations



This data can be used to determine the effective rainfall for water bodies (lakes) using evaporation or catchment watersheds (WS) and evapotranspiration. Effective rainfall was calculated as the net difference between amount of rainfall and either the amount of evaporation or evapotranspiration. Figure 3.2 shows the effective rainfall for both meteorological stations. The total average effective yearly rainfall for the Koppio station was 184 mm for the WS and 69 mm for lakes. The total average effective yearly rainfall for the White Flat station was 149 mm for the WS and 50 mm for lakes. AMC chose to use the Koppio station data as it is closer to the project site.

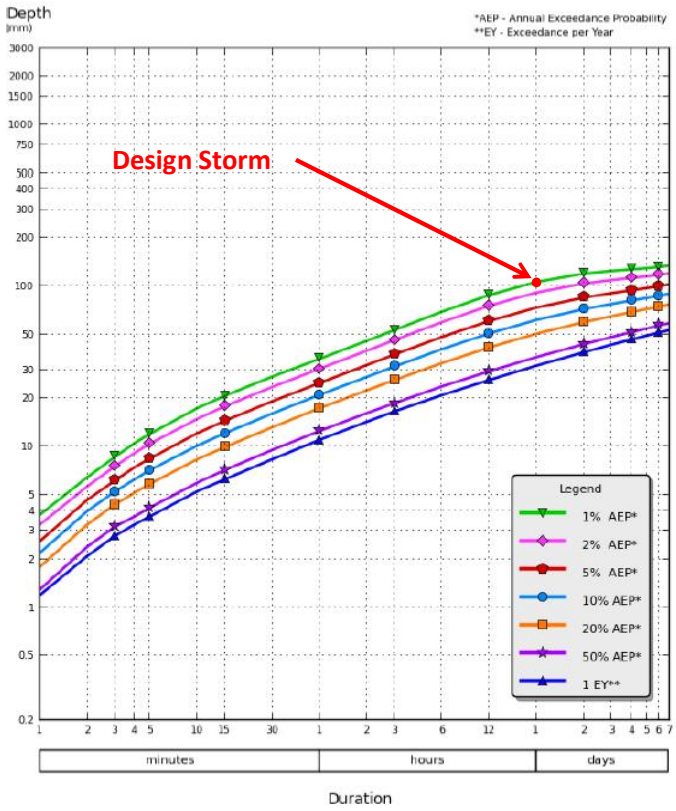
Figure 3.2 Effective rainfall for the Koppio and White Flat meteorological stations



3.3.1 Design Storm Event

Selection of an appropriate design storm event is required for a safe assessment of the TSF and to determine its flood storage requirements. AMC determined the design storm using a regional intensity-duration-frequency plot privided by the Australian Bureau of Meteorology. This plot is shown in Figure 3.3. A 24 hour rainfall was chosen as this could be compared to the daily rainfall data obtained from the Koppio station. Using an annual exceedance probability of 1%, the peak design rainfall was determined to be 100 mm/day. For comparison the maximum 24 hour rainfall recorded at the Koppio Station (117 years of operation) is 90 mm.

Figure 3.3 Design storm for TSF (from Australian Bureau of Meteorology)



AMC recommends a review of the extreme hydrological events that may be experienced by the site as the project moves forward.

3.4 Geology and Hydrogeology

There is no specific subsurface geotechnical data for the tailings storage facility (TSF) area. However, analysis of the lithologies obtained from the open-pit boreholes and previous site reports indicate an average soil thickness of 1 m (0.2 m topsoil and 0.8 m subsoil). Most boreholes also contained a thickness of clay underlying the subsoil, with the average thickness of this clay layer being 3 m. AMC assumed, based on surficial soil maps of South Australia and AMC's experience, that this clay behaves like typical stiff, low permeability South Australian clay.

The bedrock lithology from the open-pit boreholes was variable. AMC assumed that the regional geology of the site is weathered schistose rock.

No hydrogeological information for the site was available during the completion of this study.

AMC recommends that a site investigation be conducted to determine the geological and hydrogeological characteristics of the waste rock storage facility (WRSF), TSF, and stockpile areas.

3.5 Seismicity

Seismicity data for this site was determined using the 2012 Australian earthquake hazard map generated by Geoscience Australia. This study found that the 1 in 500 year earthquake, for the project area, had a maximum ground acceleration of 0.05 g.

3.5.1 Design Seismic Event

Seismic analysis will be conducted using a pseudo-static method and the ground acceleration of 0.05 g. Note that the use of pseudo-static analysis is a preliminary screening of seismic stability. The seismic analysis is included in Section 5.

4 Waste Rock and Soil Stockpiles Design

4.1 Introduction

All waste generated from open-pit operations is to be stored in a geotechnical and environmentally sound manner in permanent storage facilities. The waste rock schedule is shown in Figure 2.1, and below in Table 4.1, which shows 16.3 million tonnes of waste rock being produced over the life-of-mine.

Table 4.1 Waste rock schedule

Pit	Year	Waste Rock (Mt)
4	0.41	0.26
6	1.34	0.96
10	2.42	2.69
14	3.61	4.60
17	4.61	6.44
24	5.91	10.40
28	6.31	11.76
39	7.19	16.32

The waste rock listed above, includes an estimated 0.99 Mt of PAF material, that is to be stored in the TSF (refer to Section 5.5.4). No PAF waste rock will be stored in the WRSF. Approximately 0.78 Mt of the waste rock will be used for the construction of the TSF embankment. Also, included in the schedule above is 212,756 m^3 (loose) of topsoil and subsoil, which is equivalent to 0.43 Mt. That means that the required capacity of the WRSF is approximately 14.12 Mt.

Based on the required capacity and consultation with LML, AMC identified and evaluated suitable areas for construction of a WRSF. In collaboration with LML, the proposed design was selected, which has a capacity of 15.62 Mt, providing an excess capacity of 1.50 Mt. The capacity of the WRSF, in 10 m intervals, is shown in Table 4.2.

Table 4.2 WRSF capacity in 10 m intervals

From	To	Volume (m^3)	Tonnes	Cumulative Volume (m^3)	Cumulative Tonnes
145	155	135,501	271,002	135,501	271,002
155	165	543,727	1,087,454	679,228	1,358,456
165	175	857,176	1,714,352	1,536,404	3,072,808
175	185	1,170,334	2,340,668	2,706,738	5,413,476
185	195	1,303,560	2,607,120	4,010,298	8,020,596
195	205	1,499,991	2,999,982	5,510,289	11,020,578
205	215	1,289,134	2,578,268	6,799,423	13,598,846
215	225	728,334	1,456,668	7,527,757	15,055,514
225	235	283,588	567,176	7,811,345	15,622,690
Total	-	7,811,345	15,622,690	-	-

In addition to the permanent WRSF a topsoil stockpile (TSSP) and a subsoil stockpile (SSSP) will need to be constructed. These stockpiles need to be managed in a geotechnically and environmentally sound manner during their operational use.

The topsoil and subsoil schedules are shown in Table 4.3 and are also represented in Figure 4.1 and Figure 4.2. To estimate the volumes, an average thickness of 0.2 m and 0.8 m was assumed for the topsoil and subsoil layers, respectively, and a bulking factor of 1.3 was applied for both materials.

Based on these schedules, a topsoil stockpile and a subsoil stockpile were designed. The area selected for placement of the topsoil stockpile is relatively flat and hence facilitates easy placement of the topsoil.

The position for the subsoil stockpile was selected to minimise the disruption to arable land. As the subsoil stockpile will be a temporary stockpile which will be removed as the mine site is rehabilitated, the land on which it is constructed is reclaimed once the subsoil is recovered for rehabilitation. From a number of alternative designs, the area indicated in Figure 4.3 was selected, as it has a relatively small footprint for the volume required.

Table 4.3 Cumulative topsoil and subsoil schedule

		Pit Footprint			WRSF Footprint			TSF		Total	
Pit	Year	Area (m^2)	Topsoil (m^3)	Subsoil (m^3)	Area (m^2)	Topsoil (m^3)	Subsoil (m^3)	Topsoil (m^3)	Subsoil (m^3)	Topsoil (m^3)	Subsoil (m^3)
4	0.41	12,085	3,142	12,568	40,739	10,592	42,368	75,500	300,000	89,234	354,936
6	1.34	28,719	7,467	29,868	104,485	27,166	108,665	75,500	300,000	110,133	438,533
10	2.42	52,024	13,526	54,105	174,637	45,406	181,623	75,500	300,000	134,432	535,727
14	3.61	76,719	19,947	79,788	238,771	62,081	248,322	75,500	300,000	157,527	628,110
17	4.61	98,524	25,616	102,465	302,832	78,736	314,945	75,500	300,000	179,853	717,411
24	5.91	129,282	33,613	134,453	346,574	90,109	360,437	75,500	300,000	199,222	794,890
28	6.31	138,552	36,023	144,094	390,316	101,482	405,928	75,500	300,000	213,005	850,022
39	7.19	163,658	42,551	170,205	390,316	101,482	405,928	75,500	300,000	219,533	876,133

Figure 4.1 Topsoil schedule

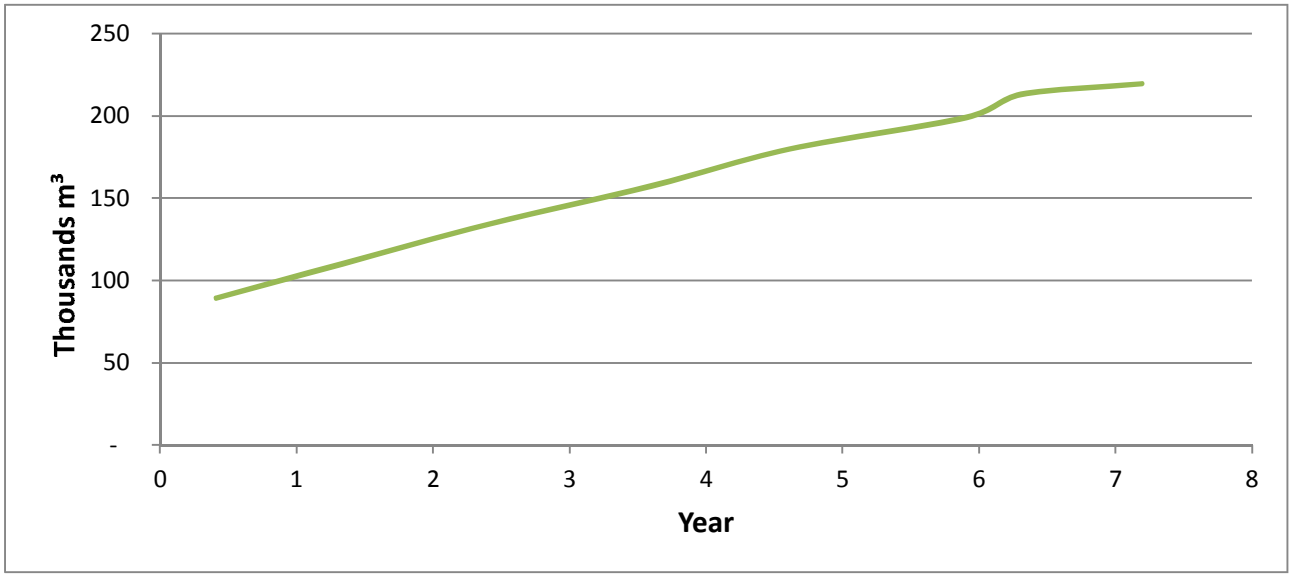
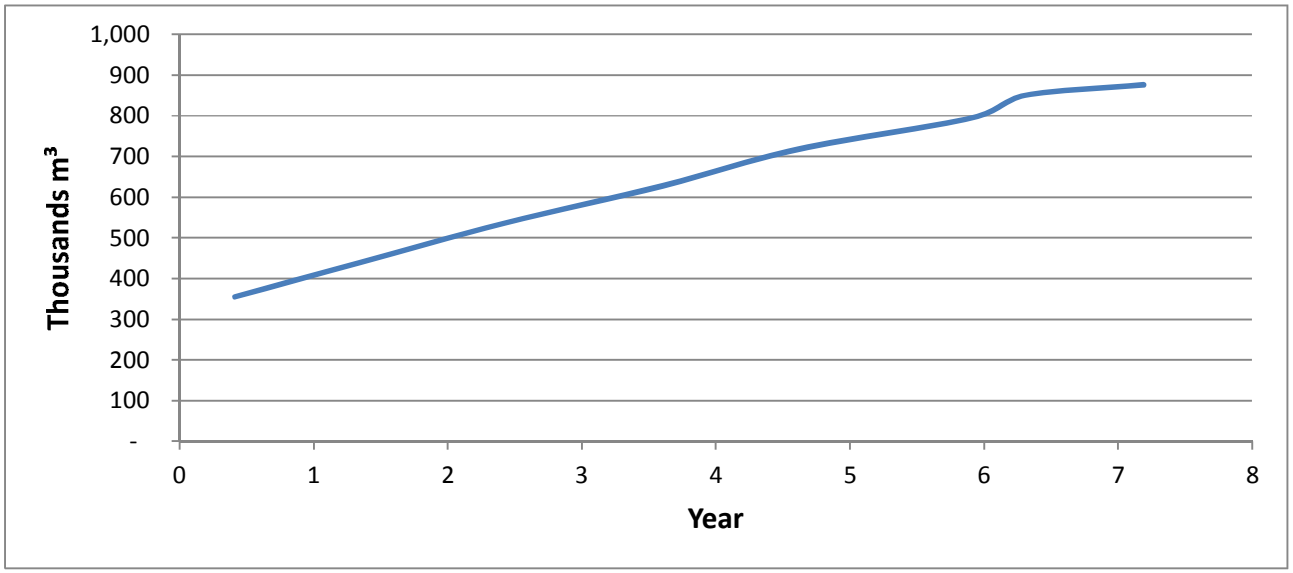


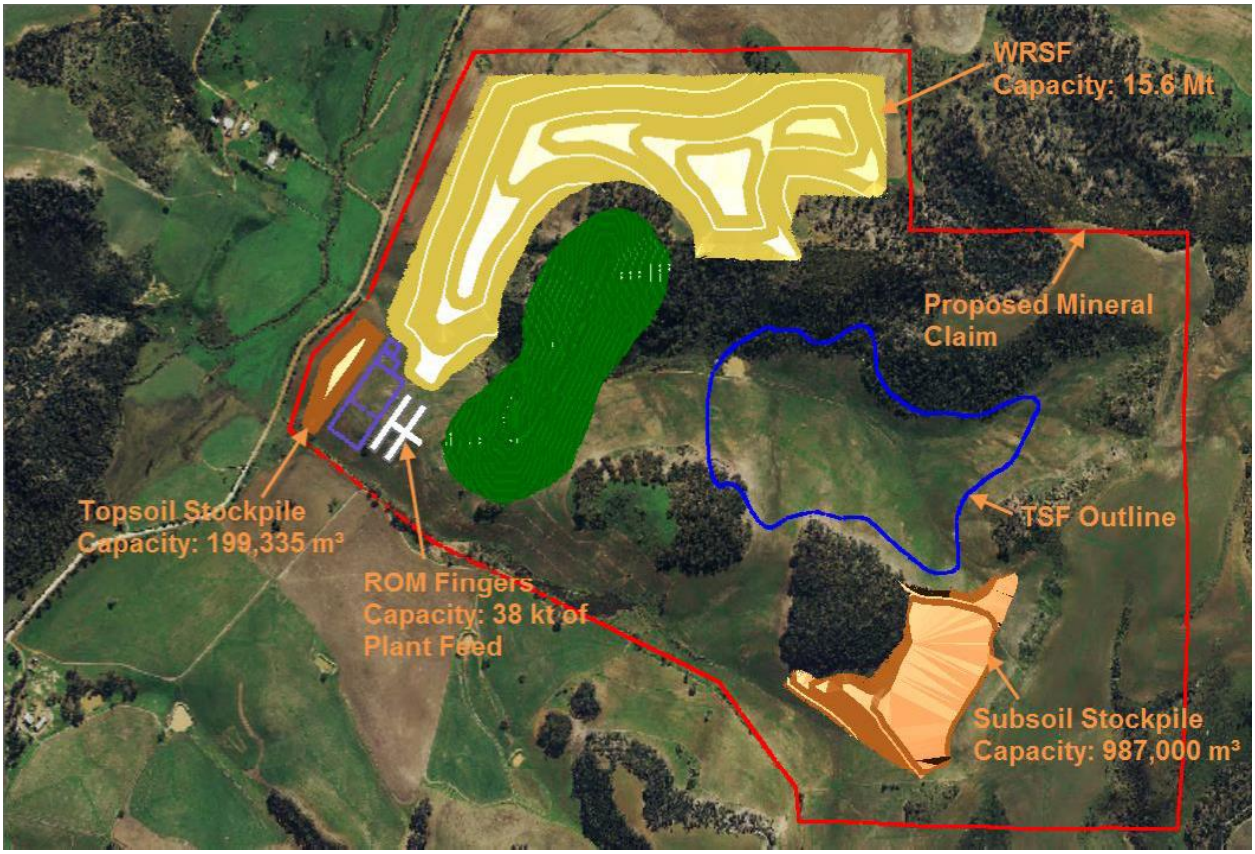
Figure 4.2 Subsoil schedule



A run-of-mine (ROM) stockpile was also designed, composed of four fingers of 9,500 t each, resulting in a total capacity of 38,000 t for plant feed, or the equivalent of almost two months of production. The ROM stockpile was designed to provide for a central ramp so trucks can build the stockpiles by tipping over the tipheads.

The conceptual design arrangements for the WRSF and soil stockpiles are shown in Figure 4.3.

Figure 4.3 Conceptual layout of WRSF, topsoil, subsoil and ROM stockpiles



4.1.1 Waste Rock and Soil Stockpile Stability Assessment

A dump stability rating (DSR) assessment was conducted for both the WRSF and the soil stockpiles and is shown in Table 4.4. The DSR provides a semi-quantitative method for assessing the relative potential dump stability and recommends the appropriate level of dump investigation and design. This was based on recommendations and guidelines given in Mined Rock and Overburden Piles Investigation and Design Manual (BC-MWRPRC, 1991).

Table 4.4 Dump stability ratings for the WRSF and soil stockpiles

Key Factors Affecting Stability	Point Rating			
	NW WRSF		Typical Soil Stockpile	
	Condition	Point Rating	Condition	Point Rating
Dump Height	50 m - 100 m	50	< 50m	0
Dump Volume	Medium	50	Small	0
Dump Slope	Flat	0	Flat	0
Foundation Slope	Flat	0	Flat	0
Degree of Confinement	Unconfined	100	Moderate	50
Foundation Type	Intermediate	100	Competent	0
Dump Material Quality	Moderate	100	Poor	200
Method of Construction	Mixed	100	Favorable	0
Piezometric and Climatic Conditions	Intermediate	100	Intermediate	100
Dumping Rate	Slow	0	Slow	0
Seismcity	Low	0	Low	0
Dump Stability Rating		**600**		**350**
	Class	Failure Hazard	Class	Failure Hazard
Dump Stability Class	**II**	**Low**	**I**	**Negligible**

The WRSF is classified as Class II or low hazard dump, meaning that a basic stability analysis is required. See Section 4.2.4 for more details on this analysis. The soil stockpiles are classified as Class 1 or negligible hazard dumps, meaning that no further stability analysis is required.

AMC recommends that these ratings be revisited if the location or design of the WRSF or soil stockpiles changes as the project progresses.

4.2 WRSF Design

4.2.1 Waste Rock Parameters

4.2.1.1 Particle Size Distribution

No particle size distribution of the waste rock is currently available. None was assumed.

4.2.1.2 Specific Gravity

A typical waste rock SG of 2.65 as advised by LML was used.

4.2.1.3 Density

No waste rock density data is currently available. The dry density of the deposited waste rock was assumed to be 2.0 t/m^3, which is equivalent of applying a swell factor of approximately 1.3.

4.2.1.4 Permeability

No permeability data is currently available. A typical waste rock permeability of 1.00E-4 m/s was assumed based on AMC experience and literature values (USBR, 1987).

4.2.2 Site Preparation

The site preparation will include the removal of topsoil and subsoil from the WRSF footprint, and storage of these materials in their specific stockpiles.

4.2.3 Embankment Details

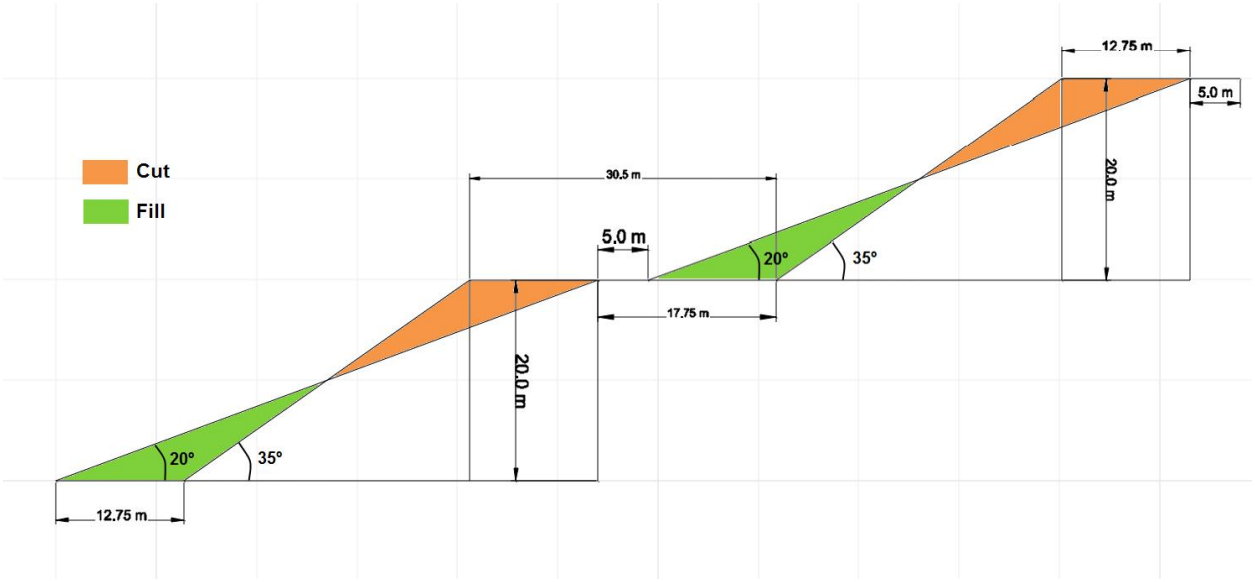
The WRSF will be constructed with the use of dump trucks tipping at tipheads on the edge of the dumps, the operational dumps will be constructed in 10 m lifts and while in operation, the slope angle will be around 35º (approximate angle of repose of the material). Once two 10 m lifts have been finished, the resloping of the face by a track dozer can commence to prepare for rehabilitation.

While in operation the initial lift of the WRSF, needs to be built 12.75 m inside the designed footprint limit, to allow area for the resloping of the dump face to 20º, to achieve the final designed configuration.

While in construction, the operational berms should have a minimum width of 17.75 m, to allow a safe operation and further resloping of the dump as designed.

A typical cross section of the WRSF face exemplifying the parameters mentioned above is shown in Figure 4.4.

Figure 4.4 Typical cross section of the WRSF face



4.2.4 Stability Analysis

The stability of one section of the WRSF was analysed using Rocscience's Slide software, which uses the limit equilibrium method. Factors of safety (FOS) were computed using the Morgenstern-Price method. This section was located at the highest embankments of the ultimate configuration of the WRSF.

As the waste rock and foundation material properties are currently unavailable the analyses were conducted using conservative material properties (Table 4.5 and Table 4.6). The in situ clay was represented using a Mohr-Coulomb constitutive model. The bedrock was modelled using the Generalized Hoek-Brown constitutive model. The waste rock was modelled using the lower bound curve of a normal stress – shear stress relationship determined by Leps (1970). The use of the lower bound is a conservative approach. Refer to Appendix A for more details on this specific model.

Table 4.5 Estimated material properties for in situ clay and waste rock

Material	Unit Weight (kN/m³)	Cohesion (kPa)	Friction Angle (degrees)
Waste Rock	20	Lower bound of Leps normal stress – shear stress relationship	
Clay	22	40	30

Table 4.6 Estimated material properties for bedrock

Material	Unit Weight (kN/m³)	UCS (MPa)	m	s	a
Weathered Bedrock	26.5	50	1.176	0.0007	0.515

The following cases were evaluated:

- Static conditions during operation
- Pseudo-static with typical material properties

AMC uses a minimum factor of safety (FOS) for waste dumps under static conditions of 1.3 for short-term operating conditions and 1.5 after rehabilitation and abandonment. A minimum FOS of 1.3 was used for pseudo-static analysis. These FOS were developed from guidelines presented in BC-MWRPRC (1991). This analysis will use the ground acceleration of 0.05 g (from Section 3.5) for pseudo-static analysis.

Table 4.7 summarizes the preliminary stability results. In all cases the computed FOS were greater than the required FOS.

Table 4.7 WRSF stability analysis results

Location	Case	Required FOS	Computed FOS	Passed
NW Cross-Section	Steady State	1.5	2.52	Yes
	Pseudo-Static	1.3	2.16	Yes

Refer to Appendix B for more details of this modelling.

AMC recommends that further site investigations of the WRSF location be conducted to determine the specific geotechnical and hydrogeological characteristics of the WRSF foundation materials prior to final detailed design of the WRSF in the Program for Environment Protection and Rehabilitation (PEPR).

4.3 Soil Stockpile Design

Topsoil and subsoil will be stripped during the development of the plant site, open-pit, WRSF and TSF. Some in situ clay will be stripped in the development of the TSF. These materials will be kept in separate stockpiles for future use in rehabilitation activities. The total topsoil removed during the life-of-mine (LOM) will be approximately 219,500 loose m^3 and the total subsoil removed is estimated at 876,100 loose m^3 (Table 4.3).

The topsoil stockpile (TSSP) will be built at the west side of the proposed processing plant, as shown in Figure 4.3. At maximum height, the TSSP will be approximately 22 m high when viewed from the west side, and 15 m high when viewed from the east side. Due to the non-permanent characteristic of this stockpile, a design slope angle of 30º was assumed. The relatively small footprint of this stockpile (285 m long by 100 m wide) and proximity to the processing plant, will also allow for easy daily monitoring and quick remediation measures to be taken if required.

The total volume of the designed TSSP is 199,300 m^3, which is 90.8% of the total topsoil generated throughout the LOM. It is likely that the TSSP will not require the total capacity, as the total footprint of the WRSF and open-pit will be progressively cleared, and a progressive rehabilitation schedule will be implemented by LML. If extra topsoil storage capacity is required during the LOM, a portion of the material can be stored within an identified area on the subsoil stockpile.

Due to the larger volume required by the subsoil stockpile (SSSP), it will be built in an area located approximately 850 m south-east of the open-pit footprint, as shown in Figure 4.3. The total capacity of the designed subsoil stockpile is 987,000 m^3, with slope angles of 20º. These relatively flat overall subsoil stockpile slopes will minimize the risk of slope instability and reduce erosion potential.

The designed volume gives an extra capacity of 12.6% over the total estimated volume of subsoil generated during the LOM.

LML should employ appropriate soil management practices when carrying out soil stripping, excavation, and stockpiling operations. These include, but are not limited to, the following:

- Avoidance of wet conditions when excavating soil.
- Avoidance of excessive vehicular traffic to avoid soil contamination and unnecessary disturbance.
- Placement of stockpiles to ensure sufficient distance from other operations to prevent contamination.
- Establishment of erosion control measures at excavation and stockpile locations. This includes limiting the height and slope of the stockpiles to the previously listed dimensions as well as vegetation establishment on the stockpiles.
- Establishment of runoff control ditches if necessary and practical.

4.4 Water Management and Sediment Control

A system of small ditches for the collection of contact water and seepage from the toe of the waste dump and stockpiles will be required. This water will then be directed to water collection ponds, developed at the lowest points downstream from the storage areas, and transferred to the process plant. Surface run-off from the flat dump crest will be permitted to infiltrate the waste piles and naturally drain down gradient into the water collection ponds. After closure, these ponds will be retained until monitoring results indicate that the run-off and seepage from the storage areas are of suitable quality for direct release to downstream waters.

4.5 Rehabilitation

The WRSF and remaining soil stockpiles will need to be rehabilitated at mine closure. AMC recommends a progressive rehabilitation program when practical. The closure and rehabilitation of these dumps will be required to meet end land use goals.

At closure, the final bench crests of the WRSF will be rounded and the faces resloped to a 20º (2.5H:1V) or flatter slope, to facilitate the placement of soil and revegetation and improve the long-term erosion stability of the waste piles. A final cover will consist of approximately 0.5 m to 1.0 m thick layer of topsoil and subsoil and revegetation with native grasses, shrubs or trees. Resloping will be conducted in conjunction with on-going geotechnical and environmental monitoring to ensure that slope stability, sediment control, and water quality objectives are met.

It is expected that the majority of the topsoil and subsoil stockpiles will be depleted during rehabilitation. Any remaining stockpiles will be contoured to blend with the natural ground and promote natural drainage, and the area will be seeded.

AMC recommends that a construction and rehabilitation plan for the WRSF and stockpiles be completed as part of the PEPR. This plan should include instrumentation and monitoring requirements.

5 Tailings Storage Facility Design

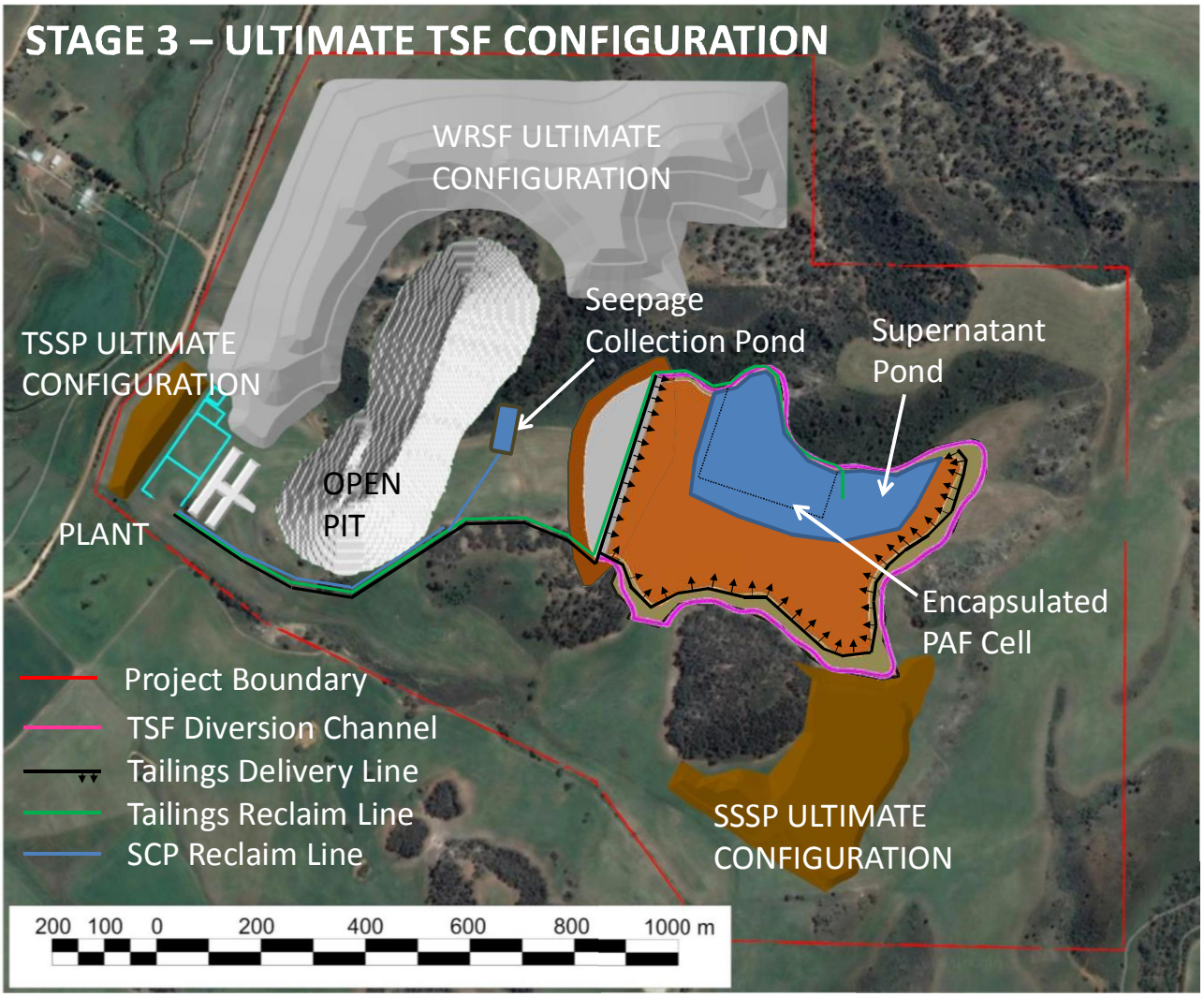
5.1 General

The principal objectives for the preliminary design of the tailings storage facility (TSF) are to provide a secure and flexible tailings management system that ensures protection for the regional ground and surface water during operation and closure. The preliminary design of the TSF includes the following requirements:

- Permanent and total confinement of all solid waste materials (tails and PAF material) within an engineered disposal facility.
- Control, collection, and removal of freed draining liquids from the TSF during operation in order to minimise release and provide milling operations with as much recycled water as possible.
- Recommendations for the necessary monitoring features to ensure that the performance goals of the facility are met as well as to validate the design criteria and assumptions.
- Provide a staged development for the facility over the life of the project.

The overall project general arrangement of the ultimate TSF is shown in Figure 5.1.

Figure 5.1 Ultimate configuration of TSF



5.2 Tailings Parameters

This section presents the available tailings characteristic data and lists AMC's estimated values if the data was not available. AMC recommends that tailings laboratory testing program be conducted on the project's tailings as the project moves forward.

5.2.1 Particle Size Distribution

No particle size distribution (PSD) of the tails is currently available. None was assumed.

5.2.2 Specific Gravity

No specific gravity (SG) for the tails is currently available. A tailings SG of 2.7 was assumed based on AMC experience.

5.2.3 Density

No drained or undrained settled density data is currently available. The in situ dry density of the surface tailings was assumed to be 1.1 t/m^3 while the lower tailings had an assumed in situ dry density of 1.4 t/m^3. It has been assumed that the consolidated tailings at the bottom of the TSF will be denser than the material at the top. This has been reflected in a unit weight of 19 kN/m^3 for the lower tailings and a unit weight of 17 kN/m^3 for the upper tailings. These values reflect typical tailings values based on AMC's experience.

5.2.4 Permeability

No permeability data is currently available. AMC assumed a permeability of 1.00E-6 m/s for surface tailings and a permeability of 1.00E-7 m/s for consolidated tailings.

5.2.5 Strength

No specific geotechnical data is currently available for the tailings. AMC assumed that the tailings can be represented by a Mohr-Coulomb constitutive model. Table 5.1 summarizes these parameters. The permeability data and unit weight of the tailings types are included in the table.

Table 5.1 Estimated tailings parameters

Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)	Permeability (m/s)
Tailings	17	10	7.5	1.00E-06
Consolidated Tailings	19	20	15	1.00E-07

5.3 Embankment Classification

An embankment classification was completed to determine the hazard rating for the proposed TSF. The selection of the hazard rating was based on guidelines given in ANCOLD's Guidelines on Tailings Dam Design, Construction, and Operation (ANCOLD, 1999). These ratings are based on two criteria: the uncontrolled release of water and embankment failure. A copy of these hazard ratings is shown in Table 5.2 where AMC has categorized the proposed TSF design.

Table 5.2 Hazard categorization of the TSF

Type of Effect	HAZARD CATEGORY		
	HIGH	SIGNIFICANT	LOW
Uncontrolled Releases or Seepage			
Potential loss of human Life	Contamination of a water supply likely to be consumed by humans is probable	Contamination of a water supply likely to be consumed by humans is possible but not probable	Contamination of a water supply likely to be consumed by humans is not expected
Potential loss of stock	Contamination of a water supply likely to be consumed by stock is probable	Contamination of a water supply likely to be consumed by stock is possible but not probable	Contamination of a water supply likely to be consumed by stock is not expected
Environmental Damage	Damage to an environmental feature of significant value is probable	The significance of the environmental feature is less or damage is possible but not expected	No environmental feature of significance or no damage expected
Embankment Failure			
Loss of human life	Loss of life expected because of community or other significant developments.	No loss of life expected, but the possibility is recognized. No urban development and no more than a small number of habitable structures downstream.	No loss of life expected.
Direct economic loss	Excessive economic loss such as serious damage to communities, industrial, commercial or agricultural facilities, important utilities, mine infrastructure, the storage itself or other storage downstream.	Appreciable economic loss such as damage to secondary roads, minor railways, relatively important public utilities, mine infrastructure, the storage itself or other storage downstream.	No significant economic loss such as limited damage to agricultural land, minor roads, mine infrastructure, etc.
Ongoing economic loss	Storage essential for services and repairs not practical.	Repairs to storage practicable without major interruption to services.	Repair to storage practical. Losses of services not significant.

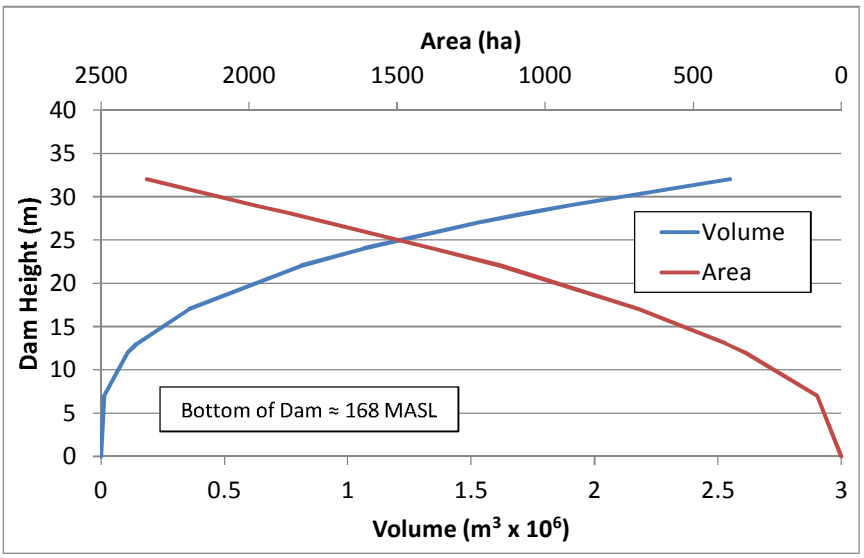
The TSF is categorized as a low hazard for uncontrolled water release. The reason for this that the open-pit is the immediate structure downstream of the TSF so any potentially uncontrolled water releases are minimal as the water would flow into the open-pit. However, the TSF is rated as a high hazard for embankment failure as such a failure could potentially cause excessive economic loss to LML.

5.4 Design Basis

The TSF was developed as a valley-impoundment and is located in the central valley of the property, east of the proposed open-pit location. The TSF will have sufficient capacity to permanently store 1.8 million tonnes of tailings and 1 million tonnes of PAF waste rock (approximately 1.27 million cubic metres of tailings at an average dry density of 1.4 t/m^3 and approximately 0.5 million cubic metres of PAF material at an average dry density of 2.0 t/m^3). The design was based on using open-pit waste rock for embankment construction with the ultimate height of the embankment being 30 m (the bottom of the TSF is at approximately 168 masl). No PAF waste rock will be used in the construction of the embankment.

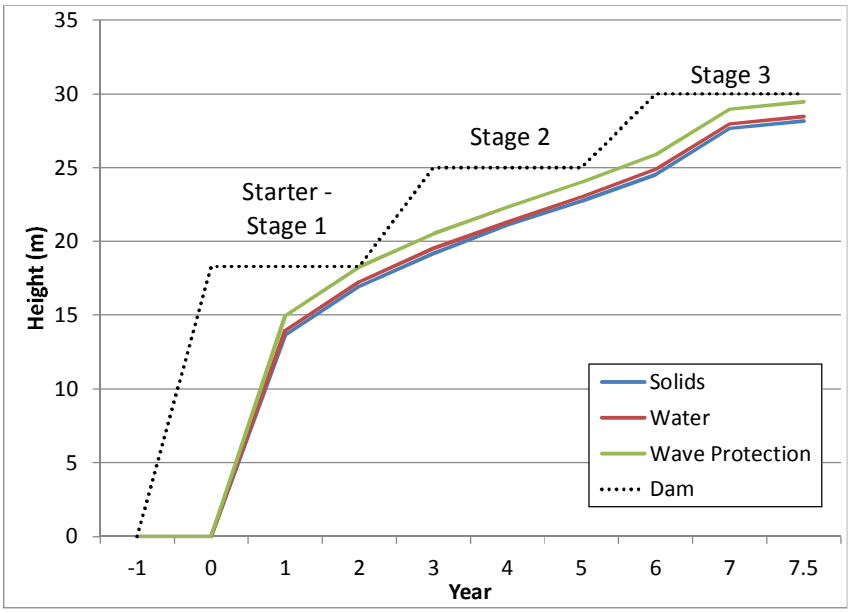
The depth-area-capacity relationship for the valley is shown in Figure 5.2. All volume and area calculations were based on topography provided by LML.

Figure 5.2 TSF depth area capacity relationship



The preliminary design filling schedule is shown in Figure 5.3, and includes sufficient capacity and freeboard to store the design flood during operations.

Figure 5.3 TSF filling schedule



A summary of the preliminary design basis and operating criteria for the TSF are given in Table 5.3.

Table 5.3 Preliminary design and operation criteria for the TSF

Item	Design Criteria
Project Location	North of Port Lincoln, West of Tumby Bay, close to the the historic Koppio Graphite Mine
Mine Production	Total Material Mined = 18.12 Mt
	Mill Throughput = 0.25 Mtpa average
	Mine Life = ~7.5 years
Tailings	Total tailings production = 1.8 Mt
	Average in situ dry density for tailings = 1.1 t/m^3
	Average in situ dry density for consolidated tailings = 1.4 t/m^3
	Specific Gravity of Tailings Solids = 2.7
Potentially Acid Forming (PAF) Waste	All PAF material stored in tailings storage facility
	Total PAF estimated to be ~1 Mt. Schedule was estimated by AMC.
	PAF waste dry density = 2.0 t/m^3
Operational Criteria	Zero discharge of process water
	Supernatant water and seepage water for re-use in process plant
	Provide sufficient storage for tailings, PAF material, 30% of supernatant water, and design storm event. Also includes 1 m of freeboard for wave run-up protection.
Dam Classification	High Hazard based on ANCOLD 1999
Hydrology Criteria	Design Storm is an annual exceedance probability of 1% 24 hour event = 100 mm
Operational Freeboard	Full containment of design storm plus design wave run-up protection (1 m)
Design Earthquake	1 in 500 year event = 0.05g ground acceleration
Stability Criteria	The minimal acceptable factors of safety (based on ANCOLD 1999) for:
	Static Conditions = 1.5
	Pseudo-Static = 1.1
Seepage Criteria	Prevent adverse downstream water quality impacts by recycling seepage water as necessary
Closure Criteria	open pit
	Provisions to permanently submerge PAF material
	Reclamation of tailings beaches, TSF embankment, and disturbed areas with topsoil cover

5.5 Layout and Operating Strategy

5.5.1 General

Tailings and PAF material will be deposited in a TSF that occupies the central valley of the site and is approximately 150 m upstream of the open-pit. The general arrangement of the TSF is shown in Figure 5.1. The TSF embankment will be constructed with open-pit waste rock in a staged downstream construction method. Construction of the starter dam will start approximately 12 months ahead of mill start-up. Note that a more precise material schedule may need to be developed as the project moves forward in order to ensure that there is enough waste material generated in time to build the embankment.

5.5.2 Water Management

The water management for the TSF is described in more detail in Section 5.7. The following section provides an overview of what is provided in that section as it applies to the operation of the TSF.

The following details the water management system for the TSF:

1. In this study the AMC design has the majority of TSF surface runoff being diverted to the seepage collection pond (SCP) using ditches. This water will then be sent to the mill as process water. This approach should be reviewed in further studies with the understanding that LML has agreed with the Eyre Peninsula Natural Resources Management board to discharge water into the nearby creek.
2. The majority of the water that enters the TSF will be reclaimed from the TSF's supernatant pond and sent the mill for process water.
3. The management of seepage from the TSF includes:

- The use and improvement of the in situ low permeability clay within the TSF basin that will form a barrier to water movement.
- A low permeability tailings mass that will restrict movement of water.
- The use of a low permeability liner on the upstream side of the TSF will form a barrier to water movement through the dam.
- The supernatant pond will be kept isolated from the embankment to minimize the development of seepage forces.
- Seepage collection system within the TSF embankment.
- SCP system downstream of the TSF embankment.
- Ground and surface water monitoring location downstream.

5.5.3 Tailings Distribution

The discharge of tailings from the delivery pipelines into the TSF will be from a series of large diameter valves or spigots located along the length of the delivery pipelines. These valves can be opened and closed in order to help facilitate tailings placement throughout the TSF.

Tailings deposition generally follows the same progression. The sandy coarse fraction of the tails settles more rapidly, accumulating closer to the discharge points and forming a beach with an approximate 1% slope. The finer tailings particles will travel further away from the discharge points and will settle at a flatter slope adjacent to and below the supernatant pond. The development of these tailings beaches serve two purposes: the first is to maximize the storage volume while the second is to control the location of the supernatant pond. As previously mentioned isolating the supernatant pond from the embankments reduces the seepage forces and also increases embankment stability.

5.5.4 PAF Waste Storage Area Development

PAF waste will be hauled to the TSF for co-disposal with tailings. The PAF waste storage area will be developed at a similar rate of rise as the TSF embankments, but the waste surface will be maintained several metres above the tailings surface to provide a dry, stable placement platform.

The PAF waste production schedule, presented in Figure 2.1, is preliminary. However, it indicates that the majority of the PAF material will be developed in 6th year of mining operations. This means the tailings produced in the final 1.5 years of the mine life will progressively encapsulate the PAF waste with tailings solids. At closure, the PAF waste will be encapsulated by tailings and submerged below the surface pond.

The PAF waste storage area was preliminarily designed to be developed along the north side of the valley and will be offset a minimum of 130 metres from any depositional location, in order to allow the development of tailings beaches. The outline of the PAF waste storage area is shown in Figure 5.1. This zone of tailings beach will provide a low permeability transition zone between the coarse, permeable PAF waste rock and the tailings embankments, and will function as a seepage control measure.

AMC recommends that this design is revisited when more details about the characteristics of both the tailings and PAF material, as well as the of the PAF waste schedule, becomes available.

5.6 Embankment Construction

5.6.1 Site Preparation

All organics need to be cleared from the TSF footprint. This includes the pre-stripping of topsoil and subsoil. This material will be stockpiled for use during rehabilitation. Any clay within the ultimate embankment footprint will be excavated to bedrock. Additional bedrock preparation, such as crack grouting, may be required. This material will also be stockpiled. Figure 5.4 shows the approximate excavation limits for the clay and the soil. Table 5.4 contains the approximate volumes for the excavated material in the TSF footprint. This table assumes a bulking factor of 30%.

Figure 5.4 Approximate limits of soil excavation for TSF

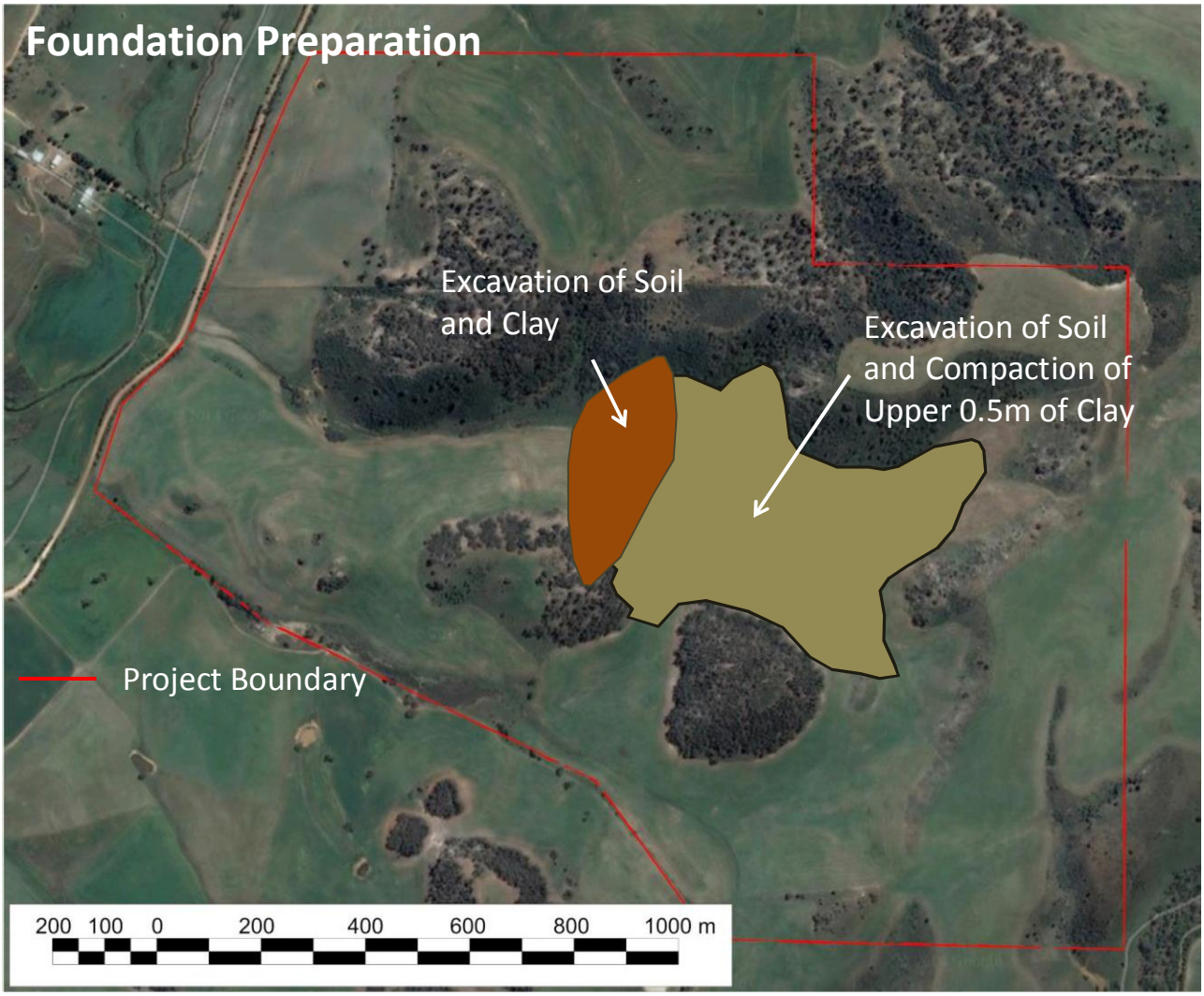


Table 5.4 Approximate volumes of excavated soil and clay from TSF footprint

Material	Thickness (m)	Approximate Volume (m^3)
Topsoil	0.2	75,500
Subsoil	0.8	300,000
Clay	3	238,000

The clay, within the tailings basin, forms a natural liner and is important for controlling basin seepage from the TSF; particularly in the initial years of operations before the tailings beaches are well developed. To this end it may be necessary to scarify and re-compact the top 0.5 m of the clay in order to decrease its permeability.

AMC recommends that further site investigations be conducted for the PEPR to determine the detailed geological and hydrogeological characteristics of the TSF area, and the lateral extent of the clay to ensure that it covers the TSF basin.

5.6.2 Embankments

The design includes a three staged construction plan for the TSF. Figure 5.5 and Figure 5.6 show the general arrangement of the starter and second stage configurations of the TSF respectively. The ultimate configuration is shown in Figure 5.1. Note that the terrain imaging shown in Figure 5.1, Figure 5.5, and Figure 5.6 was placed based on the topographic contours and is not geo-referenced.

Figure 5.5 TSF configuration for the starter dam

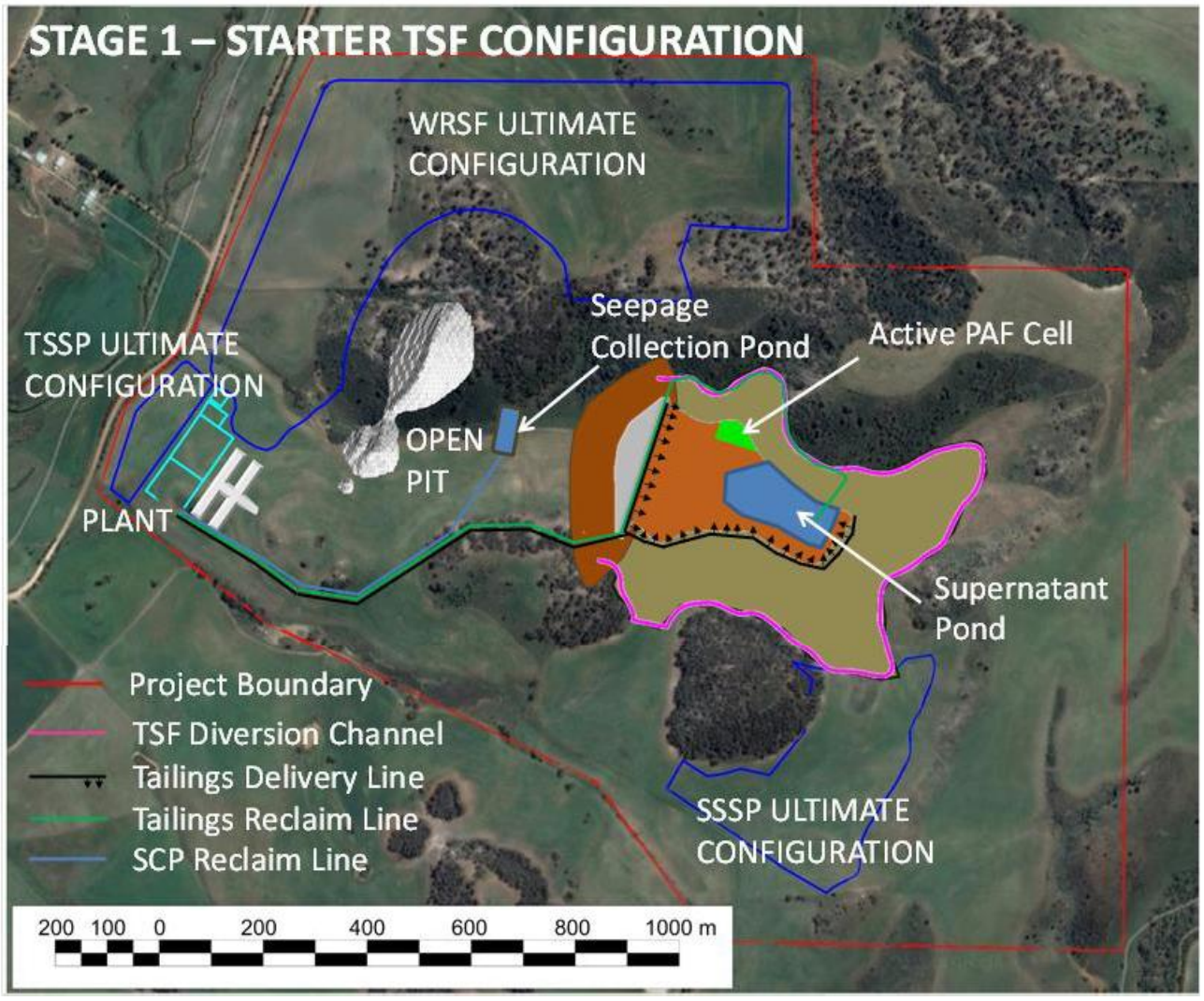


Figure 5.6 TSF configuration for Stage 2

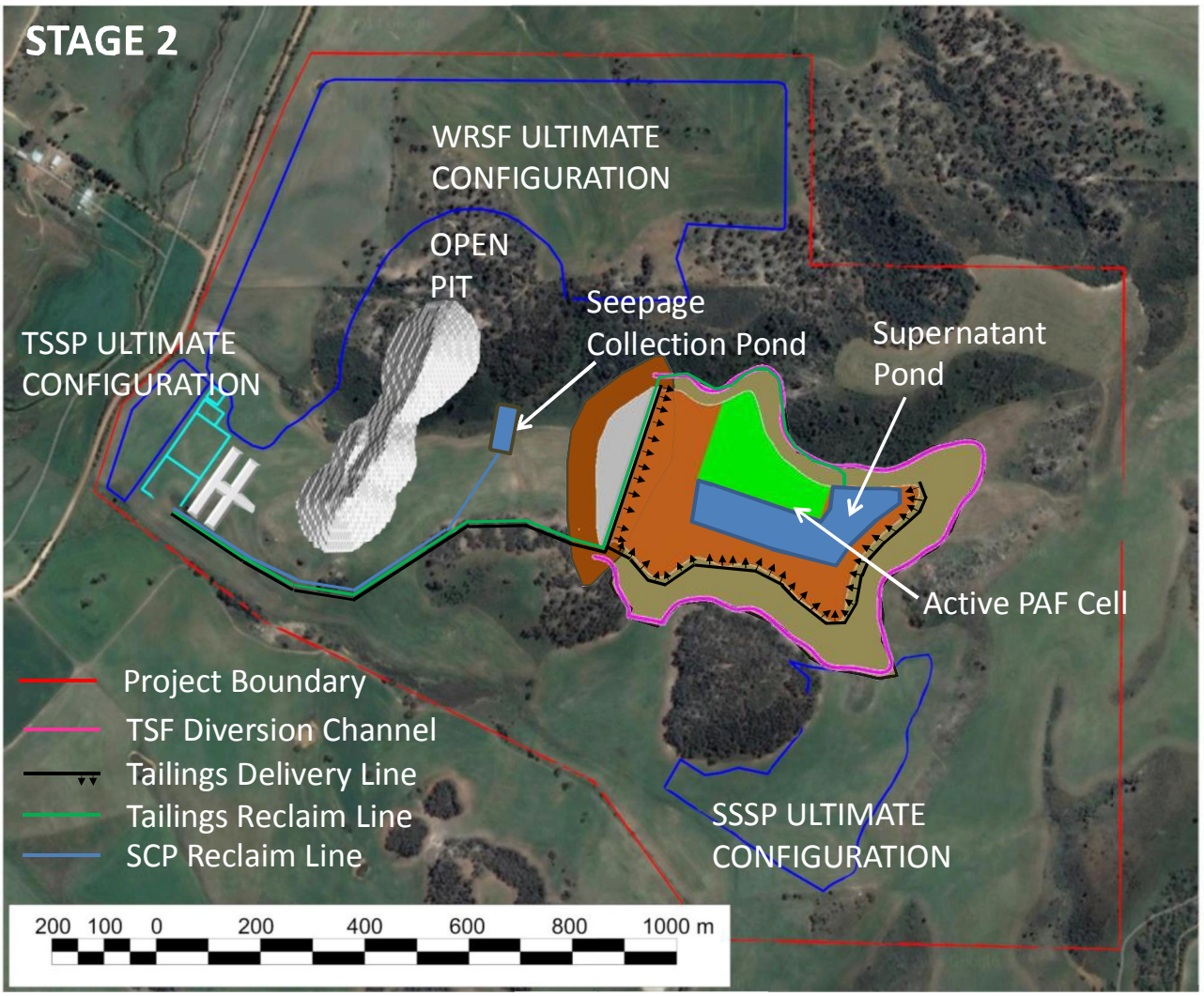


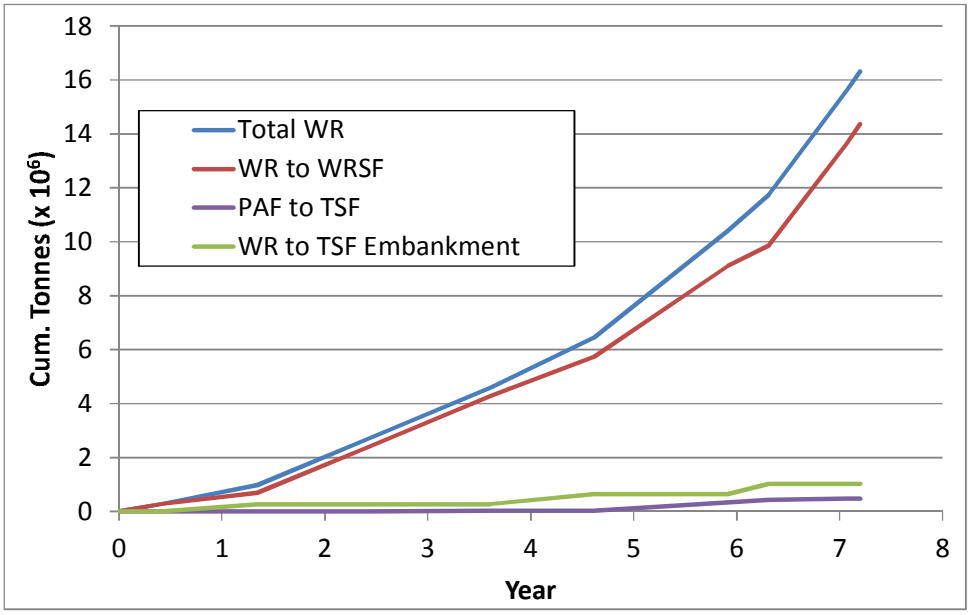
Table 5.5 shows the required volume and tonnage of waste rock required to complete the TSF embankment. A level tailings surface has been used to calculate volumes.

Table 5.5 Waste rock volume and tonnage required for the TSF embankment

Year	Stage	Incr. Vol m³	Cum. Vol. m³	Incr. Mass t	Cum. Mass t
0	1 - Starter	138,700	138,700	277,400	277,400
3	2	183,800	322,500	367,600	645,000
6	3 - Ultimate	192,400	514,900	384,800	1,029,800

Figure 5.7 presents a material balance for the waste rock. This plot shows that there is enough waste rock generated to construct the TSF embankment. However, the precise scheduling of the construction of the starter dam needs to be revisited to ensure that enough material is being produced at the time of its construction.

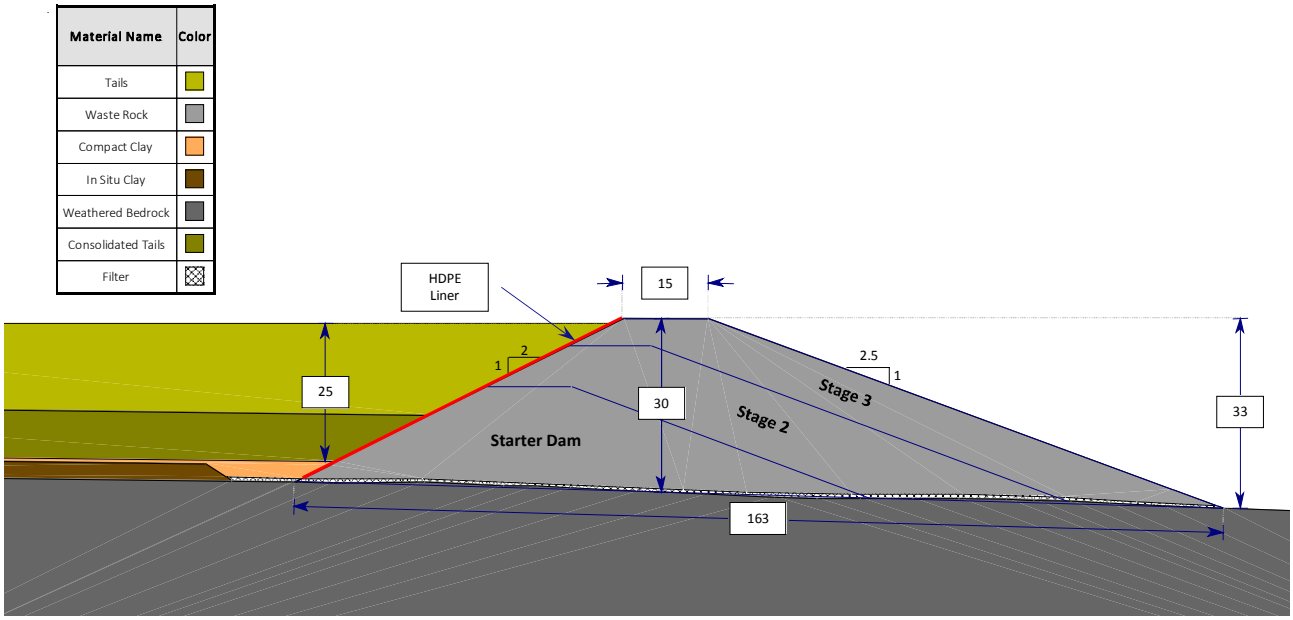
Figure 5.7 Material balance of waste rock



5.6.3 Embankment Details

A downstream construction method was used in the embankment design. A preliminary schematic of the embankment design cross-section is shown in Figure 5.8. Note that it is currently assumed that the entire embankment will be constructed of waste rock. The embankment design uses a crest of 15 m, a 2:1 upstream slope, and a 2.5:1 downstream slope. There will be filter drains placed under the embankment to prevent high pore water pressures from being generated under the embankment. The clay that was excavated from the upstream side will be replaced and compacted.

Figure 5.8 Preliminary ultimate embankment design schematic



5.6.4 Liner

It has been assumed that the entire upstream side of the embankment will be lined with a suitable high density polyethylene (HDPE) liner (or similar low permeability material). This liner would be keyed into the foundation and abutment material. Table 5.6 lists the required liner surface areas by stage. AMC recommends a site investigation be conducted in order to determine possible source locations of suitable low permeability construction material as an alternative to using an HDPE liner.

Table 5.6 HPDE liner area by stage

Year	Stage	Liner Surface Area (m^2)
0	1 - Starter	8,100
3	2	6,400
6	3 - Ultimate	5,200
	Total	**19,700**

5.6.5 Stability Analysis

Preliminary limit-equilibrium analyses were run on the main embankment design using Rocscience's Slide software. Factors of safety (FOS) were computed using the Morgenstern-Price method. The following cases were evaluated:

- Static conditions during operation.
- Pseudo-static with typical material properties.
- Pseudo-static with the less consolidated tailing under undrained conditions (no frictional strength).

Refer to Appendix D for more details of this modelling.

As the tailings, waste rock, and foundation material properties are currently unavailable, the analyses were conducted using conservative material properties (Table 5.7 and Table 5.8). The tailings and local clays were represented using a Mohr-Coulomb constitutive model. The bedrock was modelled using the Generalized Hoek-Brown constitutive model. The waste rock was modelled using the lower bound curve of a normal stress – shear stress relationship determined by Leps (1970). The use of the lower bound is a conservative approach. Refer to Appendix A for more details on this specific model.

Table 5.7 Estimated material properties for soils and waste rock

Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Tailings	17	10	7.5
Consolidated Tailings	19	20	15
Waste Rock	20	Lower bound of Leps normal stress – shear stress relationship	
Compacted Clay	22	20	25
Clay	22	20	25
Filter	20	0	35

Table 5.8 Estimated material properties for bedrock

Material	Unit Weight (kN/m^3)	UCS (MPa)	m	s	a
Weathered Bedrock	26.5	50	1.176	0.0007	0.515

The phreatic surface for the model was developed using the finite element steady-state fluid flow component of Slide. This modelling assumed a worst case scenario with ponded water up to the embankment. For information on the development of this phreatic surface refer to Section 5.7.5.2 or Appendix C.

AMC uses a minimum FOS for tailings embankments under static conditions of 1.5 for normal operating (steady-state seepage) conditions as well as for rehabilitation and abandonment. A minimum FOS of 1.1 was used for pseudo-static analysis. These FOS were developed from the Guidelines on Tailings Dam Design, Construction, and Operation (ANCOLD, 1999). The ground acceleration of 0.05 g (as discussed in Section 3.5.1) was used for the pseudo-static analysis.

Table 5.9 summarizes the preliminary stability analysis results. In all cases the computed FOS were greater than the required FOS.

Table 5.9 TSF Embankment stability analysis results

Case	Required FOS	Computed FOS	Passed
Steady State	1.5	2.53	Yes
Pseudo-static with normal parameters	1.1	2.19	Yes
Pseudo-static with undrained lesser consolidated tailings	1.1	2.19	Yes

5.7 Water Management

AMC completed a preliminary yearly water balance for the TSF and the seepage collection pond (SCP) system using average hydrological values. Other mine areas were not included in this water balance. Figure 5.9 is a schematic showing the modelled water balance. For more details about the water balance refer to Appendix E.

Figure 5.9 Preliminary yearly water balance for TSF

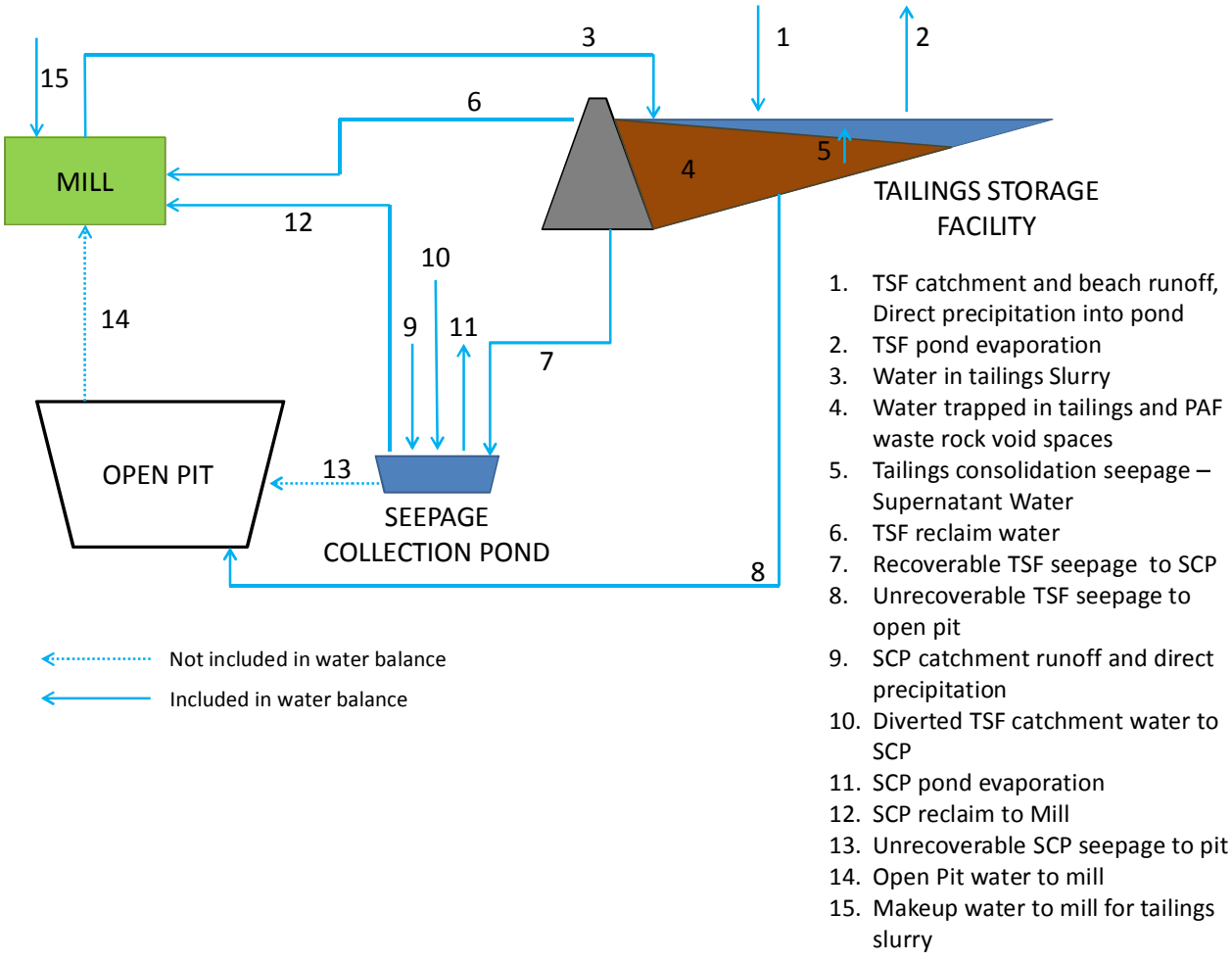
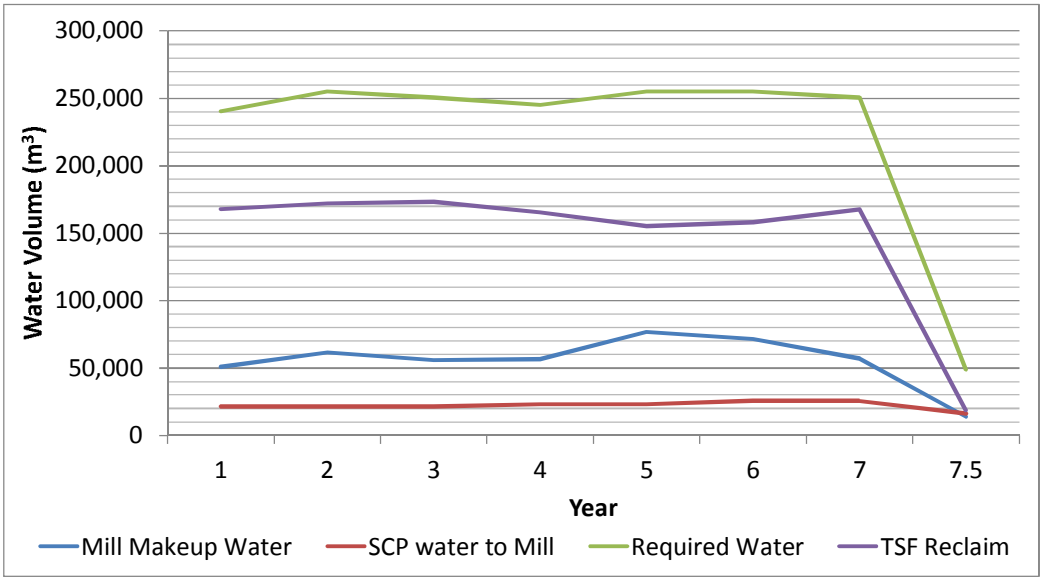


Figure 5.10 shows the required water for the tailings slurry (see Section 5.7.1 for more details) and the reclaim water from both the seepage collection pond system and the TSF. This plot shows that the yearly makeup water required by the mill varies between approximately 51,000 m^3 and 77,000 m^3. The water balance currently assumes that the supernatant pond will cover 33% of the TSF surface area.

Figure 5.10 Movement of water between the mill, the SCP system, and the TSF



AMC recommends that the TSF water balance be integrated into the mine site water balance and that the mine site water balance be updated for the PEPR when more details are available on process water requirements. The site water balance should include all water diversions, ponds, etc. and make use of extreme hydrological values. This water balance should include a study of various water management options in order to determine the best water management system for the project.

The following sections detail the inputs and outputs used in the water balance and how the values for these were determined.

5.7.1 Tailings Water

The amount of water reporting to the supernatant pond is a function of the tailings slurry solids content and water retained in the settled tailings. It was assumed that the discharge slurry has a 3:1 water to tailings ratio by volume (1:1 by mass) (Parsons-Brinckerhoff, 2012). However, given the assumptions made about the tailings data, these calculations will need to be redone when further tailings data is available.

5.7.2 Rainfall

Daily rainfall data was available from several Australian Bureau of Meteorology stations located close to the project site. Refer to Section 3.3 for further information.

5.7.3 Evaporation/Evapotranspiration

Evaporation and evapotranspiration data were determined from maps published by the Australian Bureau of Meteorology. Refer to Section 3.3 for further information.

5.7.4 Runoff

Runoff represents the amount of rainfall that is expected to report from the catchment area. This is a function of the amount of rainfall, the surface area of the catchment area, and the runoff coefficient for the catchment area. The runoff coefficient used for the non-TSF beach areas was 0.4 while a coefficient of 0.7 was used for the tailings beach.

5.7.5 Seepage

5.7.5.1 Seepage Collection System

Seepage from the TSF will result from infiltration of ponded water directly through the embankment fill, the natural ground, and from expulsion of pore water as the tailings mass consolidates. The seepage will largely be controlled by the low permeability HDPE liner, in situ clay and the tailings deposit after the development of a tailings beach.

A downstream SCP will be constructed prior to construction of the TSF embankments to prevent discharge of surface water runoff during construction. This pond will be situated downstream of the TSF embankment at a topographic low point and will collect surface runoff from the embankment, water from the TSF diversion ditches, water from the SCP's watershed, and seepage through the embankment.

Depressurization wells installed at the downstream toe of the embankment will allow dissipation of elevated pore water pressures within the embankment foundations. These wells are included to enhance the stability of the embankments and will also function to recover some of the foundation seepage.

5.7.5.2 Seepage Analysis

AMC conducted a steady state seepage analysis on the TSF embankment to provide a preliminary estimate of the amount of seepage that can expected from the embankment and the foundation material. This analysis was carried out using the finite element steady-state fluid flow component of Rocscience's Slide software. More details of this analysis are available in Appendix C.

The seepage rate through the embankment and foundation is controlled by the following factors:

- Low permeability of the in situ clay.
- The thickness and permeability of the tailings stored within the TSF.
- Low permeability of the HDPE liner on the upstream side of the embankment.
- Seepage gradients in the embankment and foundation zones.
- The seepage area (which increases during operation).

The seepage flow rate will vary over the life of the TSF due to increasing thickness of tailings and any self-weight consolidation that occurs. This was examined by conducting seepage analysis at the different construction stages. The same cross section location was used for each model and represents the deepest section of the valley. Figure 5.8 shows the cross-section for the ultimate configuration. All of the seepage analyses used a worst case scenario of ponded water directly adjacent to the embankment.

Table 5.10 summarizes the permeability values used in the modelling. These values were estimated by AMC since no material permeability values are currently available.

Table 5.10 Estimate permeability values for embankment materials

Material	Permeability (m/s)
Tailings	1.00E-06
Consolidated Tailings	1.00E-07
Waste Rock	1.00E-04
HDPE	1.00E-11
Compacted Clay	1.00E-08
Clay	5.00E-08
Weathered Bedrock	3.00E-06
Filter	1.00E-04

The seepage through the system was monitored through a series of discharge sections through the embankment liner and foundation. This was used to estimate the seepage flows through these locations. The total seepage from the TSF at the ultimate configuration is calculated to be approximately 0.7 l/s. Approximately 70% of the total seepage goes through the foundation while the remaining 30% goes through the embankment. The seepage collection pond system is expected to capture all of the embankment seepage. Although the natural slope of the ground will result in seepage flowing to the pit, there is currently no system intended to capture the rest of the seepage (for example, the use of groundwater interception wells may capture up to 60% of this seepage). It may be necessary to examine the inclusion of such a system as the project moves forward.

AMC recommends that further site investigations be conducted to determine hydrogeological and geotechnical material properties of the TSF location and that the seepage analysis be updated when the additional data is made available.

5.7.6 Freeboard

A 1 m freeboard height was used to ensure protection from wave run-up damage on the embankment. The freeboard height does not include any storage for the design storm event as this was taken into consideration by previous runoff calculations. Note that the current design does not contain an emergency spillway. AMC recommends that the use of an emergency spillway be reviewed as the project moves forward.

5.7.7 Water Recovery

A decant structure shall be constructed in the supernatant pond in order to return supernatant water to the process plant. The pumping system will need to have the capacity to maintain the size of the supernatant pond during a precipitation event as the TSF has no emergency spillway installed during operation. The type of decant structure is variable depending on both TSF and process plant requirements. AMC recommends that this be studied in more detail as the project moves forward.

5.8 Pipework

A preliminary general layout of the tailings discharge and reclaim water pipelines are shown on Figure 5.1, Figure 5.5, and Figure 5.6.

5.8.1 Tailings Discharge System

This system has not been determined beyond a general layout at this time. AMC recommends that this be studied in more detail when more site specific details about the tailings characteristics are available.

5.8.2 Reclaim Water System

This system has not been determined beyond a general layout at this time and should be addressed as the project moves forward.

5.9 Instrumentation, Closure Plan, and Monitoring

5.9.1 Instrumentation

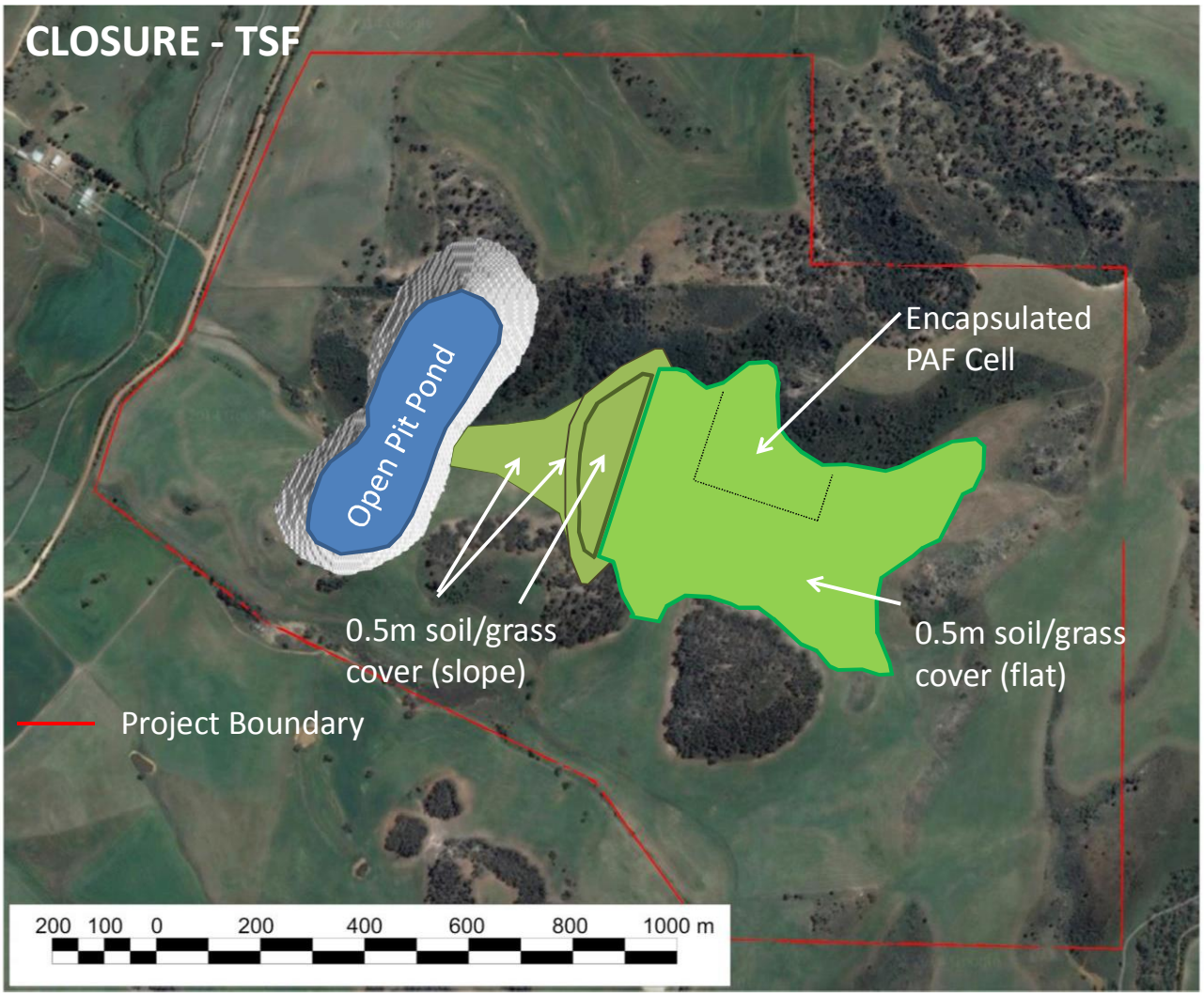
Geotechnical instrumentation, consisting of piezometers and movement indicators, will be installed in the TSF embankment and foundations during construction and over the life of the project. The instrumentation will be monitored during the construction and operation of the TSF to assess embankment performance and to identify any conditions different to those assumed during design and analysis. Amendments to the on-going designs and remediation work, as appropriate, can be implemented to respond to the changed conditions, should the need arise.

It is also possible to install groundwater wells at suitable locations downstream of embankment if this proves necessary.

5.9.2 Closure Plan

The primary objective of the closure and rehabilitation initiatives will be to eventually return the TSF site to a self-sustaining facility. The TSF will be required to maintain long-term stability, protect the downstream environment, and manage surface water. Activities that will be carried out during operations and at closure to achieve these objectives are discussed in the following sections. The ultimate conceptual arrangement for the initial rehabilitation period after operations have ended is shown on Figure 5.11.

Figure 5.11 Conceptual TSF closure configuration



Upon mine closure, surface facilities will be removed in stages and full rehabilitation of the TSF will be initiated. General aspects of the closure plan include:

- Selective discharge of tailings around the facility during the final years of operations to establish a final tailings beach that will facilitate surface water management and rehabilitation.
- Dismantling and removal of the tailings and reclaim delivery systems and all pipelines, structures and equipment not required beyond mine closure.
- Removal of the seepage collection system at such time that suitable water quality for direct release is achieved.
- Removal and re-grading of all access roads, ponds, ditches and borrow areas not required beyond mine closure.
- Installation of a long term spillway that channels TSF surface water towards the open-pit.
- Long-term stabilization of all exposed erodible materials.
- Rehabilitation of the tailings beaches, including a base layer of non-PAF waste rock or overburden (approximately 0.5 m thick) excavated from the non-PAF waste dump, covered by a layer of topsoil (approximately 0.5 m thick) from stockpiled material. This soil layer will be seeded using native grasses.
- Rehabilitation of previously excavated areas and embankment slopes with a layer of topsoil (approximately 0.5 m thick) from stockpiled material. This soil layer will be seeded using native grasses.
- Further study is required to maintain the encapsulation of the PAF zone. This may include the use of a HDPE liner over the top of the zone or the use of water pond.

AMC recommends that this conceptual plan be revisited and changed as the project moves forward in order to incorporate the TSF closure plan into the site wide closure plan.

5.9.3 Monitoring

The SCP system will be retained until monitoring results indicate that any seepage from the TSF is of suitable quality for direct release to downstream waters. This system will then be removed and surface water left to enter the pit. The geotechnical instrumentation, and groundwater monitoring wells if installed, will be retained for use as long-term monitoring devices.

Post-closure requirements will also include an annual inspection of the TSF and an on-going evaluation of water quality, flow rates, and instrumentation records to confirm design assumptions for closure.

6 Recommendations

AMC recommendations for further work are summarized below. Once these studies are complete the design can be redone based on the findings of these studies.

AMC recommends that additional site investigations be conducted to help quantify the geotechnical, hydrogeological, and hydrological properties of the TSF and WRSF areas.

The geotechnical investigation would be aimed at determining the availability of construction material borrow sources as well as the properties of these materials and determining the TSF and WRSF foundation conditions and materials. The properties and lateral extent of these properties also needs to be determined as part of this investigation.

The hydrogeological and hydrological site investigation would provide and update data for the project's site wide water balance.

AMC recommends a laboratory testing program aimed at determining the material properties and geotechnical characteristics of the project's tailings material.

As the encapsulation of the PAF waste is an important component of the TSF operating philosophy the determination of the actual PAF production schedule is required. A laboratory testing program would also be required to determine the physical characteristics of the PAF waste material.

AMC recommends that a site wide water balance be completed. This water balance should include a study of various water management options. This water balance should use extreme hydrological values in addition to average values. This study would help determine the appropriate decant and water return systems for the TSF.

AMC recommends that detailed mine design, mine schedule, and reserve estimate are done during the feasibility study, which will allow the amount of different materials generated through the LOM and the economic return of the project to be quantified.

AMC recommends that the rehabilitation and closure plans continue to be updated for both the TSF and WRSF as the project moves forward. Part of this closure plan would include the necessary monitoring requirements for both facilities.

AMC recommends that an additional study be conducted looking at the possibility of dry-stacking the project's tailings. This deposition method has advantages in reducing the water needed to transport the tailings as well as increasing the density of the tailings. Both of these reduce the volume required for tailings storage. Note that the use of dry-stack tailings may require a different storage method for the PAF material.

Once these studies are completed the design of the WRSF and TSF would need to be reworked.

7 References

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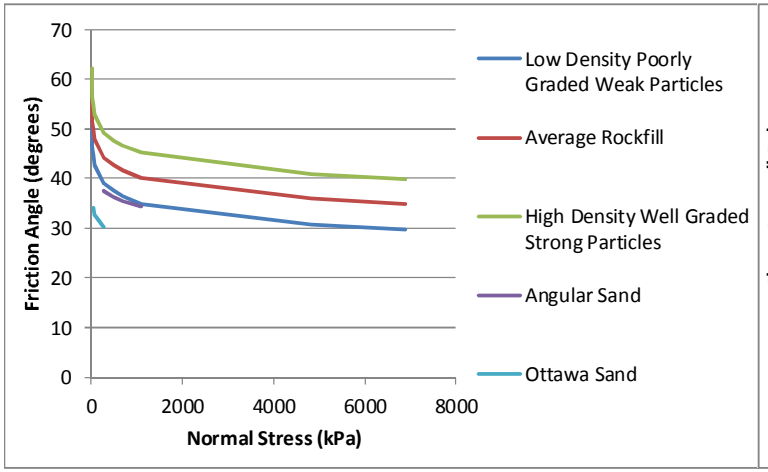
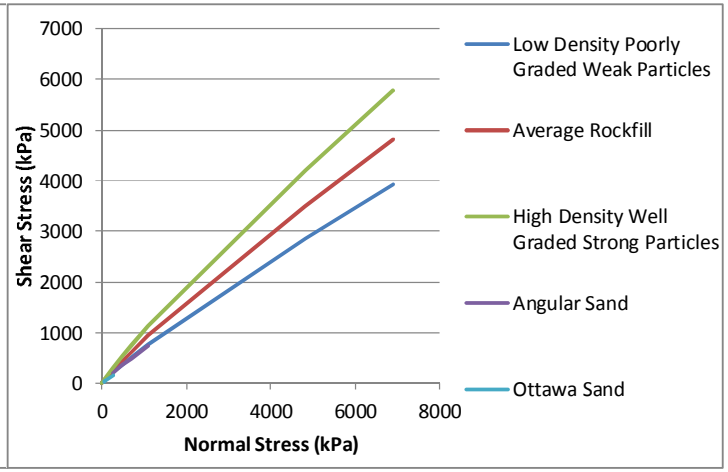
Appendix A
Typical Shear Strength of Rock Dumps (LEPS, 1970)

WASTE DUMPS AND STOCKPILES PRELIMINARY DESIGN – TYPICAL SHEAR STRENGTH OF ROCKFILL (LEPS, 1970)

	Friction Angle					Shear Stress (kPa)				
Normal Stress (kPa)	Low Density Poorly Graded Weak Particles	Average Rockfill	High Density Well Graded Strong Particles	Angular Sand	Ottawa Sand	Low Density Poorly Graded Weak Particles	Average Rockfill	High Density Well Graded Strong Particles	Angular Sand	Ottawa Sand
3.4	52	57.2	62.2			4.4	5.4	6.5		
24.1	46.3	51.5	56.5			25.2	30.3	36.4		
41.4	44.7	49.9	54.9		34.1	40.9	49.1	58.9		28
82.7	42.6	47.9	52.9		32.7	76.2	91.4	109.3		53.1
275.8	39.1	44.3	49.3	37.5	30.3	224.1	269.3	321.1	211.6	161.2
482.6	37.4	42.7	47.7	36.2		369.6	445	530.5	353.5	
689.5	36.4	41.6	46.7	35.4		508.3	612.8	730.6	490	
1103.2	35	40.2	45.3	34.3		773	933.8	1114.1	753.2	
4826.3	30.7	35.9	41			2863.4	3494.9	4189.7		
6894.8	29.6	34.9	39.9			3921.7	4802.8	5768.3		

From Leps, T.M. (1970), Review of Shearing Strength of Rockfill, Journal of the Soil Mechanics and Foundations Division, Vol. 96, pp 1159 - 1170.



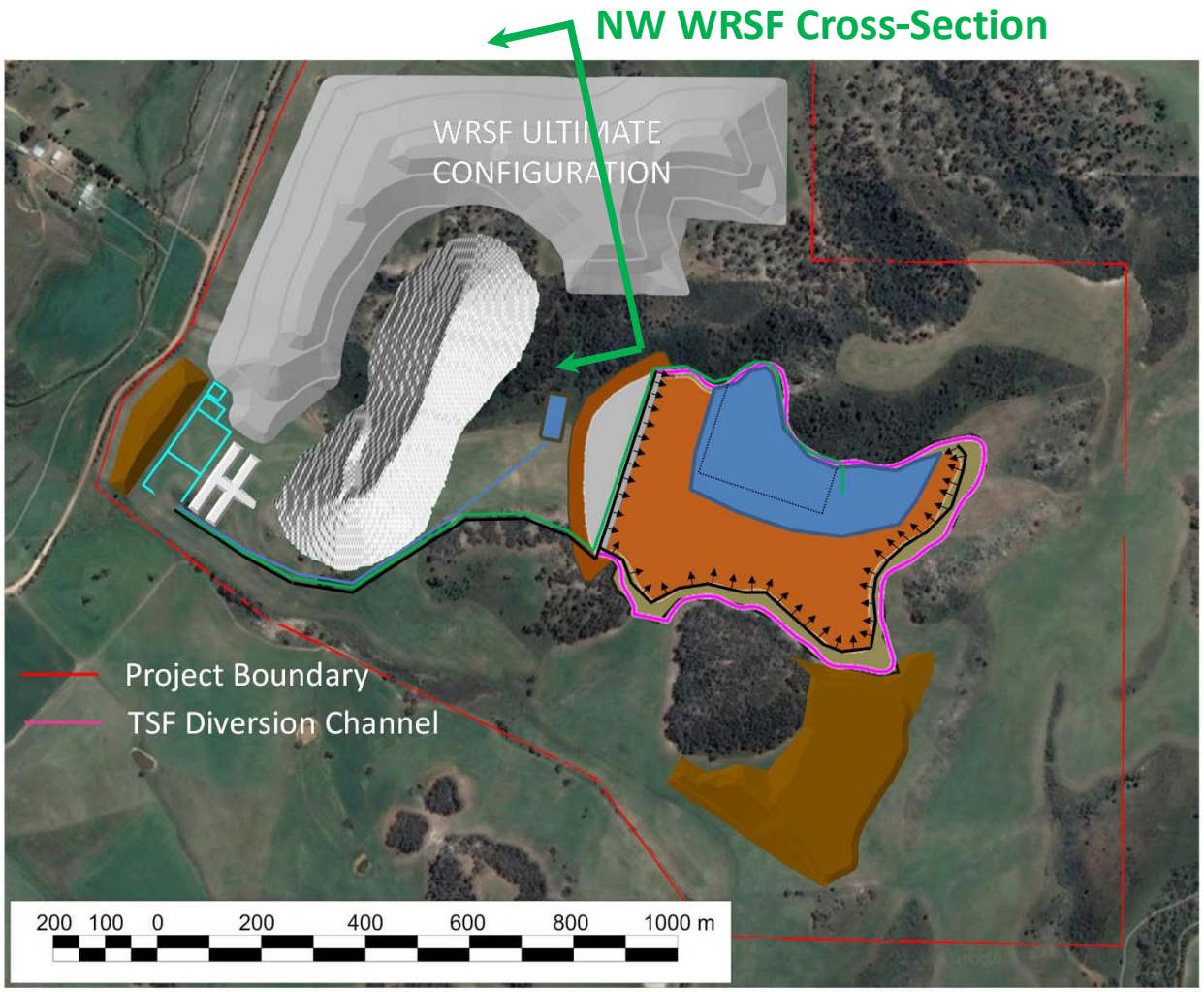


APPENDIX A:
Waste Dumps and Stockpile Design Sheet

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

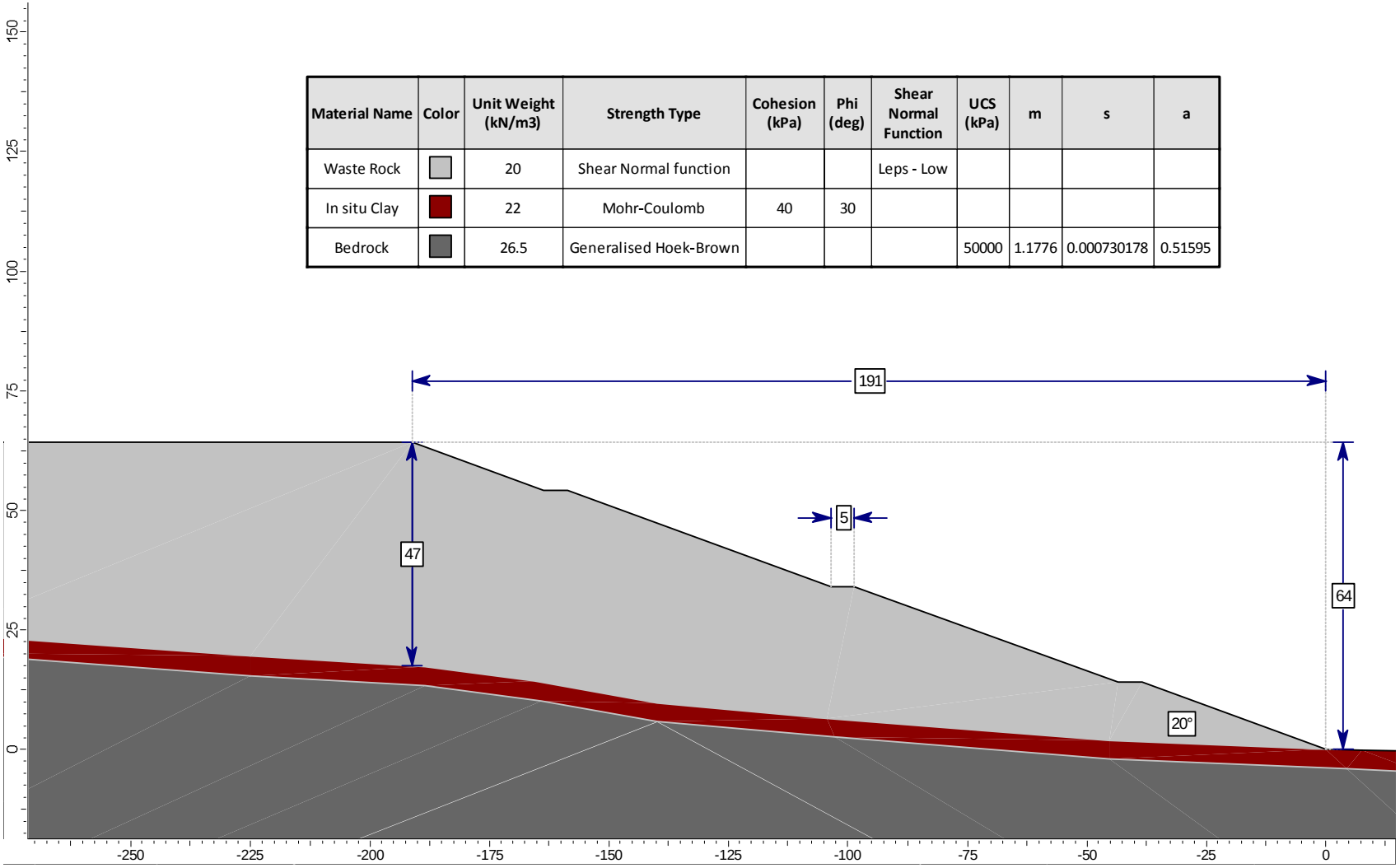
Figure A-1

Appendix B
Waste Rock Storage Facility Stability Assessment



APPENDIX B: **WRSF Cross-Section Locations**	**SCALE**	**DATE**	**Figure B-1**
	na	June-14	
	DRAWING REFERENCE		
	AMC # 814004		

Material Name	Color	Unit Weight (kN/m3)	Strength Type	Cohesion (kPa)	Phi (deg)	Shear Normal Function	UCS (kPa)	m	s	a
Waste Rock		20	Shear Normal function			Leps - Low				
In situ Clay		22	Mohr-Coulomb	40	30					
Bedrock		26.5	Generalised Hoek-Brown				50000	1.1776	0.000730178	0.51595

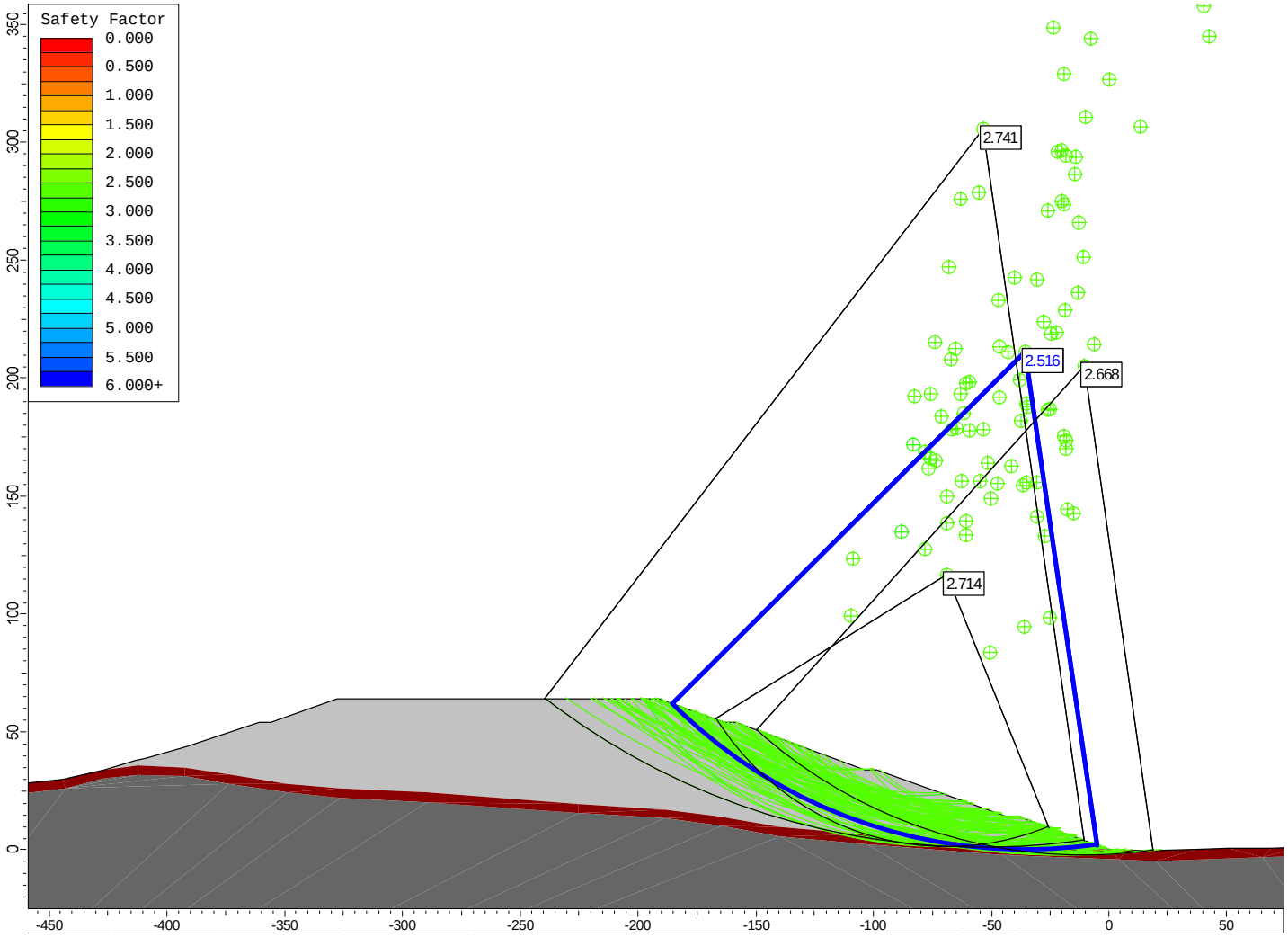


APPENDIX B:
NW WRSF Cross-Section

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

Figure B-2

AMC CONSULTANTS

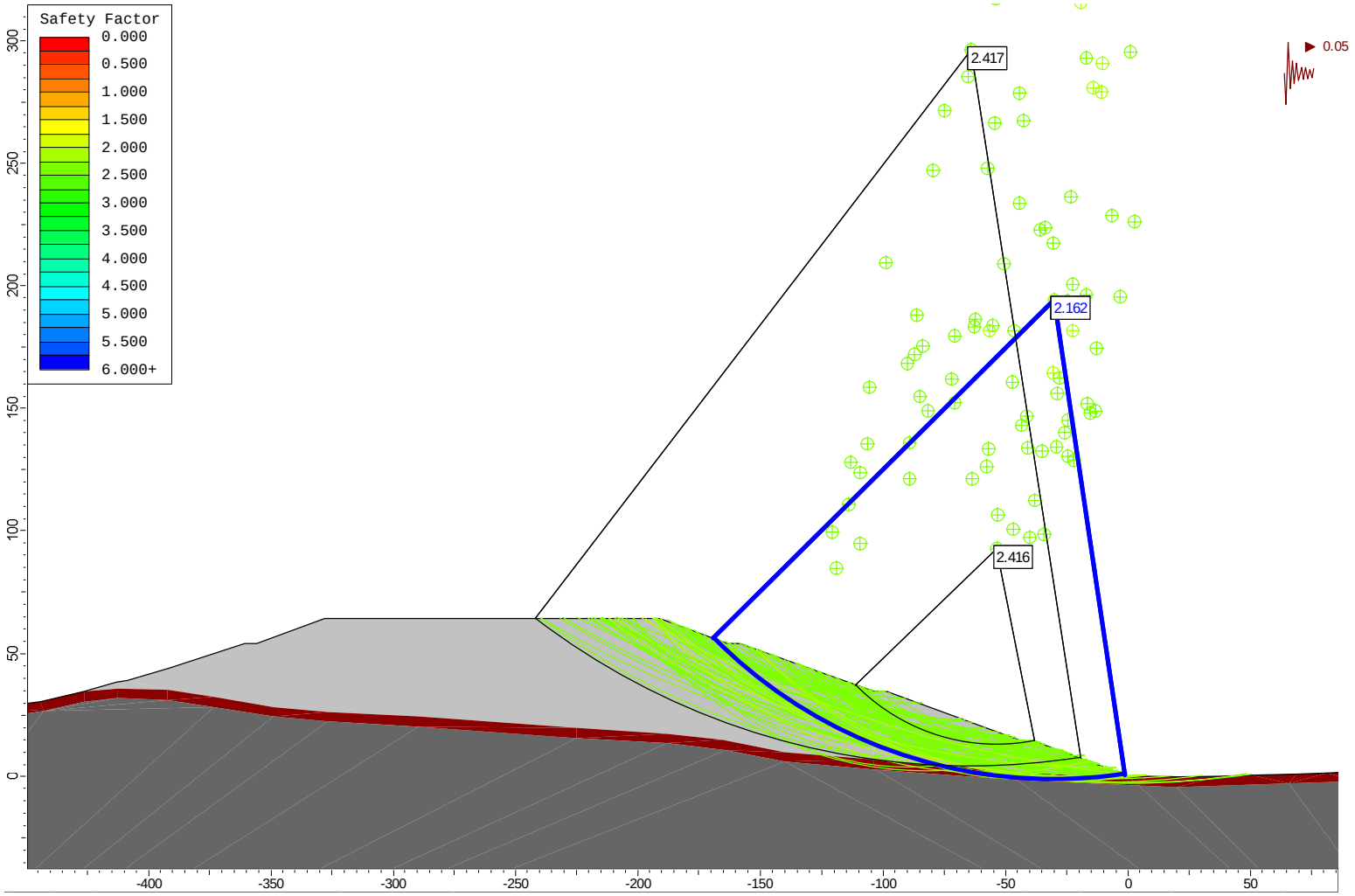


APPENDIX B:
NW WRSF Slide Analysis

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

Figure B-3

AMC CONSULTANTS



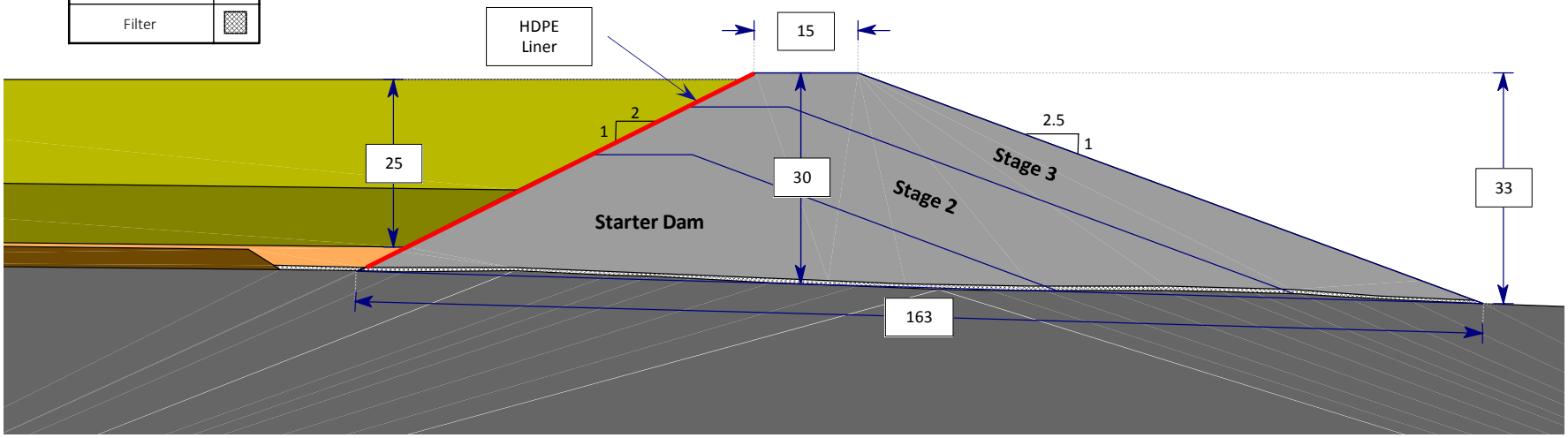
APPENDIX B: **NW WRSF Slide Analysis – Pseudo-Static**	**SCALE** na	**DATE** June-14
	DRAWING REFERENCE AMC # 814004	

Figure B-4

Appendix C
Tailings Storage Facility Seepage Assessment

Material	Permeability (m/sec)
Tailings	1.00E-06
More Consolidated Tailings	1.00E-07
Waste Rock	1.00E-04
HDPE	1.00E-11
Compacted Clay	1.00E-08
Clay	5.00E-08
Weathered Bedrock	3.00E-06
Filter	1.00E-04

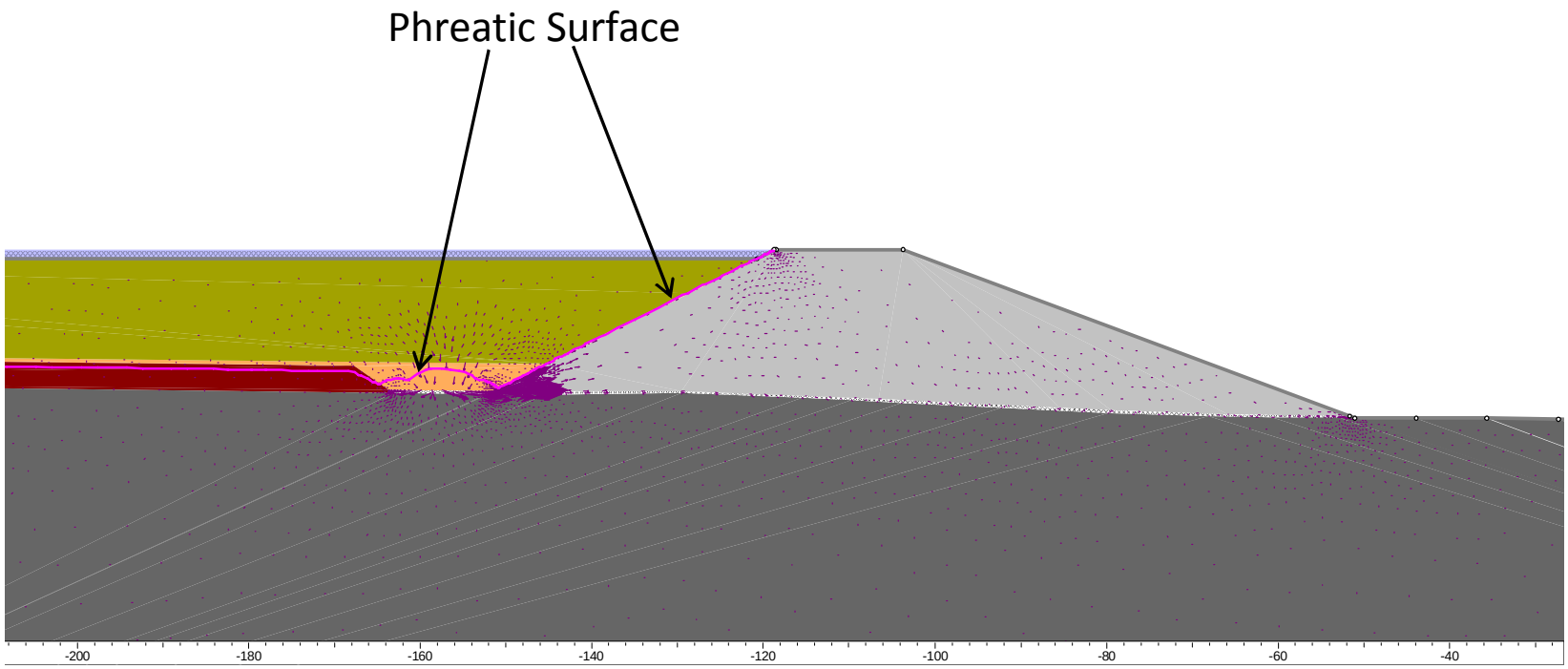
Material Name	Color
Tails	
Waste Rock	
Compact Clay	
In Situ Clay	
Weathered Bedrock	
Consolidated Tails	
Filter	



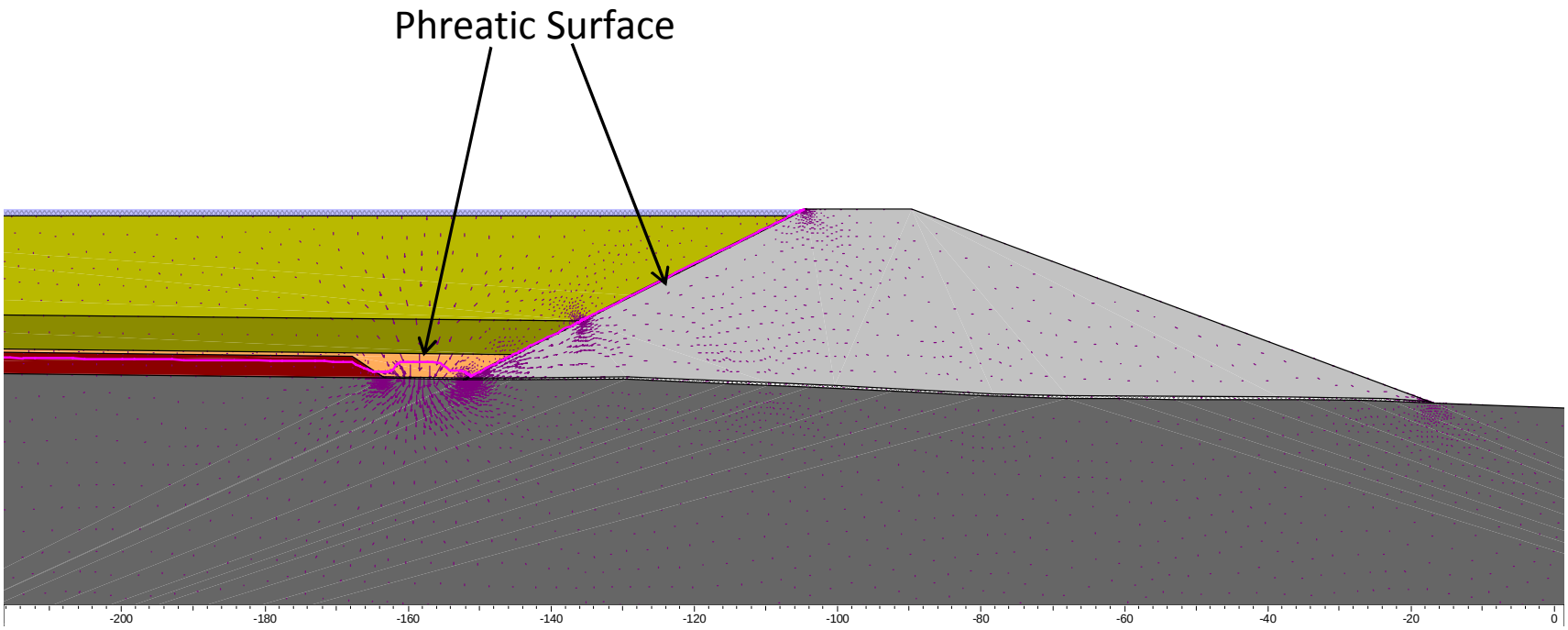
APPENDIX C:
TSF Embankment Cross-Section

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

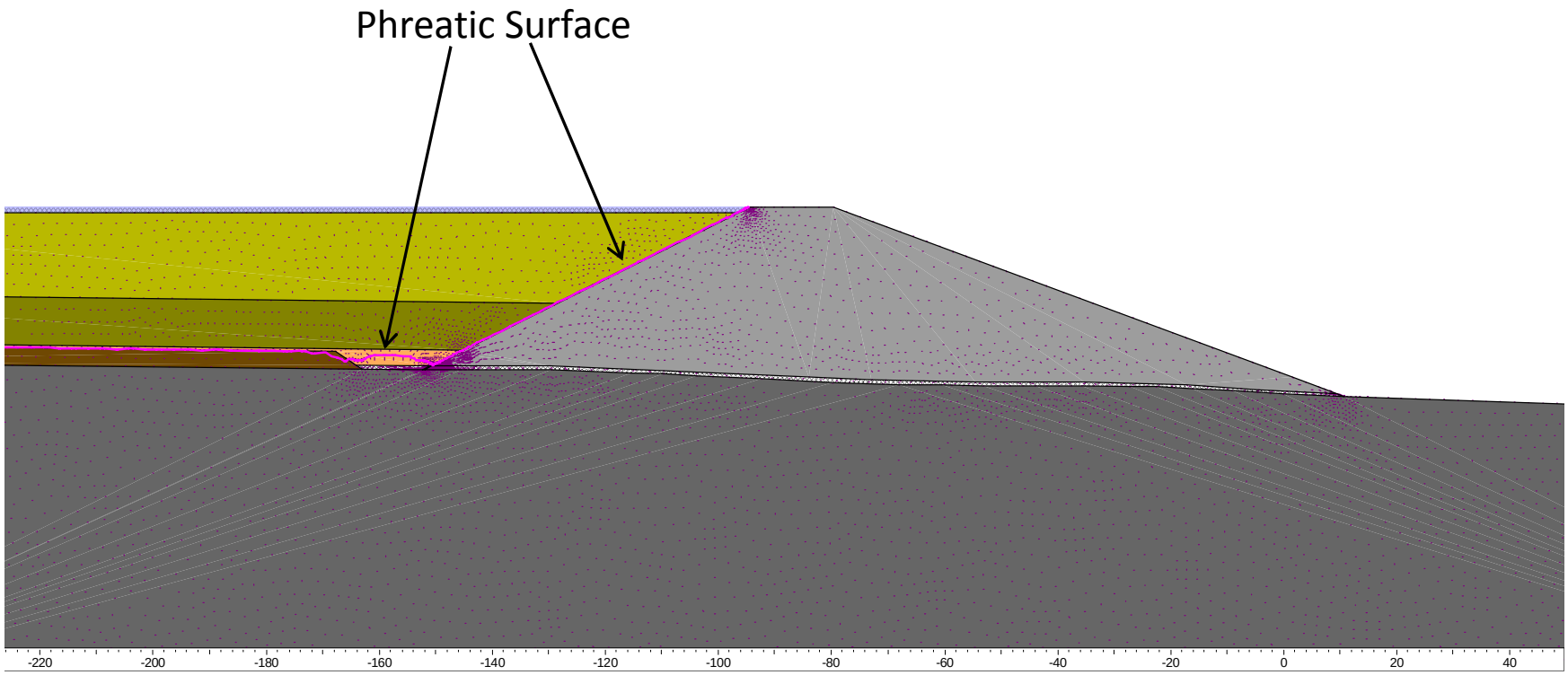
Figure C-1



APPENDIX C: Stage 1 Seepage Model	SCALE	DATE	Figure C-2
	na	June-14	
	DRAWING REFERENCE		
	AMC # 814004		



APPENDIX C: Stage2 Seepage Model	SCALE	DATE	Figure C-3
	na	June-14	
	DRAWING REFERENCE		
	AMC # 814004		



APPENDIX C: **Stage 3 Seepage Model**	**SCALE** na	**DATE** June-14
	DRAWING REFERENCE AMC # 814004	

Figure C-4

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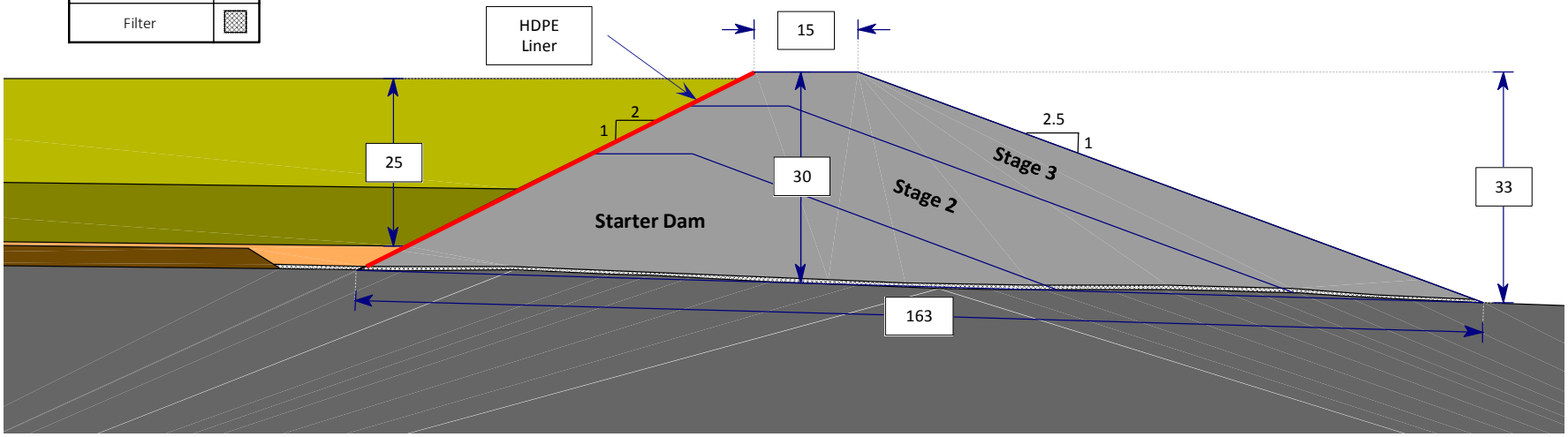
Appendix D
Tailings Storage Facility Stability Assessment

Material Name	Color
Tails	
Waste Rock	
Compact Clay	
In Situ Clay	
Weathered Bedrock	
Consolidated Tails	
Filter	

Material	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (degrees)
Tailings	17	10	7.5
More Consolidated Tailings	19	20	15
Waste Rock	20	Leps Low	
Compacted Clay	22	20	25
Clay	22	20	25
Filter	20	0	35

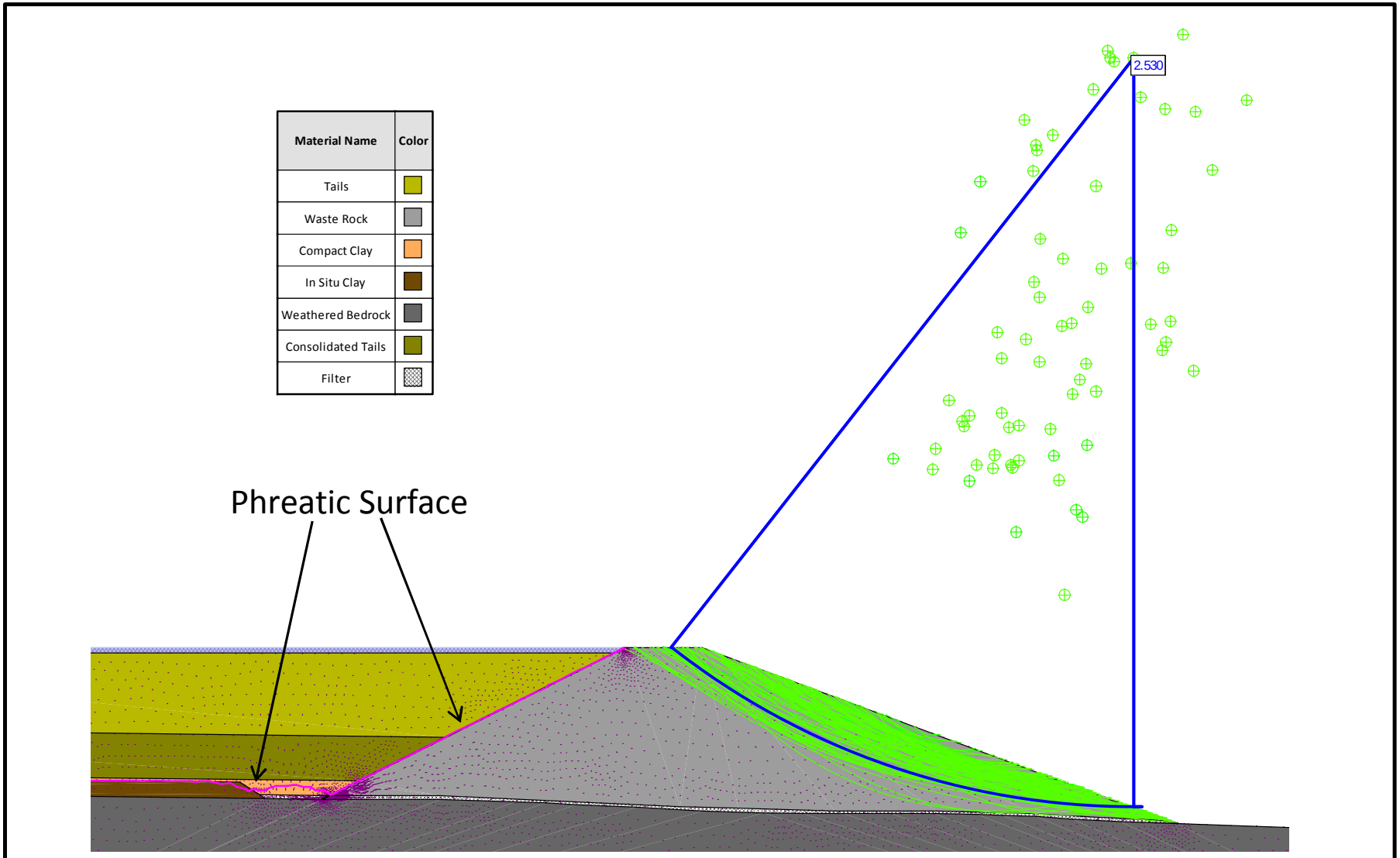
Material	Unit Weight (kN/m^3)	UCS (MPa)	m	s	a	
Weathered Bedrock	26.5	50	1.176	0.0007	0.515	



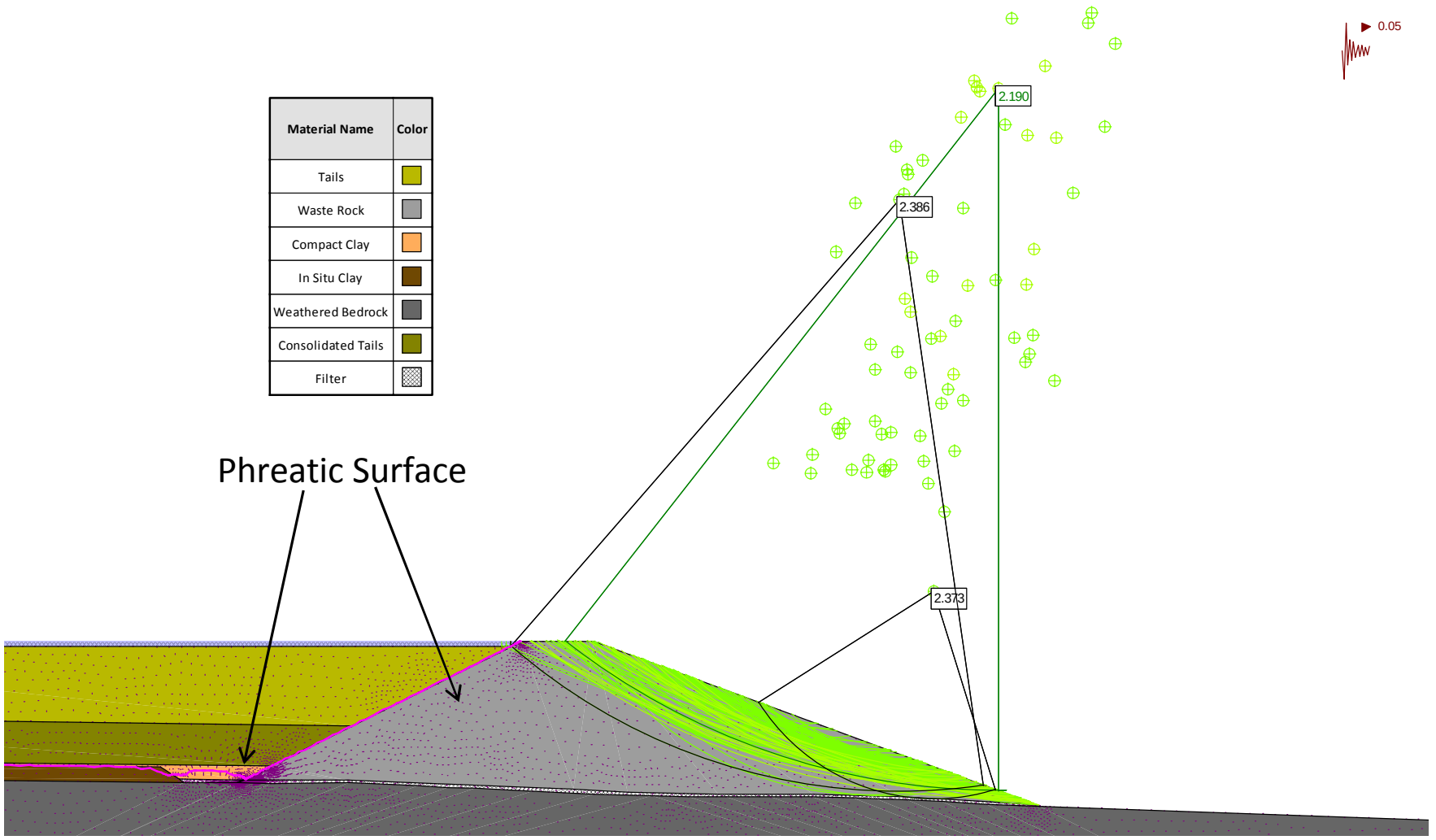
APPENDIX D:
TSF Embankment Cross-Section

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

Figure D-1



APPENDIX D: Steady State Case	**SCALE** na / **DATE** June-14	**Figure D-2**
	DRAWING REFERENCE AMC # 814004	

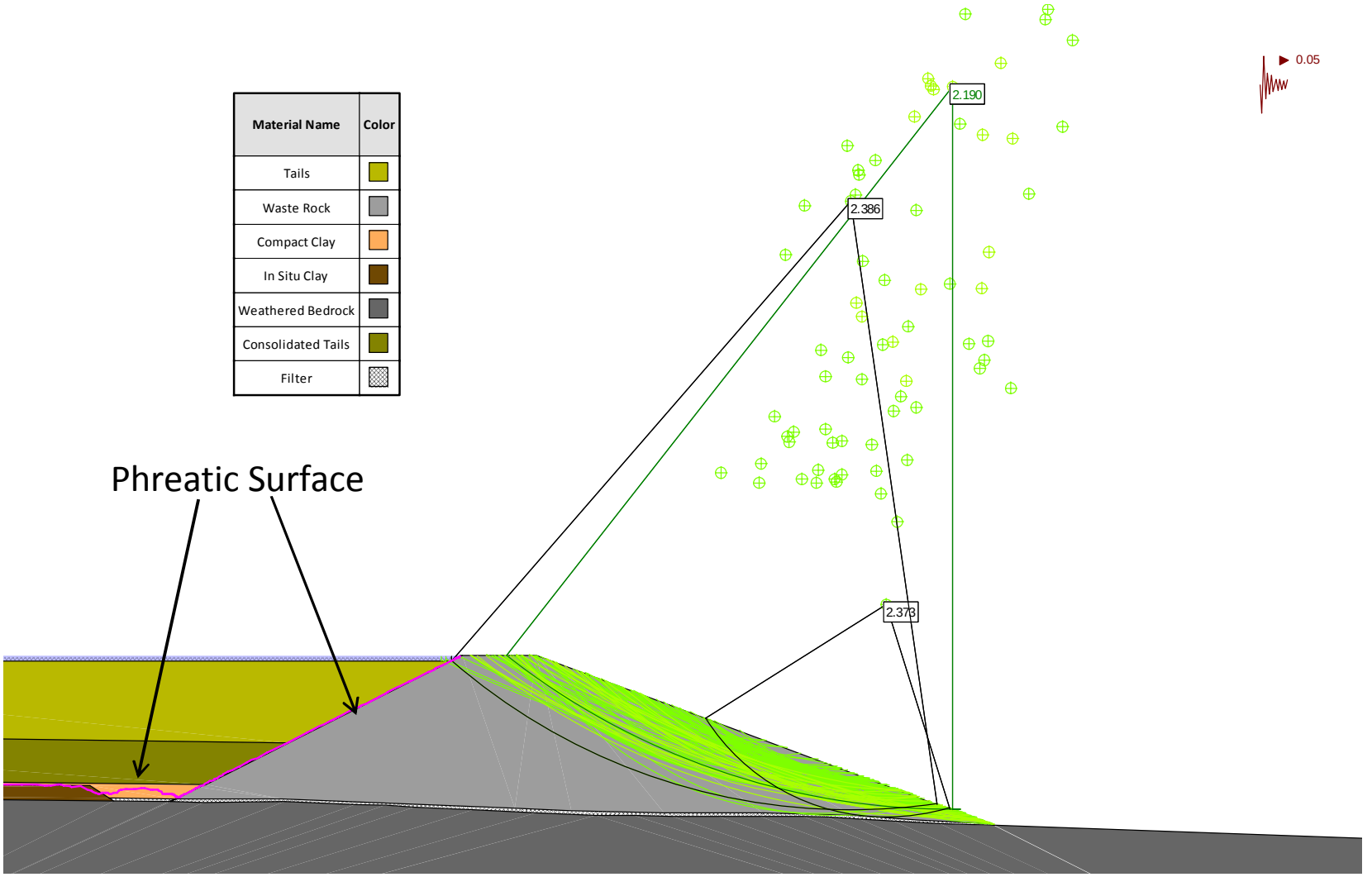


APPENDIX D:
Pseudo-Static with Normal Parameters

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

Figure D-3

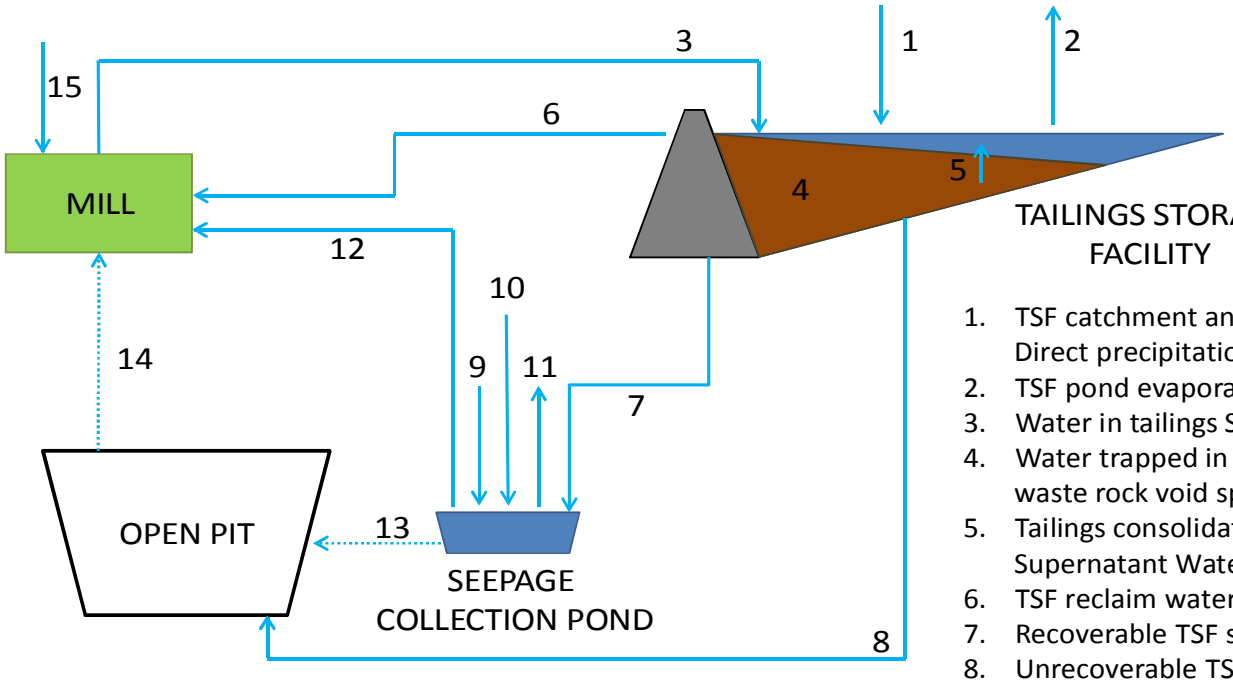
AMC CONSULTANTS



APPENDIX D: **Pseudo-Static with Tailings with no Frictional Strength**	**SCALE** na	**DATE** June-14
	DRAWING REFERENCE AMC # 814004	

Figure D-4

Appendix E
Tailings Storage Facility Preliminary Yearly Water Balance



1. TSF catchment and beach runoff, Direct precipitation into pond
2. TSF pond evaporation
3. Water in tailings Slurry
4. Water trapped in tailings and PAF waste rock void spaces
5. Tailings consolidation seepage – Supernatant Water
6. TSF reclaim water
7. Recoverable TSF seepage to SCP
8. Unrecoverable TSF seepage to open pit
9. SCP catchment runoff and direct precipitation
10. Diverted TSF catchment water to SCP
11. SCP pond evaporation
12. SCP reclaim to Mill
13. Unrecoverable SCP seepage to pit
14. Open Pit water to mill
15. Makeup water to mill for tailings slurry

APPENDIX E:
TSF Water Balance Schematic

SCALE	DATE
na	June - 14
DRAWING REFERENCE	
AMC # 814004	

Figure E-1

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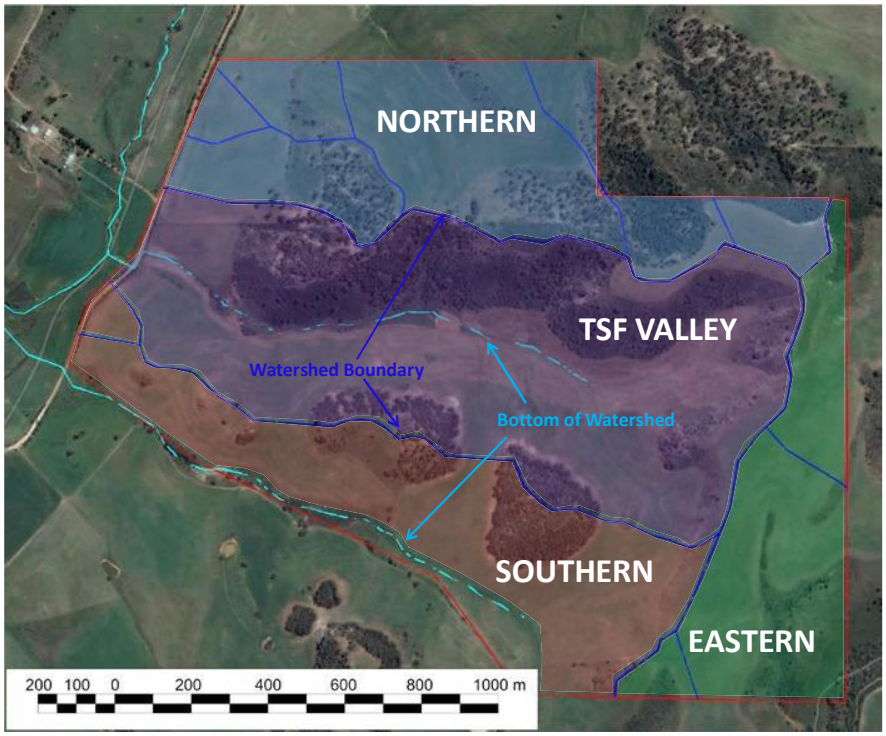
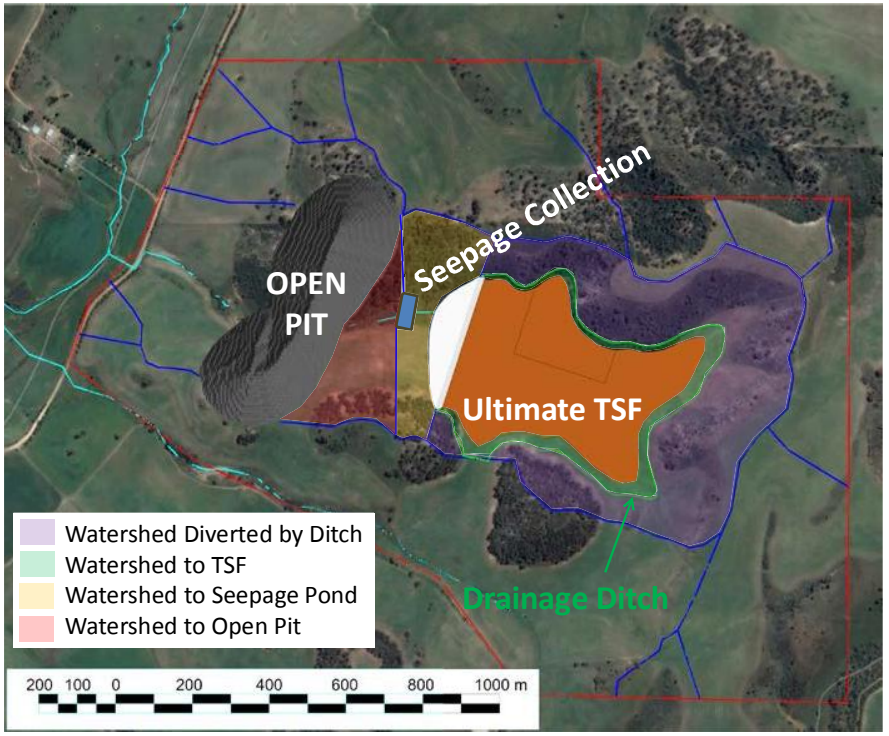
PRE-CONSTRUCTION



POST-CONSTRUCTION



APPENDIX E: **Pre and Post Construction Watersheds**	**SCALE** / na **DATE** / June-14 **DRAWING REFERENCE** **AMC # 814004**	**Figure E-2**

TSF diverted WS Area (m^2)	304,488
TSF Undiverted WS Area (m^2)	248,662
Runoff coefficient for land	0.4
Runoff coefficient for tailings beach	0.7
SCP WS area (m^2)	117600
SCP Area (m^2)	3500

YEAR	1	2	3	4	5	6	7	7.5
Avg. Eff. Rainfall for water bodies (mm)	69	69	69	69	69	69	69	35
Avg. Eff. Rainfall for all else (mm)	184	184	184	184	184	184	184	92
Percent supernatant water left in TSF	33%	33%	33%	33%	33%	33%	33%	33%

	Tailings Storage Facility								
	Beach and SN pond area (m^2)	35,000	60,000	85,000	105,000	140,000	170,000	185,000	190,000
	Inputs	m^3	m^3	m^3	m^3	m^3	m^3	m^3	m^3
	Water in Pond	0	1,652	9,902	18,152	8,294	19,844	33,977	38,927
1a	Pond Percipitation	797	1,366	1,935	2,391	3,188	3,871	4,212	2,163
1b	TSF WS Percipitation	15,726	13,886	12,046	10,574	7,998	5,790	4,686	2,159
1c	Beach Percipitation	3,020	5,178	7,335	9,061	12,081	14,670	15,965	8,198
3	Tailings Slurry Water From Mill	240,526	255,263	250,526	245,263	255,263	255,263	250,526	48,947
4	Trapped water	80,526	85,263	80,526	85,263	85,263	85,263	80,526	18,947
5	Supernatant water	160,000	170,000	170,000	160,000	170,000	170,000	170,000	30,000
	TOTAL	***179,543***	***192,081***	***201,218***	***200,177***	***201,561***	***214,175***	***228,840***	***81,447***
	Outputs								
6	TSF reclaim To Mill	167,993	172,281	173,168	165,527	155,361	158,075	167,790	18,747
7	Dam Seepage	2,593	2,593	2,593	4,152	4,152	6,796	6,796	6,796
	TSF Basin Seepage to Pit	7,305	7,305	7,305	22,204	22,204	15,327	15,327	15,327
	Total	**177,891**	**182,179**	**183,066**	**191,883**	**181,717**	**180,198**	**189,913**	**40,870**
	Water Left In Pond	**1,652**	**9,902**	**18,152**	**8,294**	**19,844**	**33,977**	**38,927**	**40,577**

	Seepage Collection Pond								
	Inputs								
7	Dam Seepage	2,593	2,593	2,593	4,152	4,152	6,796	6,796	6,796
8	TSF diverted Runoff	15,687	15,687	15,687	15,687	15,687	15,687	15,687	7,844
9a	SCP Percipitation	80	80	80	80	80	80	80	40
9b	SCP WS Percipitation	3,149	3,149	3,149	3,149	3,149	3,149	3,149	1,575
	Outputs								
10	SCP water to Mill	21,509	21,509	21,509	23,068	23,068	25,712	25,712	16,254

	Mill								
13	Makeup Water Required By Mill	51,024	61,472	55,849	56,668	76,834	71,476	57,024	13,946

APPENDIX E:
Preliminary Water Balance for the TSF

SCALE	DATE
na	June-14
DRAWING REFERENCE	
AMC # 814004	

Figure E-3

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Report

Kookaburra Gully TSF and Waste Dump Design Addendum 1

Lincoln Minerals Limited

AMC Project 814004 Addendum 1
12 September 2014

12 September 2014

Dr John Parker
Managing Director
Lincoln Minerals Limited
28 Greenhill Road
WAYVILLE SA 5034
AUSTRALIA

Kookaburra Gully TSF and Waste Dump Design – Addendum 1

Dear John

As requested by Lincoln Minerals Limited (LML), AMC Consultants Pty Ltd (AMC) estimated the available capacity at an alternative location for the waste rock storage facility (WRSF) for Kookaburra Gully. Please note that this report is intended as an addendum to AMC report 814004, and must be read with that report.

Yours sincerely

Johann van Wijk
Principal Geotechnical Engineer

Quality control

The signing of this statement confirms this report has been prepared and checked in accordance with the AMC Peer Review Process. AMC's Peer Review Policy can be viewed at www.amcconsultants.com.

Project Manager

Johann van Wijk	**12 September 2014**

Peer Reviewer

Barnes Fallaw	**12 September 2014**

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Contents

1 Introduction 4
2 Scenario 1 5
3 Scenario 2 7
4 Slope Stability Analysis 9
5 Summary 11

Tables

Table 2.1 North-west WRSF V3 volume 5
Table 2.2 South WRSF V1b volume 6
Table 2.3 Cumulative topsoil and subsoil schedule 6
Table 3.1 North-west WRSF V3 volume 7
Table 3.2 South WRSF V2 volume 8
Table 4.1 Results of stability analysis 9

Figures

Figure 1.1 Map from LML indicating the approximate position of the alternative WRSF 4
Figure 2.1 Alternative WRSF with final slope angle <20° 5
Figure 3.1 Alternative WRSF with final slope angle <15° 7
Figure 4.1 Positions of cross sections for stability analyses 9
Figure 4.2 Schematic representations of cross sections used for stability analyses 10

Distribution list

1 e-copy to Dr John Parker, Lincoln Minerals
1 e-copy to AMC Adelaide office

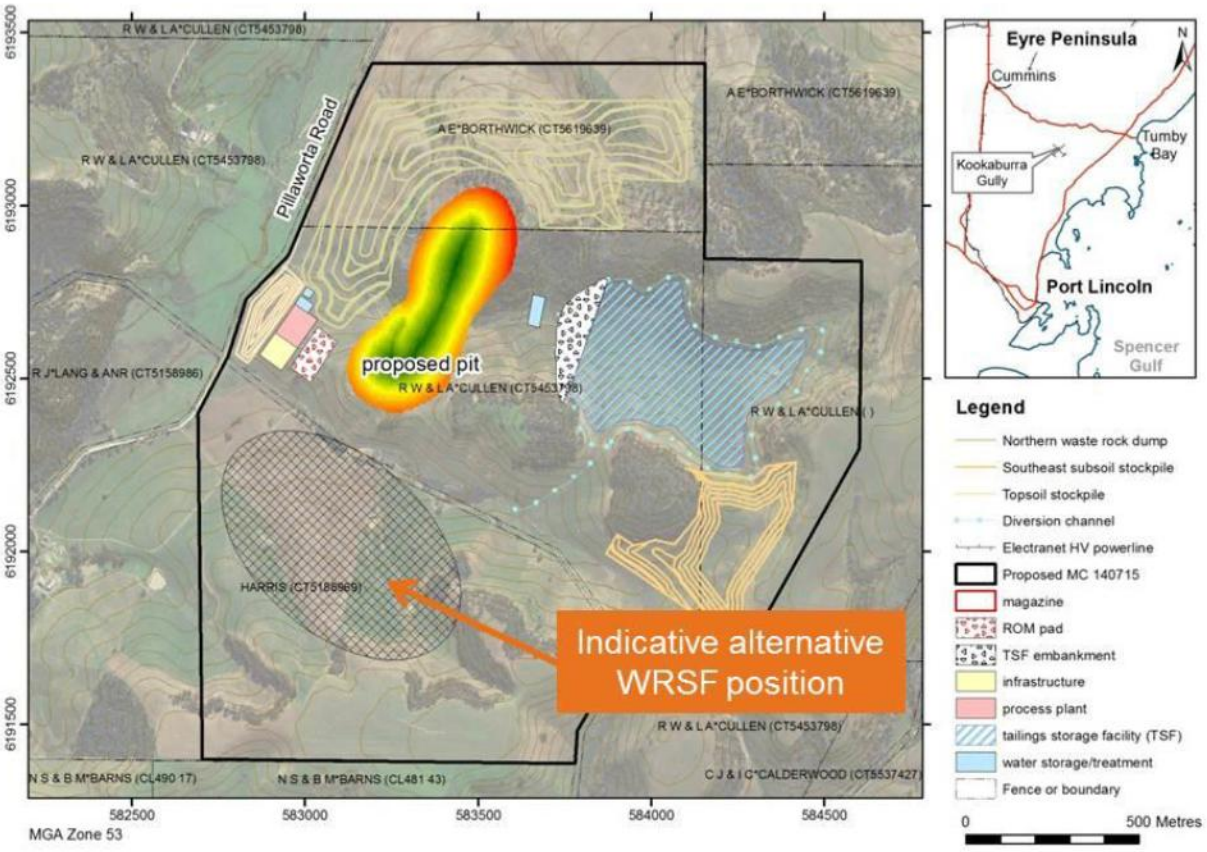
1 Introduction

Lincoln Minerals Limited (LML) requested AMC Consultants Pty Ltd (AMC) to determine the capacity of an alternative site for a waste rock storage facility (WRSF) at Kookaburra Gully to the one proposed in the AMC report 814004 (AMC, 2014). The alternative WRSF would still use a small area in the north-west of the project area, but the majority of the WRSF would be situated to the south of the project area.

LML further requested that AMC evaluates two scenarios for the alternative WRSF, namely one where the final angle of the main WRSF slopes is not greater than 20° and the other where the final slope angle is not greater than 15°.

Figure 1.1 shows a map provided by LML indicating the approximate position for the alternative WRSF.

Figure 1.1 Map from LML indicating the approximate position of the alternative WRSF



2 Scenario 1

For this scenario, the design was aimed at ensuring that the final slope angle does not exceed 20°. In addition, AMC placed the WRSF such that it minimises the impact on arable land and avoids encroachment on streams and natural vegetation.

The combined capacity of the WRSFs shown in Figure 2.1, i.e. the smaller facility in the north-west and the main facility in the south, is 18.18 Mt. Compared to the estimated required capacity of 14.12 Mt (AMC, 2014) this scenario provides for approximately 29% surplus capacity. A breakdown of the capacity of each WRSF, in 10 m intervals, is shown in Table 2.1 and Table 2.2. The final slope angle for this design is 18°.

The updated topsoil and subsoil schedules, using the new north-west and south WRSF designs are shown in Table 2.3.

Figure 2.1 Alternative WRSF with final slope angle <20°

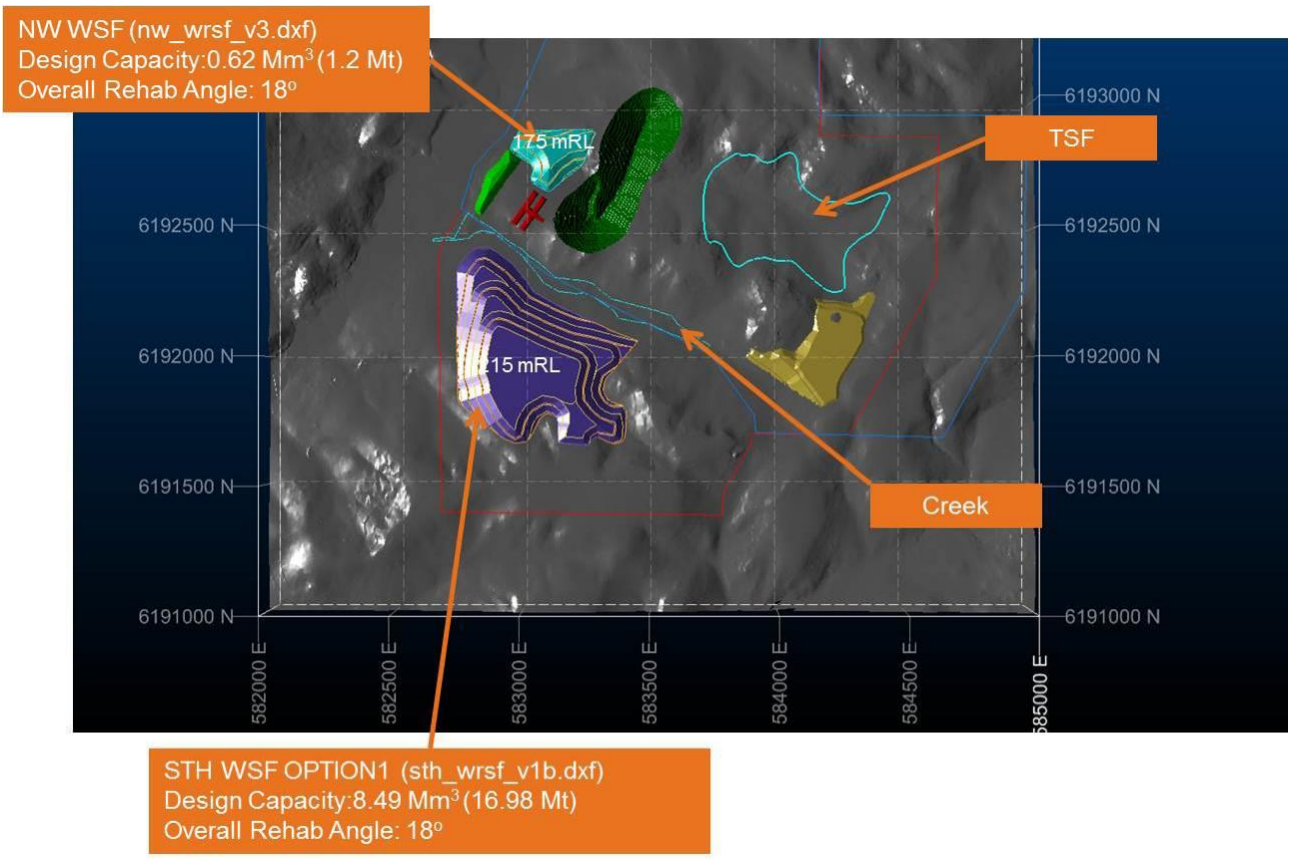


Table 2.1 North-west WRSF V3 volume

From (mRL)	To (mRL)	Volume (m³)	Tonnes	Cumulative Volume (m³)	Cumulative Tonnes
145	155	140,639	281,278	140,639	281,278
155	165	297,736	595,473	438,376	876,751
165	175	180,790	361,580	619,165	1,238,331
Total		619,165	1,238,331		

Table 2.2 South WRSF V1b volume

From (mRL)	To (mRL)	Volume (m³)	Tonnes	Cumulative Volume (m³)	Cumulative Tonnes
145	155	73,188	146,375	73,188	146,375
155	165	488,447	976,893	561,634	1,123,269
165	175	1,124,964	2,249,928	1,686,598	3,373,196
175	185	1,836,268	3,672,535	3,522,866	7,045,732
185	195	2,024,542	4,049,083	5,547,408	11,094,815
195	205	1,737,348	3,474,696	7,284,756	14,569,511
205	215	1,207,736	2,415,473	8,492,492	16,984,984
Total	-	8,492,492	16,984,984	-	-

Table 2.3 Cumulative topsoil and subsoil schedule

		Pit Footprint			WRSF Footprint			TSF		Total	
Pit	Year	Area	Topsoi (m³)	Subsoil (m³)	Area	Topsoil (m³)	Subsoil (m³)	Topsoil (m³)	Subsoil (m³)	Topsoil (m³)	Subsoil (m³)
4	0.41	12,085	3,142	12,568	53,097	13,805	55,221	75,500	300,000	92,447	367,789
6	1.34	28,719	7,467	29,868	53,097	13,805	55,221	75,500	300,000	96,772	385,089
10	2.42	52,024	13,526	54,105	157,773	41,021	164,084	75,500	300,000	130,047	518,189
14	3.61	76,719	19,947	79,788	262,450	68,237	272,948	75,500	300,000	163,684	652,736
17	4.61	98,524	25,616	102,465	351,333	91,347	365,386	75,500	300,000	192,463	767,851
24	5.91	129,282	33,613	134,453	400,388	104,101	416,403	75,500	300,000	213,214	850,856
28	6.31	138,552	36,023	144,094	400,388	104,101	416,403	75,500	300,000	215,624	860,497
39	7.19	163,658	42,551	170,205	413,804	107,589	430,356	75,500	300,000	225,640	900,561

3 Scenario 2

To evaluate the scenario if the final slope angle does not exceed 15°, the conceptual design illustrated in Figure 3.1 is proposed. In this case, the total capacity of the WRSF is 14.57 Mt, or 3% more than required. A breakdown of the capacity of each WRSF, in 10 m intervals, is shown in Table 3.1 and Table 3.2. There is also a substantial area in the south of the property that has not been used, and may be available should it be required.

As the footprint of the WRSF is the same as the 20º case, there are no significant changes in the topsoil and subsoil schedule.

Figure 3.1 Alternative WRSF with final slope angle <15°

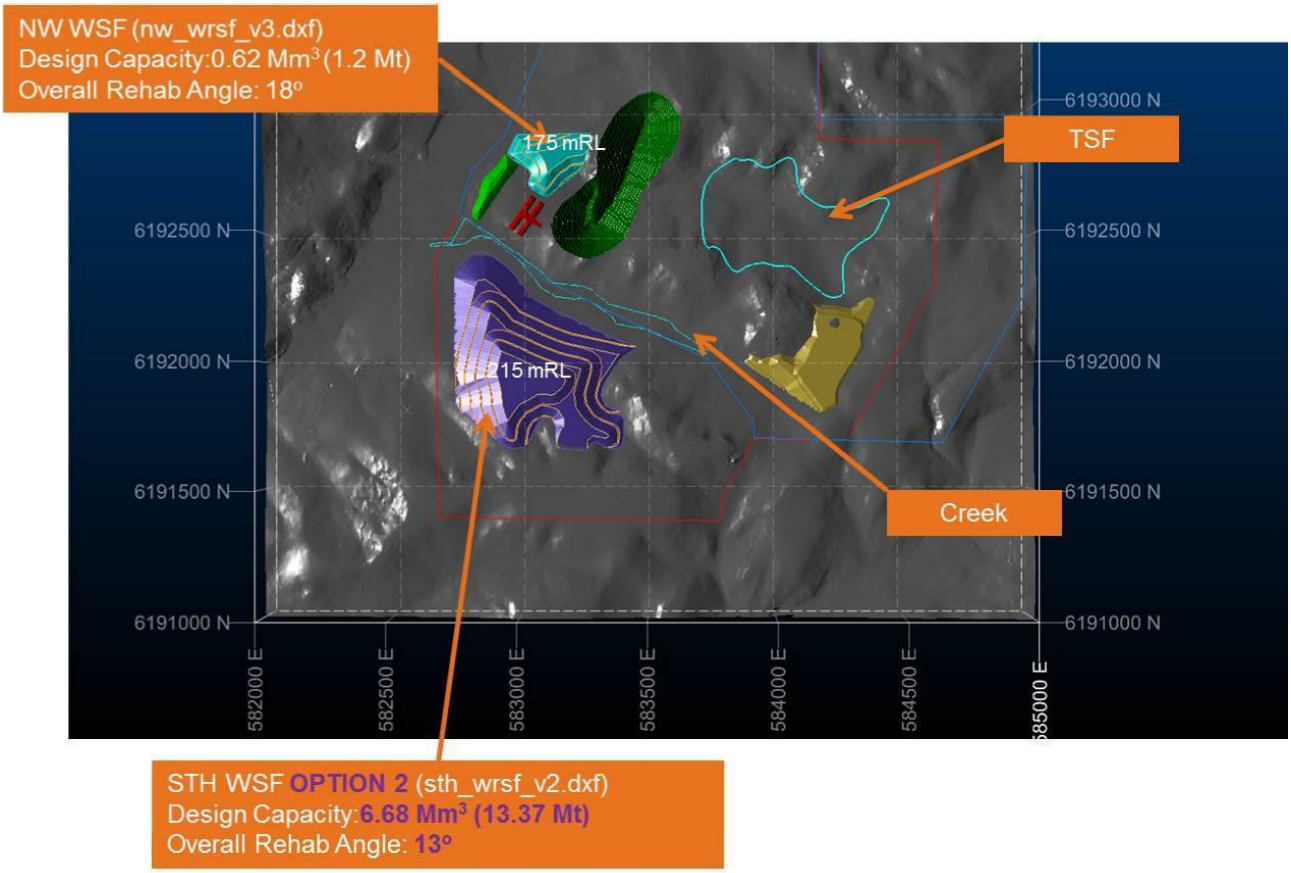


Table 3.1 North-west WRSF V3 volume

From (mRL)	To (mRL)	Volume (m³)	Tonnes	Cumulative Volume (m³)	Cumulative Tonnes
145	155	140,639	281,278	140,639	281,278
155	165	297,736	595,473	438,376	876,751
165	175	180,790	361,580	619,165	1,238,331
Total	-	619,165	1,238,331	-	-

Table 3.2 South WRSF V2 volume

From (mRL)	To (mRL)	Volume (m^3)	Tonnes	Cumulative Volume (m^3)	Cumulative Tonnes
145	155	67,910	135,821	67,910	135,821
155	165	444,065	888,129	511,975	1,023,950
165	175	1,050,966	2,101,932	1,562,941	3,125,883
175	185	1,623,994	3,247,989	3,186,936	6,373,871
185	195	1,672,442	3,344,884	4,859,378	9,718,755
195	205	1,282,933	2,565,866	6,142,311	12,284,622
205	215	541,967	1,083,935	6,684,278	13,368,557
Total	-	6,684,278	13,368,557	-	-

4 Slope Stability Analysis

Slope stability analyses were completed for the alternative WRSF in the south of the property. The analyses were completed for two cross sections, as shown in Figure 4.1. Schematic representations of the cross sections modelled are shown in Figure 4.2. A slope angle of 20° was modelled for both cross sections. The analyses were completed for steady state and pseudo-static loading conditions, and the results are shown in Table 4.1. The results show that the factors of safety for the proposed final dump design exceed the minimum requirements.

Table 4.1 Results of stability analysis

Location	Case	Required FOS	Computed FOS	Passed
Section A	Steady State	1.5	2.61	Yes
	Pseudo-Static	1.3	2.23	Yes
Section B	Steady State	1.5	2.56	Yes
	Pseudo-Static	1.3	2.18	Yes

Figure 4.1 Positions of cross sections for stability analyses

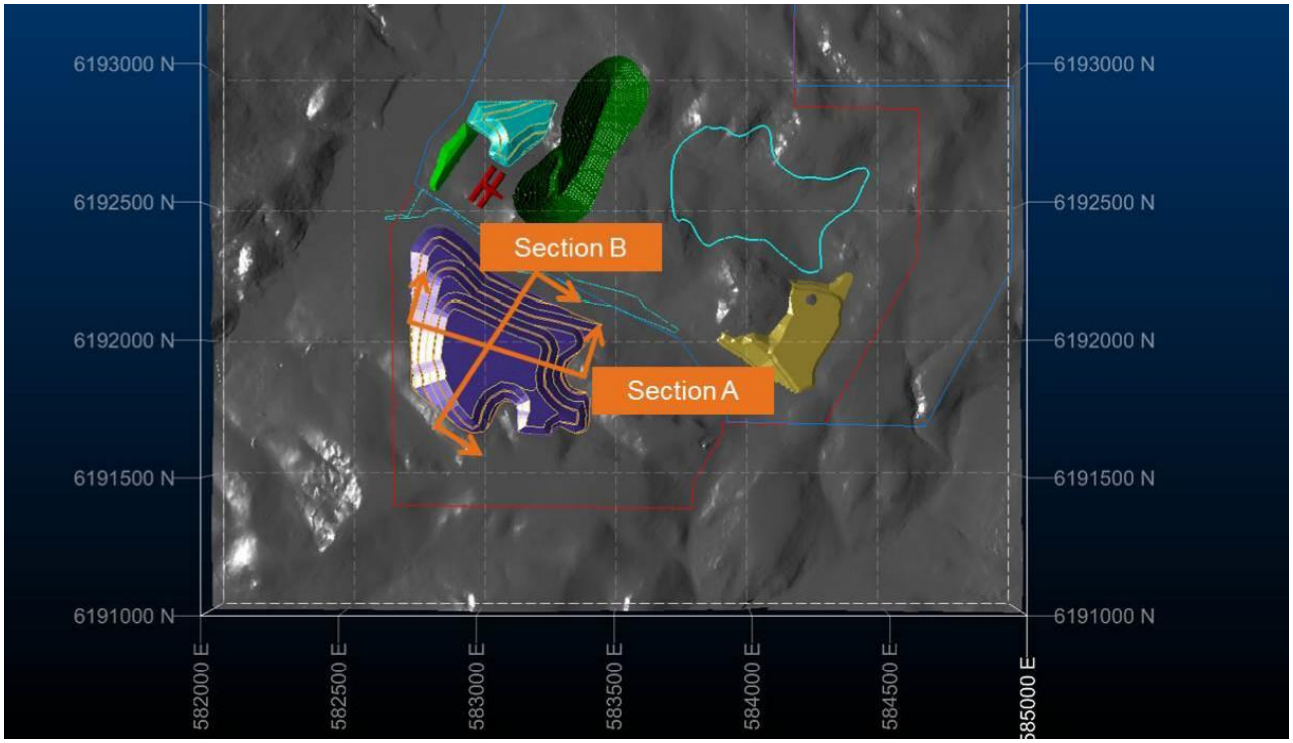
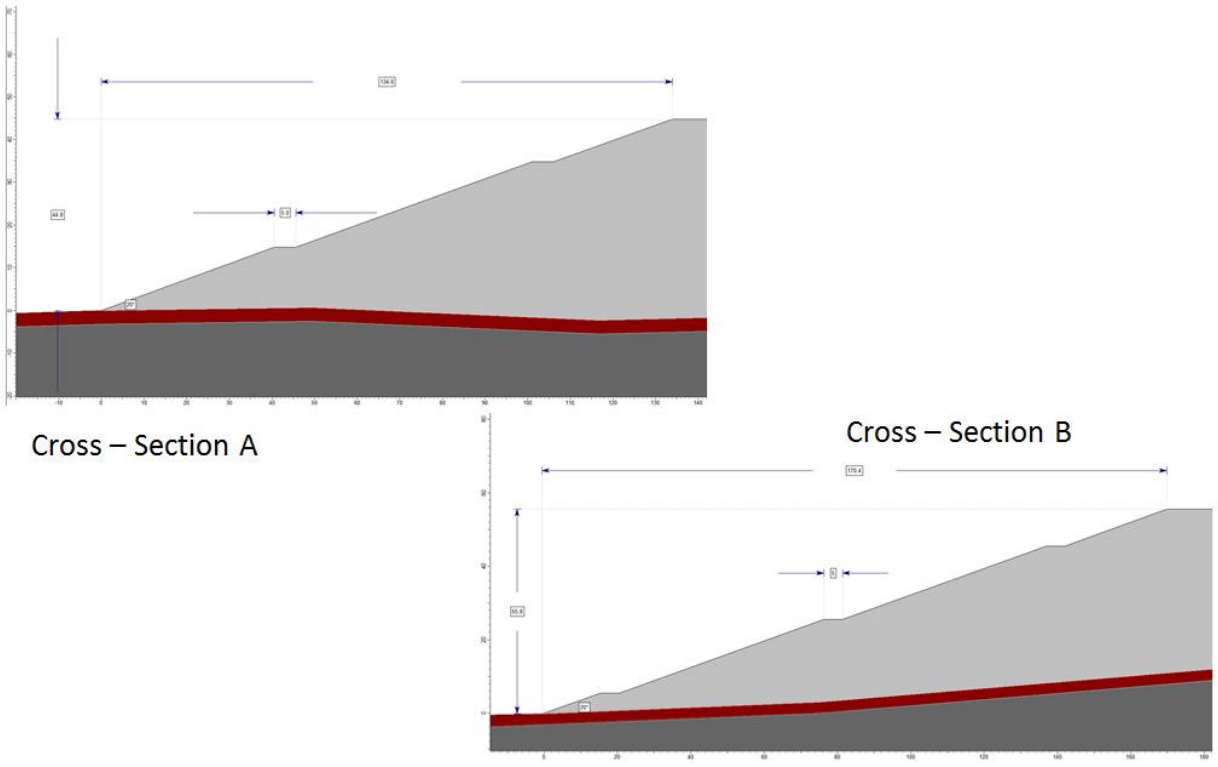


Figure 4.2 Schematic representations of cross sections used for stability analyses



5 Summary

Analysis of the alternative WRSF position in the south of the property indicated that there is sufficient capacity in this area to meet the life-of-mine waste rock dumping requirements, when combined with a small WRSF in the north-west of the property.

The stability analysis of the alternative WRSF indicates that the proposed final WRSF design is stable under static and pseudo-static loading conditions.

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Appendix I

Acid rock drainage

Lincoln Minerals Pty Ltd

Kookaburra Gully Graphite Project

Initial Acid Rock Drainage Assessment

8 October 2014

PARSONS BRINCKERHOFF

Document information

Client: Lincoln Minerals Pty Ltd
Title: Kookaburra Gully Graphite Project
Subtitle: Initial Acid Rock Drainage Assessment
Document No: 14-0280-00-2200002A
Date: 8 October 2014

Rev	Date	Details
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Author, Reviewer and Approver details

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Distribution

Lincoln Minerals Pty Ltd, Parsons Brinckerhoff file

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Contents

Page number

Executive summary iii

1. Background 1

1.1 The Kookaburra Gully Graphite project 1
1.2 Acid rock drainage issues 1
1.3 Geology of the Kookaburra Gully Graphite project 1

2. Objectives and methodology 3

2.1 Acid rock drainage potential 3

3. Investigation guidelines 5

3.1 Acid rock drainage potential 5
3.2 GAI 6
3.3 Salinity 6

4. Acid rock drainage potential 7

4.1 ARD testing results 7
4.2 Quality assurance 13

5. Discussion 15

5.1 Summary 15
5.2 Distribution of ARD material 15

6. Recommendations 19

7. References 20

List of tables

Page number

Table 2.1 Rock samples chosen for ARD testing 4
Table 3.1 Acid forming potential classification criteria 6
Table 3.2 Salinity ranking based on EC_{sat} 6
Table 4.1 Acid forming potential screening test results 8
Table 4.2 Summary classification of acid forming potential 10
Table 4.3 GAI values for rock samples 12
Table 4.4 RPD calculations 14

List of figures

Page number

Figure 1.1	Regional geology based on Lincoln 1:250,000 geological map and aeromagnetic image	2
Figure 2.1	Locations of ARD samples	3
Figure 4.1	Acid-base account plot for rock samples	11
Figure 4.2	Geochemical classification by rock type	11
Figure 5.1	Distribution of rocks with S > 0.3% – Section 1	16
Figure 5.2	Distribution of rocks with S > 0.3% – Section 2	16
Figure 5.3	Distribution of rocks with S > 0.3% – Section 3	17
Figure 5.4	Distribution of rocks with S > 0.3% – Section 6	17
Figure 5.5	Distribution of rocks with S > 0.3% – Section 9	18

List of appendices

Appendix A	Laboratory results

Executive summary

Parsons Brinckerhoff was engaged to undertake an initial acid rock drainage (ARD) assessment of the Kookaburra Gully Graphite located 35 km north of Port Lincoln on Eyre Peninsula in South Australia.

The study examined the geochemical characteristics 26 selected samples of overburden waste rock, low grade ore and high grade ore and three samples of tailings.

Study findings

Sixteen of the rock samples were classified as NAF (including biotite gneiss, schist, biotite schist and all samples of high grade ore) indicating that ARD was unlikely to occur.

Three rock samples were classified as PAF and comprised biotite schist, schist with a trace of pyrite and highly weathered low grade graphite schist ore.

Two rock samples were classified as low capacity PAF and comprised graphite schist (low grade ore) and quartz vein in schist with trace graphite. As the quartz vein would not comprise a significant volume of the total rock mass it is unlikely that this material would significantly acid forming.

Three rock samples were classified as uncertain due to conflicting NAGpH and NAPP results. Further examination of the results indicates that the high grade graphitic schist ore has a low sulphide S content of 0.08% and a low NAPP of 0.9 and on that basis is unlikely to be acid forming. Similarly the sample of biotite gneiss has a low sulphide S content of 0.12% and a low NAPP of 0.6 and on that basis is unlikely to be acid forming. Another sample of biotite gneiss has a sulphide S content of 0.5% and a NAPP of 9.6 and on that basis is likely to be acid forming.

On the basis of the analytical program the dolomitic marble was also classified as low capacity PAF. However the sample has a low sulphide content of 0.17% suggesting that the potential for acid generation is unlikely.

The three tailings samples were classified as NAF. The tailings samples were analysed for total petroleum hydrocarbons and Total Recoverable Hydrocarbons with the results all being below the laboratory detection levels and are below NEPM sensitive landuse acceptance levels.

The testing program indicates that for the majority of samples the total sulphur S% and sulphide S% are essentially equivalent, indicating that any sulphur present in the samples is in the sulphide form. This would provide a good diagnostic tool for the management and scheduling of waste rock storage. The PAF material has sulphide S averaging 1.11%, the low capacity PAF material has sulphide S averaging 0.38% and the low capacity NAF material has sulphide S generally less than 0.01%.

Assessment of the results of kinetic testing since the late 1980's of samples of diverse mineralogy by Dr Graeme Campbell suggests that if sulphide S is less than 0.3% the material is unlikely to acidify. However there is no unifying acceptable standard. The initial results suggest that a "cut-off" of 0.3% could be adopted for the Kookaburra Gully project, subject to additional testing as the project progress.

On this basis the distribution of material exceeding the 0.3% was developed by AGL utilising information from the exploration drilling program. The volume of PAF material was calculated as 217,417 bank cubic metres (BCM) and allowing for a specific gravity of 2.6 and 1.2 bulking factor the estimated tonnage of PAF material is 678,341 tonnes.

The trace element analyses indicate that some of the samples are enriched with respect to silver, cadmium, bismuth, molybdenum, selenium and sulphur. Groundwater sampling should routinely include these chemicals in addition to the usual suite of major elements, as these are shown to be either enriched or elevated with respect to average crustal abundances.

Recommendations

Based on the findings of the initial ARD assessment Parsons Brinckerhoff recommends the following:

- Some additional testing is undertaken to help understand the scale of the acid drainage issue and to help refine classification criteria.
- Groundwater and surface water sampling should routinely include Ag, Bi, Cd, Mo, S and Se in addition to the usual suite of major elements, as these are shown to be either enriched or elevated with respect to average crustal abundances.

1. Background

1.1 The Kookaburra Gully Graphite project

Lincoln Minerals Limited (LML) is proposing the development of the Kookaburra Gully Graphite Project located approximately 35 km north of Port Lincoln on Eyre Peninsula in South Australia.

Graphite was mined in the early 1900's from the Koppio Graphite Mine which is situated 1–2 km to the south and south east of the Kookaburra and Kookaburra Extended prospects. More recent exploration work was carried out by Pancontinental Mining in the 1980s, followed by air core (AC) and reverse circulation (RC) drilling by LML in January 2013.

1.2 Acid rock drainage issues

Experience at other mines in South Australia and in several states, has shown that mining of ore or waste rock that contains sulphides can result in acid rock drainage (ARD) and associated environmental problems.

This initial ARD study was undertaken to assess whether there was a risk of potential acid generation and if so, provide recommendations of additional testing and management measures that could be adopted as part of mining operations.

1.3 Geology of the Kookaburra Gully Graphite project

The regional geology indicates that basement rocks in the project area include early to middle Proterozoic age quartz gabbro-norite of the Donnington Suite, fine to medium grained flaggy and foliated quartzite of the Warrow Quartzite and fine grained quartzite (locally hematitic, cherty and graphitic) and minor graphitic schist of the Lower Middleback Jaspilite (LINCOLN 1: 250,000 geological map, PIRSA, 2003). The Warrow Quartzite and Middleback Jaspilite form part of the Hutchison Group. To the west are foliated, medium to coarse grained granites, gneisses and granodiorites of the Mitalie Gneiss. More recent units include Tertiary age nodular, mottled and pisolitic ferricrete and laterite and Pleistocene age colluvial sands and gravelly clays of the Pooraka Formation or equivalents.

On a local scale the following geological units have been defined:

- Cover Sequence – alluvium/colluvium clays and other float rocks lying above Proterozoic basement, usually less than 2 m in thickness and sometimes absent.
- Saprolite – weathered Hutchison Group rocks where the protolith may be totally unrecognisable due to the weathering of primary minerals.
- Metasedimentary Hutchison Group – a sequence of platformal mixed carbonate and clastic sediments. The basal Warrow Quartziteis a massive to flaggy feldspathic to micaceous medium grained quartzite. Warrow Quartzite is overlain by a platformal carbonate sequence now represented by dolomitic marble, calcsilicate gneiss and banded iron formation (BIF). The carbonate/BIF sequence is overlain by a thick sequence of fine grained clastic sediments now represented by garnetiferous schist, gneiss and amphibolite. The latter may represent a mafic volcanic component. The boundary between the Cleve and Spencer subdomains is a major crustal shear zone, the Kalinjala Mylonite Zone that has had a long history of movement and associated alteration, metamorphic fluid flow and mineralisation. The project site to date has intersected only schist and gneissic rock types.
- Intrusive igneous rocks which are represented by local pegmatites in the study area.

- Graphite mineralisation within graphitic schist –including high grade graphite; medium grade graphite; low grade graphite; iron bearing graphite; trace graphite; weathered graphite.

The Kookaburra Gully deposit is stated to consist of a series of graphite schist lenses which are interpreted to be fold limbs of an antiformal structure.

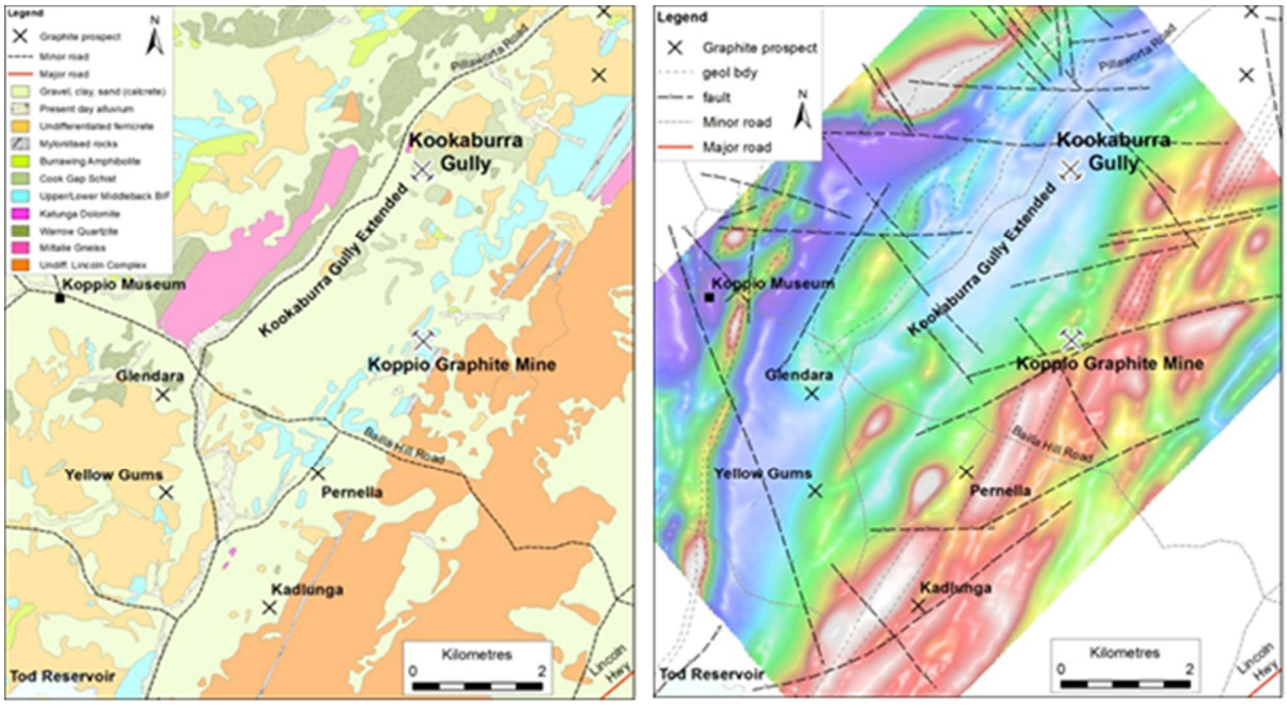

Figure 1.1 Regional geology based on Lincoln 1:250,000 geological map and aeromagnetic image

2. Objectives and methodology

2.1 Acid rock drainage potential

Where iron sulphides such as pyrite are present in rocks, either ore or waste, there is the possibility that oxidation may lead to ARD), which may be accompanied by elevated levels of dissolved toxic elements such as heavy metals (e.g. copper, lead, zinc and arsenic

With the assistance of LML, a selection of 'typical' rock types from exploration drillholes were collected and submitted to ALS for laboratory determination of acid producing/consuming potential (Figure 2.1). Samples that represented the different types of overburden (oxide rocks), low grade ore, high grade ore and unweathered hanging wall and footwall rocks were chosen. In addition duplicate rock samples were submitted for analysis to assess the precision and repeatability of the laboratory tests. In addition three samples of tailings were submitted to ALS for analysis.

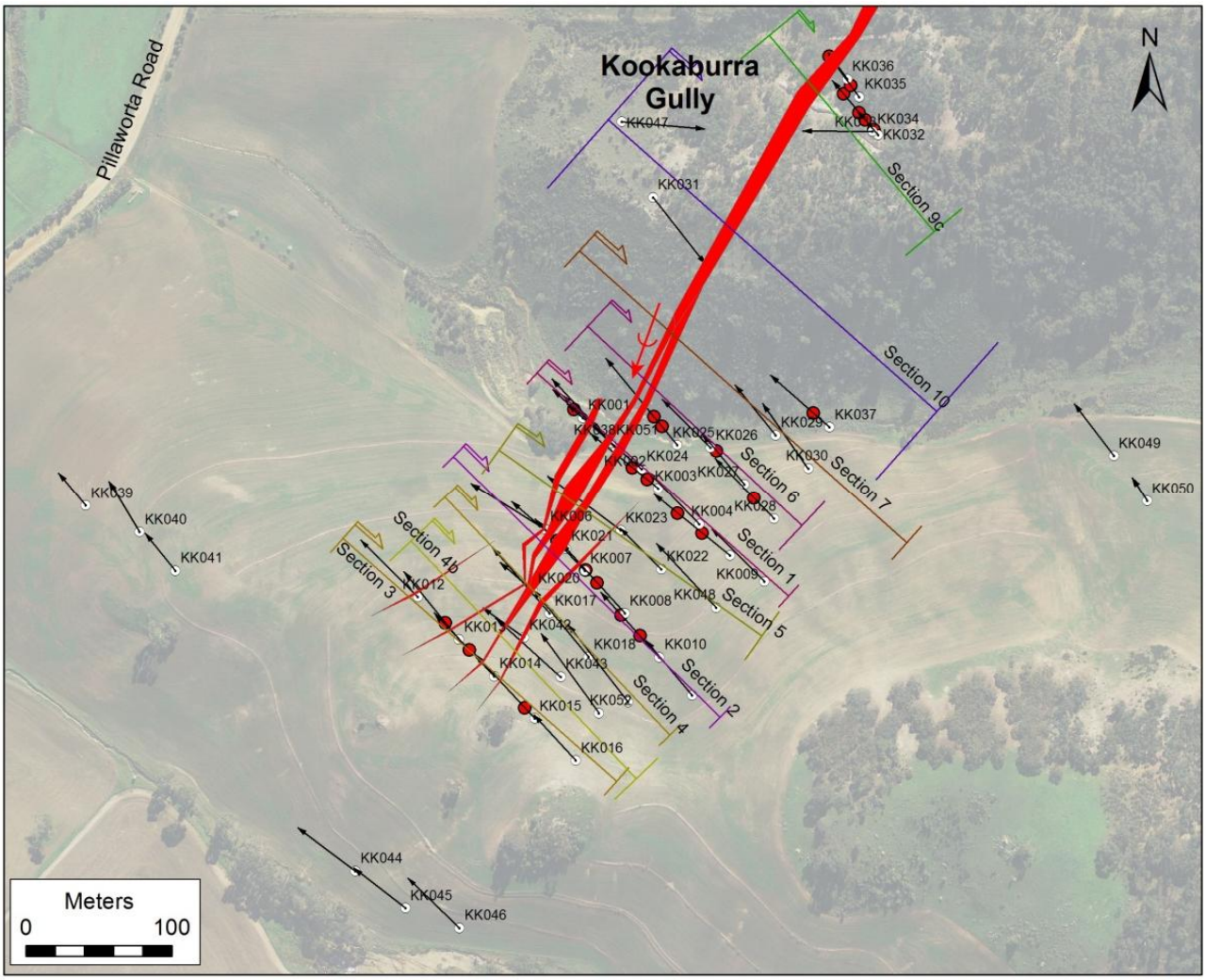

Figure 2.1 Locations of ARD samples

The investigations and laboratory analysis was considered to be appropriate for an initial assessment of the potential for acid generation. Characteristics of the rock and tailings samples chosen for testing are included in Table 2.1.

Table 2.1 Rock samples chosen for ARD testing

Rock type	Sample identification	Borehole ID	Sample interval (m)
Schist	WKG001	KK013	29–30
Biotite Schist	WKG002	KK014	49–50
Biotite Gneiss	WKG004	KK015	19–20
Graphite Schist	WKG005	KK021	16–17
Biotite Schist	WKG006	KK008	79–80
Graphite Schist	WKG007	KK008	56–57
Graphite Schist	WKG008	DUP 8	56–57
Biotite Gneiss	WKG009	KK010	39–40
Schist	WKG010	KK010	77–78
Biotite Schist	WKG011	KK001	16–17
Biotite Schist	WKG012	DUP 11	16–17
Graphite Schist	WKG013	KK003	45–46
Schist	WKG014	KK003	19–20
Schist	WKG015	KK005	49–50
Graphite Schist	WKG016	KK005	92–93
Biotite Gneiss	WKG018	KK037	29–30
Biotite Gneiss	WKG019	KK028	39–40
Quartz vein in Schist	WKG020	KK027	59–60
Biotite Gneiss	WKG021	KK025	39–40
Graphite Schist	WKG022	KK025	25–26
Biotite Gneiss	WKG023	KK033	29–30
Biotite Gneiss	WKG024	KK033	79–80
Graphite Schist	WKG025	KK033	116–117
Biotite Gneiss	WKG026	KK035	19–20
Marble	WKG027	KK035	69–70
Graphite Schist	WKG028	KK032	72–73
Tailings	Rougher tail	NA	NA
Tailings	Cleaner tail	NA	NA
Tailings	Slime	NA	NA

3. Investigation guidelines

3.1 Acid rock drainage potential

The ARD study was undertaken using standard laboratory tests suitable for a first stage investigation. The aim of the tests is to classify the selected rock and low grade ore as:

- Potentially acid forming (PAF)
- Potentially acid forming – low capacity (PAF-LC)
- Non-acid forming (NAF)
- Acid consuming material (ACM).

Because of the preliminary nature of the tests chosen, some samples may not be differentiated and are classified as 'uncertain' (UNC). The chosen tests and their relevance are described below.

3.1.1 Net acid producing potential (NAPP)

NAPP is determined by subtracting the estimated acid neutralising capacity (ANC) of a sample from the estimated maximum potential acidity of the sample (estimated from the total sulphur content, assuming all sulphur is present as pyrite and can oxidise to sulphuric acid). Neutralising capacity comprises primarily carbonates and silicate minerals, and to a lesser extent exchangeable cations on clays. ANC is calculated from titration of a ground sample with a known quantity of acid.

Both NAPP and ANC are typically expressed as kilograms of sulphuric acid per tonne of sample. A sample with NAPP greater than zero may be classified as potentially acid forming (PAF). Where the value is close to zero or negative, material is usually classified as non-acid forming (NAF). A material with strongly negative NAPP (i.e. ANC considerably greater than total potential acidity) may be acid consuming material (ACM). These materials are typically carbonate rich. Samples with marginal or apparently contradictory results are typically classified as 'uncertain' (UC).

While the NAPP indicates the acid generating potential by acid-base accounting, it does not quantify the reactivity of the material. Pyrrhotite is typically more reactive than pyrite, which is considerably more reactive than other sulphides including copper, lead and zinc sulphide ores. The style of sulphide occurrence can also be important, e.g. finely disseminated small grains of pyrite are more reactive than the same weight percentage of massive pyrite crystals.

Where carbonates are present, the type of carbonate is important: limestone/marble ($CaCO_3$) is more effective at neutralising acid than dolomite or magnesite ($CaMg(CO_3)_2$ or $MgCO_3$ respectively), while siderite ($FeCO_3$) is not neutralising. Other issues can also reduce the effectiveness of carbonates for neutralisation. Some silicates are neutralising but typically react more slowly than carbonates.

The reactivity of sulphides and neutralising materials will determine whether acid conditions are likely to occur in the field. It is important that the NAPP test only be used as a screening process.

3.1.2 Net acid generation (NAG) test

This procedure estimates acid generation directly. A strong oxidising agent is added to a prepared sample and the solution pH is measured after the oxidation reaction is complete (final NAG pH). As with NAPP, a positive NAG indicates potentially acid forming material (PAF). A NAG pH of 4.5 or less (using the classification system in Table 3.1) confirms that sulphide oxidation generates an excess of acidity and classifies the material as higher risk.

The NAG and NAPP tests are complementary, in that the NAPP provides the theoretical net potential for acid generation, while the NAG test is a direct measure of the net result of the balance of these reactions.

3.1.3 Classification

The classification indicated in the Department of Industry Tourism and Resources (DITR) Guidelines (2007) for ARD has been adopted for classification of the tested rocks (Table 3.1).

Table 3.1 Acid forming potential classification criteria

Primary geochemical type	Final NAG pH	NAPP kg H_2SO_4/t
Potentially Acid Forming (PAF)	< 4.5	> 10
Potentially Acid Forming – Low Capacity (PAF-LC)	< 4.5	0 -10
Non Acid Forming (NAF)	≥ 4.5	< 0
Acid Consuming Material (ACM)	≥ 4.5	< -100
Uncertain (UC)	≥ 4.5 < 4.5	Positive Negative

DITR indicates that an ANC/MPA ratio of 2 or more signifies that there is a high probability that the material will remain neutral in pH and should not be problematic, where MPA is the maximum potential acidity.

Other criteria used to determine the potential for acid generation are as follows:

- NAF: sulphide-S <0.3%. For sulphide-S >= 0.3% both a negative NAPP and ANC/MPA ratio >= 2
- PAF: for sulphide-S >=0.3%, any positive NAPP; negative NAPP value with an ANC/MPA ratio <2.

3.2 GAI

The geochemical abundance index (GAI) value is used to assess the extent of enrichment of trace elements in the waste rock material. The GAI is calculated by relating the actual concentration in a sample with either background levels in a specific area or lithology, or more typically, average crustal abundances, on a log 2 scale. Generally, a result with a GAI value of 3 or above is considered to be 'enriched' with respect to that element.

3.3 Salinity

The salinity of the samples was determined by undertaking electrical conductivity (EC_{sat}) analysis of soil-water saturation extracts. The salinity rankings based on the EC_{sat} are provided in **Error! Reference source not found.**.

Table 3.2 Salinity ranking based on EC_{sat}

EC_{sat} (dS/m)	Salinity
< 2	Non-saline
2 to 4	Slightly saline
4 to 8	Moderately saline
> 8	Highly saline

4. Acid rock drainage potential

4.1 ARD testing results

The results of the ARD testing are summarised in Table 4.1 and Table 4.2 and laboratory reports are included in Appendix A.

The characterisation of the samples is indicated in Figure 4.1 and Figure 4.2. It should be noted that the NAPP is calculated by the laboratory in terms of total-S which provides a conservative estimate as it assumes all S is sulphide. In this assessment the NAPP has been recalculated on the basis of the sulphide S analytical results.

Table 4.1 Acid forming potential screening test results

Sample ID	Description	Borehole	Interval	Ec	Sat, Paste pH	Static NAG (pH 7)	NAPP (based on sulphide S)	ANC	TotalS /SulphideS (%)	NAG pH	MPA	ANC/ MPA Ratio	Class
				dS/m		kg H_2SO_4/t							
WKG001	Schist	KK013	29–30	0.94	7.2	<0.1	-6.8	6.8	<0.01/<0.01	7.8	0	-	NAF
WKG002	Biotite Schist	KK014	49–50	0.37	7.4	0.5	-5.7	5.7	0.13/<0.01	6.9	0	-	NAF
WKG004	Biotite Gneiss	KK015	19–20	2.3	7.2	<0.1	-6.2	6.2	<0.01/<0.01	7.1	0	-	NAF
WKG005	Graphite Schist	KK021	16–17	1.6	7.8	<0.1	-9.6	9.6	0.01/<0.01	8.3	0	-	NAF
WKG006	Biotite Schist	KK008	79–80	0.9	5.5	15.8	28.7	0.8	0.90/0.82	3.5	30	0	PAF
WKG007	Graphite Schist (high grade)	KK008	56–57	0.72	6.9	2.9	-2.8	2.8	<0.01/<0.01	6.3	0	-	NAF
WKG008	Graphite Schist (high grade)	DUP 8	56–57	0.6	7.0	3.7	-1.8	1.8	0.01/<0.01	6.4	0	-	NAF
WKG009	Biotite Gneiss	KK010	39–40	0.36	8.4	<0.1	-7.4	7.4	<0.01/<0.01	7.5	0	-	NAF
WKG010	Schist (trace graphite)	KK010	77–78	0.53	6.9	16.1	25.1	3.0	0.81/0.76	3.3	28	0.1	PAF
WKG011	Biotite Schist	KK001	16–17	0.06	7.6	<0.1	-8.0	8.0	<0.01/<0.01	7.3	0	-	NAF
WKG012	Biotite Schist	DUP 11	16–17	0.29	7.8	<0.1	-7.8	7.8	<0.01/<0.01	7.5	0	-	NAF
WKG013	Graphite Schist (medium grade)	KK003	45–46	0.4	5.9	3.5	0.0	<0.5	0.02/<0.01	6.0	0	-	NAF
WKG014	Schist	KK003	19–20	0.2	7.3	<0.1	-6.2	6.2	<0.01/<0.01	7.1	0	-	NAF
WKG015	Schist	KK005	49–50	0.31	7.1	<0.1	-6.4	6.4	<0.01/<0.01	7.1	0	-	NAF
WKG016	Graphite Schist (low grade)	KK005	92–93	0.9	7.5	4.0	5.0	1.5	0.20/0.18	3.9	6	0.2	PAF-LC
WKG018	Biotite Gneiss	KK037	29–30	0.27	8.1	<0.1	-8.0	8.0	<0.01/<0.01	7.4	0	-	NAF
WKG019	Biotite Gneiss	KK028	39–40	0.39	7.9	<0.1	-9.0	9.0	<0.01/<0.01	7.6	0	-	NAF

Sample ID	Description	Borehole	Interval	Ec	Sat, Paste pH	Static NAG (pH 7)	NAPP (based on sulphide S)	ANC	TotalS /SulphideS (%)	NAG pH	MPA	ANC/ MPA Ratio	Class
				dS/m		kg H_2SO_4/t							
WKG020	Quartz vein in Schist (trace graphite)	KK027	59–60	0.29	6.7	3.4	9.9	5.6	0.48/0.43	4.4	15	0.4	PAF-LC
WKG021	Biotite Gneiss	KK025	39–40	0.43	6.8	0.7	-3.0	4.1	0.21/0.03	6.6	1	3.8	NAF
WKG022	Graphite Schist (high grade)	KK025	25–26	0.43	7.1	1.7	0.9	2.0	0.38/0.08	5.8	3	0.7	UC (NAF)
WKG023	Biotite Gneiss	KK033	29–30	1.35	6.2	0.6	0.6	3.7	0.13/0.12	6.7	4	0.9	UC (NAF)
WKG024	Biotite Gneiss	KK033	79–80	0.51	7.8	2.0	8.4	9.6	0.53/0.50	4.6	18	0.5	UC (PAF-LC)
WKG025	Graphite Schist (highly weathered low grade)	KK033	116–117	1.5	6.5	55.6	61.6	1.4	1.84/1.75	2.7	63	0	PAF
WKG026	Biotite Gneiss	KK035	19–20	0.33	6.1	1.8	-3.3	3.6	0.01/<0.01	6.6	0	-	NAF
WKG027	Marble (dolomitised)	KK035	69–70	0.28	6.0	3.1	3.3	2.2	0.18/0.17	4.5	6	0.4	PAF-LC
WKG028	Graphite Schist (high grade)	KK032	72–73	0.93	8.0	0.7	-2.0	2.0	<0.01/<0.01	6.4	0	-	NAF
Tailings	Rougher tail	NA	NA	273	8.3	<0.1	-9.4	10.0	0.02/0.02	7.6	0.6	16.7	NAF
Tailings	Cleaner tail	NA	NA	611	8.4	<0.1	-25.6	26.2	0.02/0.01	8.5	0.3	87.3	NAF
Tailings	Slime	NA	NA	275	8.2	<0.1	-20.4	21.6	0.04/0.03	8.1	0.9	24	NAF

Table 4.2 Summary classification of acid forming potential

Classification	Rock/Ore types
Non Acid Forming (NAF)	WKG001, WKG002, WKG004, WKG005, WKG007, WKG008, WKG009, WKG011, WKG012, WKG013, WKG014, WKG015, WKG018, WKG019, WKG021, WKG026, WKG028, Rougher tail, Cleaner tail, Slime
Acid Consuming Material (ACM)	None
Potentially Acid Forming (PAF – low capacity)	WKG016, WGK020, WKG027
Potentially Acid Forming	WKG006, WKG010, WKG025
Uncertain (NAF)	WKG022, WKG023
Uncertain (PAF-LC)	WKG024

Sixteen of the rock samples were classified as NAF (including biotite gneiss, schist, biotite schist and all samples of high grade ore) indicating that ARD was unlikely to occur.

Three rock samples were classified as PAF and comprised biotite schist, schist with a trace of pyrite and highly weathered low grade graphite schist ore.

Two rock samples were classified as low capacity PAF and comprised graphite schist (low grade ore) and quartz vein in schist with trace graphite. As the quartz vein would not comprise a significant volume of the total rock mass it is unlikely that this material would significantly acid forming.

Three rock samples were classified as uncertain due to conflicting NAGpH and NAPP results. Further examination of the results indicates that the high grade graphitic schist ore has a low sulphide S content of 0.08% and a low NAPP of 0.9 and on that basis is unlikely to be acid forming. Similarly the sample of biotite gneiss has a low sulphide S content of 0.12% and a low NAPP of 0.6 and on that basis is unlikely to be acid forming. Another sample of biotite gneiss has a sulphide S content of 0.5% and a NAPP of 9.6 and on that basis is likely to be acid forming.

On the basis of the analytical program the dolomitic marble was also classified as low capacity PAF. However the sample has a low sulphide content of 0.17% suggesting that the potential for acid generation is unlikely.

The three tailings samples were classified as NAF.

On the basis of the electrical conductivity results all rock samples are classified as non-saline with the exception of WKG003 and WKG004 which are classified as slightly saline. The three tailings samples are classified as non-saline.

In general the rocks analysed have neutral to slightly alkaline pH, with the exception of the WKG006 and WKG013 which had pH values of 5.5 and 5.9 respectively. The tailings samples have a slightly alkaline pH.

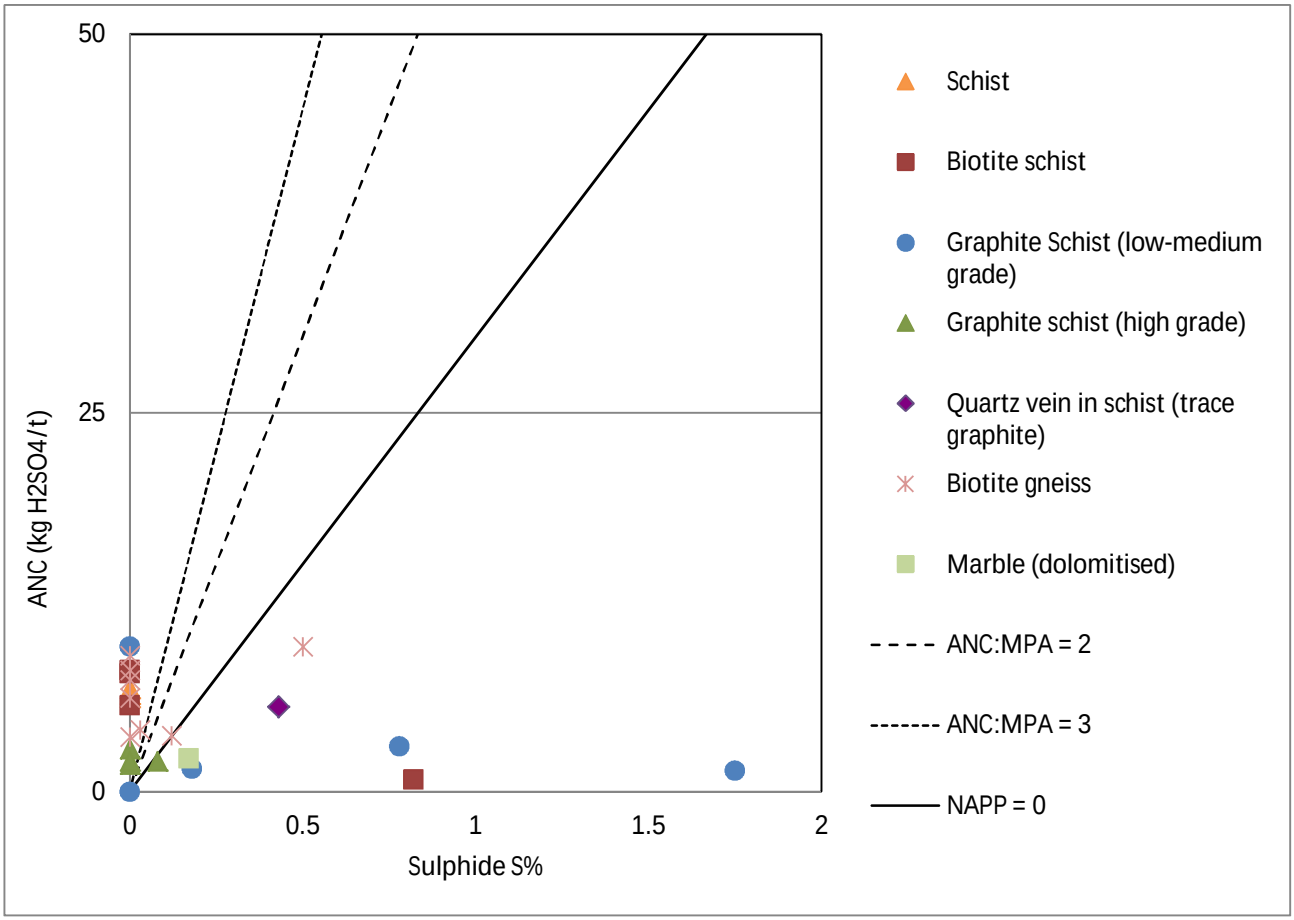

Figure 4.1 **Acid-base account plot for rock samples**

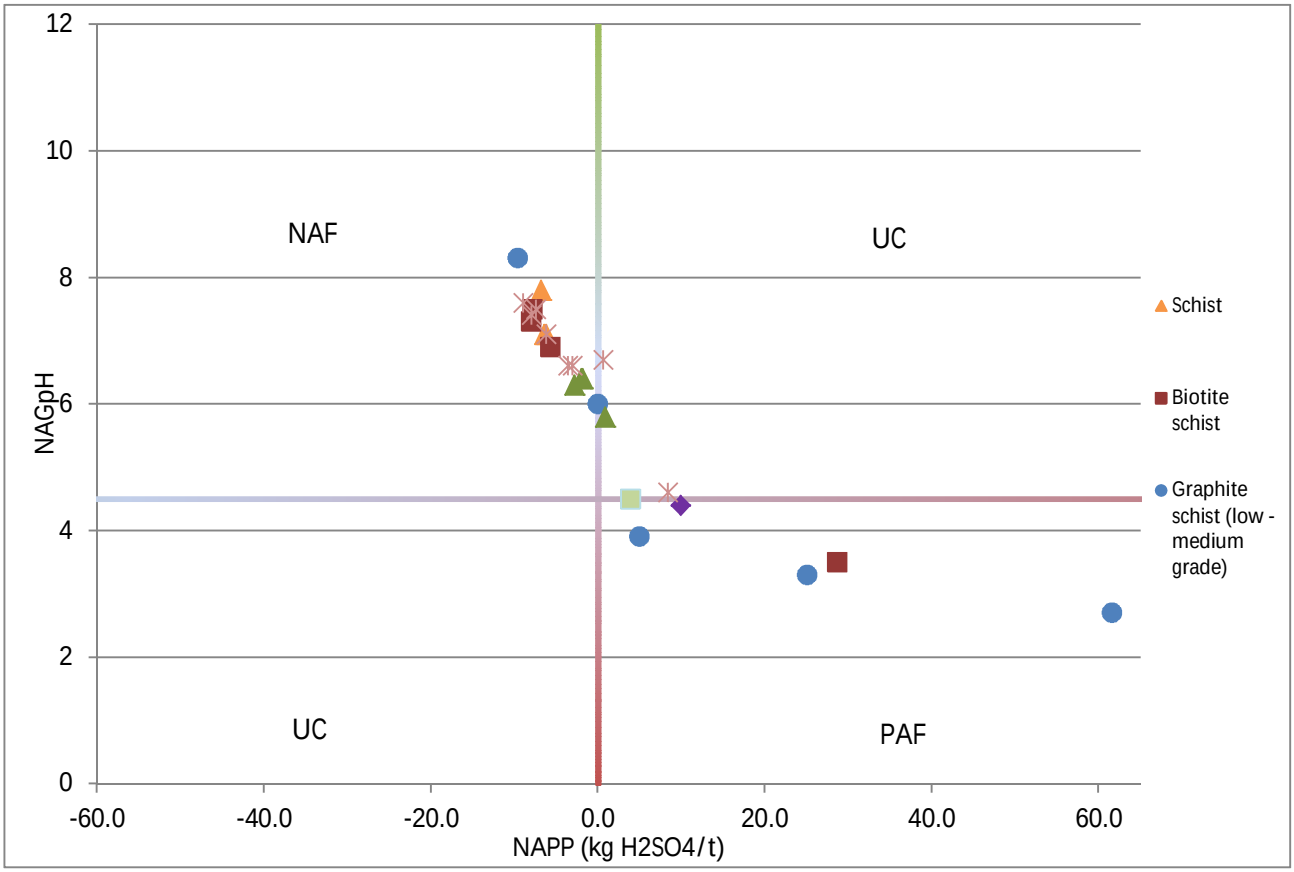

Figure 4.2 **Geochemical classification by rock type**

The rock samples were assayed for a range of trace metals and a summary of GAI results included in Table 4.3. The results indicate that the rock samples are enriched (GAI of >=3) with respect to metals as follows:

- Silver in WKG021
- Bismuth in WKG005, WKG007, WKG008, WKG016, WKG025, WKG028
- Cadmium in WKG006
- Molybdenum in WKG005, WKG016, WKG022, WKG025
- Sulphur in WKG006, WKG020, WKG022, WKG024, WKG025
- Selenium in WKG005, WKG007, WKG008, WKG025

Table 4.3 GAI values for rock samples

Element	Crustal abundance	Concentration (% or ppm)	Range of GAI	Sample with GAI >= 3	GAI
Ag	0.07 ppm	0.01-0.68	0 - 3	WKG021	3
Al	8.2 %	0.24-4.88	0	None	-
As	1.5 ppm	0.1-0.9	0	None	-
Ba	500 ppm	40-190	0	None	-
Be	2.6 ppm	0.14-4.12	0	None	-
Bi	0.048 ppm	0.08-1.88	0 - 5	WKG005 WKG007 WKG008 WKG016 WKG025 WKG028	4 4 4 3 5 4
Ca	1.5 %	0.01-0.25	0	None	-
Cd	0.11 ppm	<0.01-1.95	1 - 4	WKG006	4
Ce	50 ppm	23.1-140.0	0 - 1	None	-
Co	20 ppm	0.4-38.7	0	None	-
Cr	100 ppm	25-257	0 - 1	None	-
Cu	50 ppm	10.0-206	0 - 1	None	-
Fe	4.1 %	0.53-20.0	0 - 2	None	-
Hg	0.06 ppm	<0.01-0.01	0	None	-
K	1.4 %	0.12-2.34	0	None	-
Li	20 ppm	0.5-36.5	0	None	-
Mg	0.5 %	0.02-1.58	0 - 1	None	-
Mn	950 ppm	28-1640	0	None	-
Mo	1.5 ppm	0.4-60.3	0 - 5	WKG005 WKG016 WKG022 WKG025	5 4 4 4
Na	0.5 %	0.03-0.12	0	None	-
Ni	80 ppm	2.0-54.8	0	None	-
P	800 ppm	60-1080	0	None	-

Element	Crustal abundance	Concentration (% or ppm)	Range of GAI	Sample with GAI >= 3	GAI
Pb	14 ppm	3.0-23.0	0	None	-
S	0.03 %	<0.01-1.89	0 - 5	WKG006 WKG020 WKG022 WKG024 WKG025	4 3 3 3 5
Sb	0.2 ppm	<0.05-0.07	0	None	-
Se	0.4 ppm	0.3 7.9	0 - 4	WKG005 WKG007 WKG008 WKG025	3 4 4 3
Sn	2.2 ppm	0.3-2.6	0	None	-
Sr	370 ppm	5.4-116.5	0	None	-
Th	12 ppm	8.4-19.8	0	None	-
Tl	0.6	0.04-1.37	0	None	-
U	1.8 ppm	1.55-10.95	0 - 2	None	-
V	160 ppm	20-1240	0 - 2	None	-
W	2 ppm	<0.05-3.52	0	None	-
Zn	75 ppm	7-121	0	None	-

Results are represented as chemical analysis/GAI

The tailings samples were analysed for total petroleum hydrocarbons and Total Recoverable Hydrocarbons with the results all being below the laboratory detection levels and are below NEPM sensitive landuse acceptance levels.

4.2 Quality assurance

Analytical results and Relative Percentage Difference (RPD) calculations for the intra-laboratory field duplicates are included in the analytical results tables in Appendix A. The precision of the results for each analyte between the primary sample and the field duplicate was determined by calculating the RPD as follows:

$$RPD = \frac{(Concentration\,1 - Concentration\,2)\ x\ 100}{(Concentration\,1 + Concentration\,2)\ /\ 2}$$

Based on Australian Standard AS 4482.1-1997, a field duplicate RPD not exceeding 50% is considered acceptable. Generally higher RPD values occur for organic compounds than for metals and where low concentrations of an analyte are recorded and where there is ample heterogeneity. The RPD results for field duplicates are presented in Table 4.4.

The results of internal laboratory quality control procedures are provided within the laboratory analysis reports (Appendix A). The acceptance criterion for internal laboratory replicates is generally set at an RPD of 20% to 50%.

Table 4.4 RPD calculations

Analyte	WKG007	WKG008	RPD %	WKG011	WKG012	RPD %
pH	6.3	6.4	*2*	7.3	7.5	3
Conductivity	770	870	12	200	180	11
Aluminium	0.97	1.13	15	4.19	4.13	1
Antimony	0.05	0.06	18	<0.05	<0.05	0
Arsenic	0.4	0.6	40	0.2	0.3	40
Beryllium	0.64	0.7	9	0.77	0.79	3
Bismuth	1.12	1.13	1	0.28	0.24	15
Cadmium	0.13	0.12	8	0.05	0.05	0
Calcium	0.02	0.02	0	0.05	0.05	0
Cobalt	12.1	12.7	5	16.5	16.4	1
Chromium	27	35	26	59	56	5
Copper	150	158.5	6	16.5	16.4	1
Iron	1.31	1.7	26	4.58	4.59	0
Lead	23	22.7	1	7.4	7.4	0
Mercury	<0.01	<0.01	0	<0.01	<0.01	0
Molybdenum	10.15	9.72	4	1.83	1.98	8
Nickel	24.5	25.4	4	50.5	50.9	1
Phosphorus	120	130	8	80	90	12
Selenium	7.5	7.9	5	0.6	0.6	0
Silver	0.15	0.17	13	0.03	0.03	0
Sodium	0.03	0.04	29	0.05	0.05	0
Tin	0.9	1	11	2.2	2.1	5
Uranium	7.95	8.25	4	3.31	3.37	2
Vanadium	51	61	18	75	71	5
Zinc	14	12	15	102	101	1

The RPDs for the field duplicate do not exceed 50% and on this basis the results are considered acceptable as are the laboratory QA/QC results.

5. Discussion

5.1 Summary

The generation of ARD depends on the combination of susceptible minerals, and the availability of oxygen and water. Water is both a reactant and the main means by which ARD can spread. The potential for acid generation can be dependent on the incidence of rainfall. During dry periods, evaporation may lead to the formation of precipitates and salts which may store metals, sulphate and acidity. During rainfall periods these may be flushed out resulting in the release of acidic waters, with elevated sulphates and metals.

Sixteen samples were classified as NAF (including biotite gneiss, schist, biotite schist and all samples of high grade ore) indicating that ARD was unlikely to occur.

Three samples were classified as PAF and comprised biotite schist, schist with a trace of pyrite and highly weathered low grade graphite schist ore.

Two samples were classified as low capacity PAF and comprised graphite schist (low grade ore) and quartz vein in schist with trace graphite. As the quartz vein would not comprise a significant volume of the total rock mass it is unlikely that this material would significantly acid forming.

Three samples were classified as uncertain due to conflicting NAGpH and NAPP results. Further examination of the results indicates that the high grade graphitic schist ore has a low sulphide S content of 0.08% and a low NAPP of 0.9 and on that basis is unlikely to be acid forming. Similarly the sample of biotite gneiss has a low sulphide S content of 0.12% and a low NAPP of 0.6 and on that basis is unlikely to be acid forming. Another sample of biotite gneiss has a sulphide S content of 0.5% and a NAPP of 9.6 and on that basis is likely to be acid forming.

On the basis of the analytical program the dolomitic marble was also classified as low capacity PAF. However the sample has a low sulphide content of 0.17% suggesting that the potential for acid generation is unlikely.

The three tailings samples were classified as NAF. The tailings samples were analysed for total petroleum hydrocarbons and Total Recoverable Hydrocarbons with the results all being below the laboratory detection levels and are below NEPM sensitive land use acceptance levels.

The trace element analyses indicate that some of the samples are enriched with respect to silver, cadmium, bismuth, molybdenum, selenium and sulphur. Groundwater sampling should routinely include these chemicals in addition to the usual suite of major elements, as these are shown to be either enriched or elevated with respect to average crustal abundances.

5.2 Distribution of ARD material

The testing program indicates that for the majority of samples the total sulphur S% and sulphide S% are essentially equivalent, indicating that any sulphur present in the samples is in the sulphide form. This would provide a good diagnostic tool for the management and scheduling of waste rock storage. The PAF material has sulphide S averaging 1.11%, the low capacity PAF material has sulphide S averaging 0.38% and the low capacity NAF material has sulphide S generally less than 0.01%.

Assessment of the results of kinetic testing since the late 1980's of samples of diverse mineralogy by Dr Graeme Campbell suggests that if sulphide S is less than 0.3% the material is unlikely to acidify. However

there is no unifying acceptable standard. The initial results suggest that a “cut-off” of 0.3% could be adopted for the Kookaburra Gully project, subject to additional testing as the project progress.

On this basis the distribution of material exceeding the 0.3% was developed by AGL utilising information from the exploration drilling program is indicated in Figures 5.1 to 5.5 and cross section locations indicated in Figure 2.1.

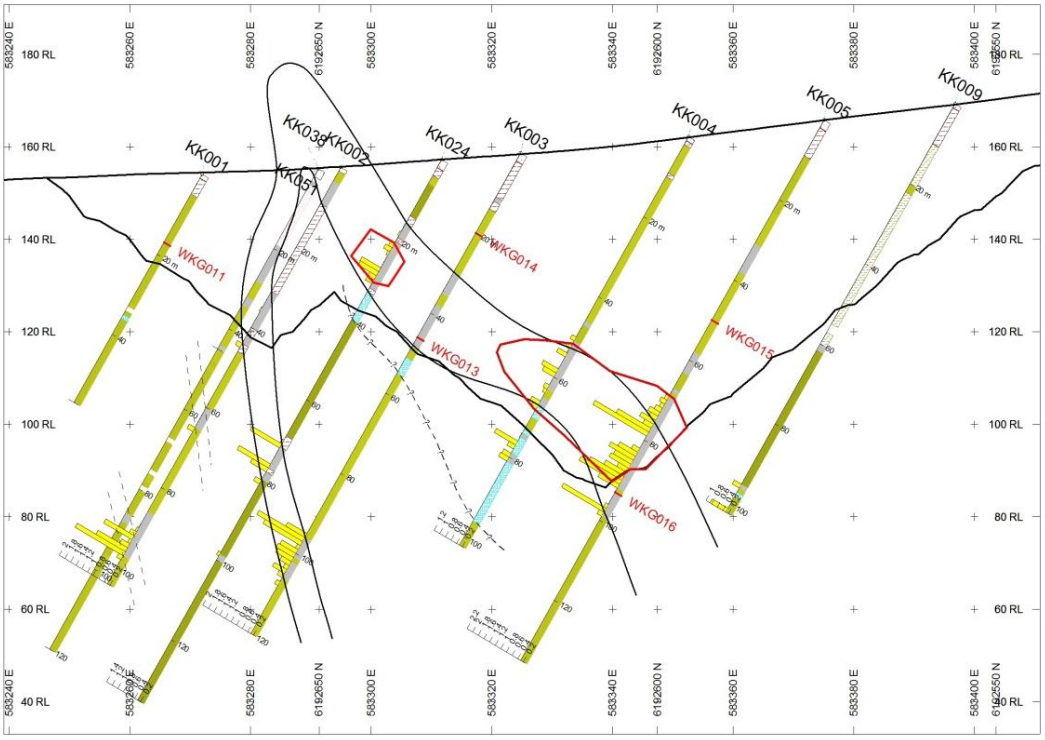

Figure 5.1 Distribution of rocks with S > 0.3% – Section 1

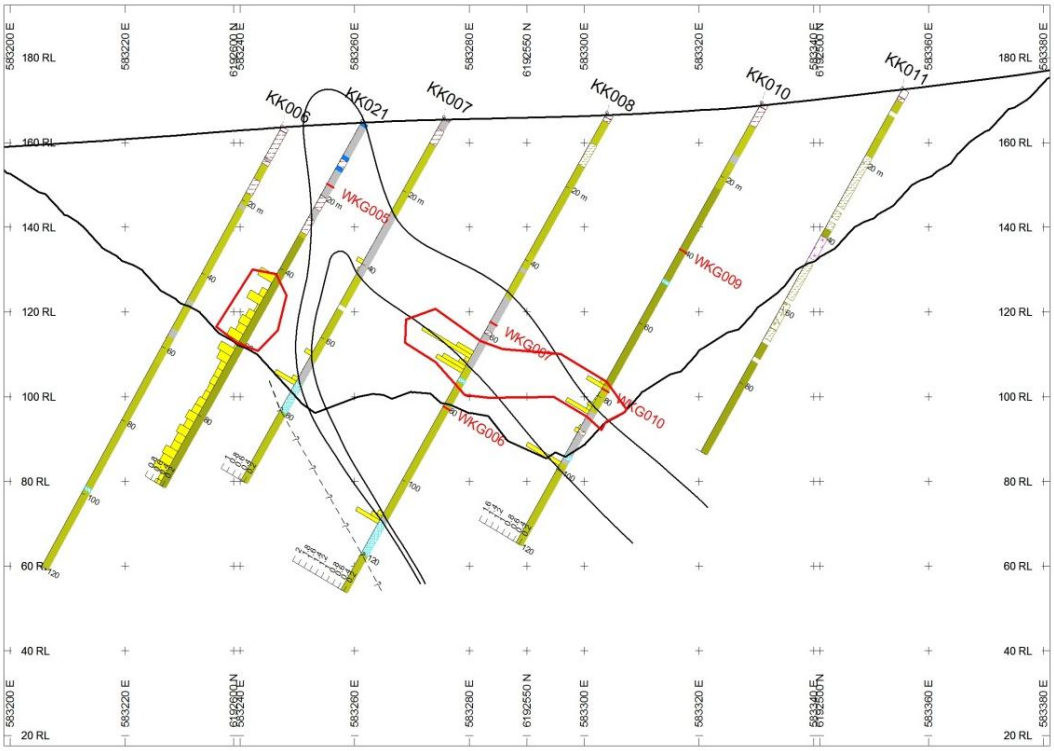

Figure 5.2 Distribution of rocks with S > 0.3% – Section 2

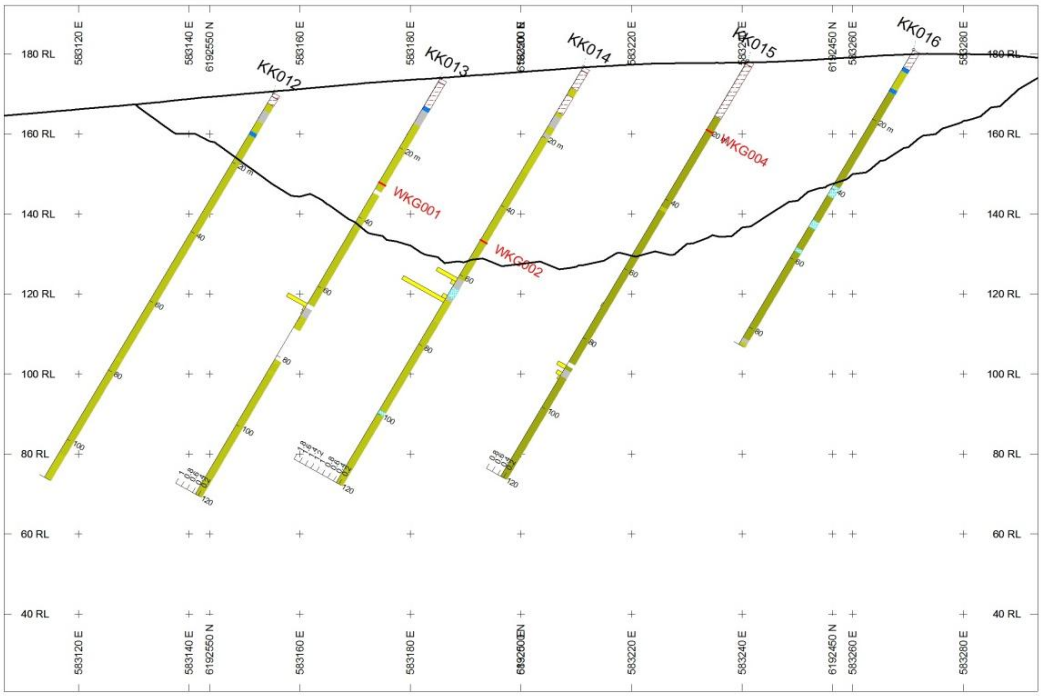

Figure 5.3 Distribution of rocks with S > 0.3% – Section 3

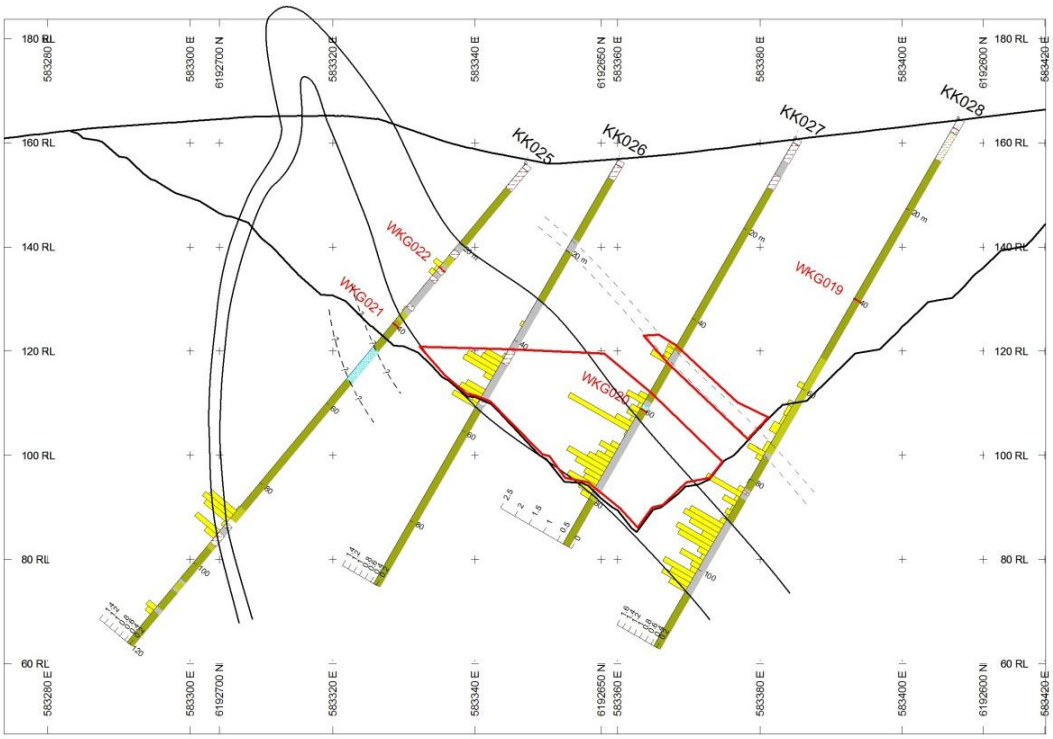

Figure 5.4 Distribution of rocks with S > 0.3% – Section 6

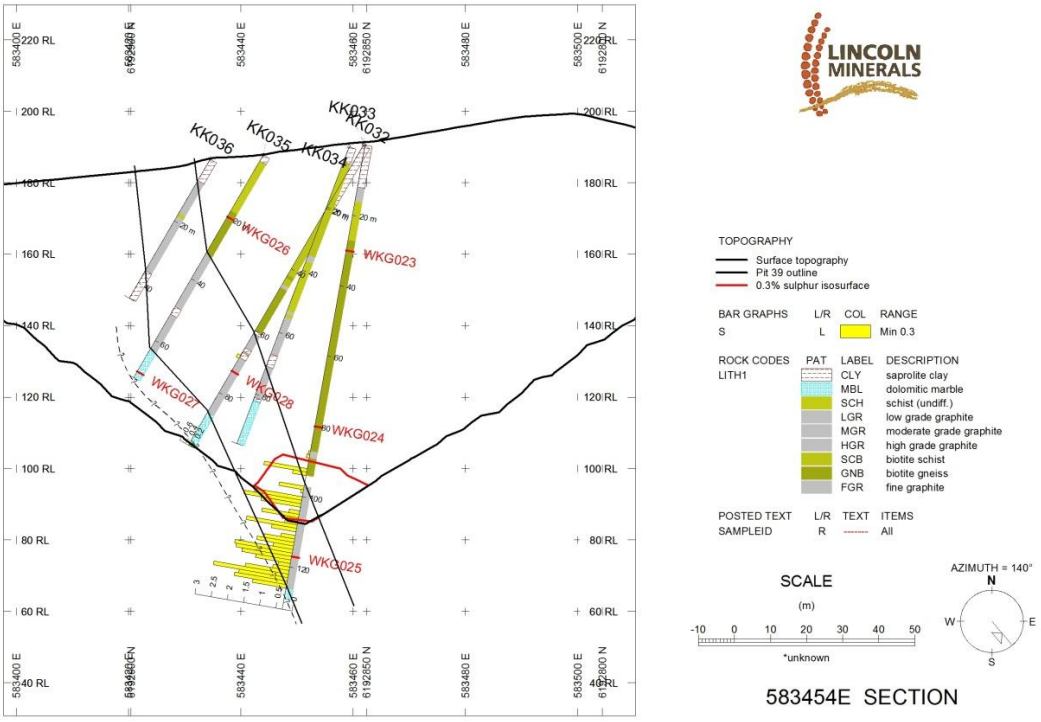

Figure 5.5 Distribution of rocks with S > 0.3% – Section 9

The volume of PAF material as defined above was calculated as 217,417 bank cubic metres (BCM) and allowing for a specific gravity of 2.6 and 1.2 bulking factor the estimated tonnage of PAF material is 678,341 tonnes.

6. Recommendations

Based on the findings of the initial ARD assessment Parsons Brinckerhoff recommends the following:

- Some additional testing is undertaken to help understand the scale of the acid drainage issue and to help refine classification criteria.
- Groundwater and surface water sampling should routinely include Ag, Bi, Cd, Mo, S and Se in addition to the usual suite of major elements, as these are shown to be either enriched or elevated with respect to average crustal abundances.

7. References

Department of Industry Tourism and Resources (2007), *Leading Practice Sustainable Development Program FOR THE Mining Industry: Managing Acid and Metalliferous Drainage*.

Appendix A

Laboratory results

CERTIFICATE OF ANALYSIS

Work Order	: **EB1403485**	Page	: 1 of 8
Client	: **ALS MINERALS**	Laboratory	: Environmental Division Brisbane
Contact	: MR SHAUN KENNY	Contact	: Customer Services
Address	: 32 SHAND ST STAFFORD QLD, AUSTRALIA 4053	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: BR_Workorder_Write_Up@alsglobal.com	E-mail	: Brisbane.Enviro.Services@alsglobal.com
Telephone	: ----	Telephone	: +61 7 3243 7222
Facsimile	: ----	Facsimile	: +61 7 3243 7218
Project	: BR14013084	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 10-FEB-2014
Sampler	: ----	Issue Date	: 24-FEB-2014
Site	: ----		
		No. of samples received	: 30
Quote number	: ----	No. of samples analysed	: 30

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Greg Vogel	Laboratory Manager	Brisbane Inorganics
SATISH.TRIVEDI	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WKG001	WKG002	WKG003	WKG004	WKG005
				Client sampling date / time	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]
Compound	CAS Number	LOR	Unit		EB1403485-001	EB1403485-002	EB1403485-003	EB1403485-004	EB1403485-005
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-6.8	-1.7	-73.2	-6.2	-9.3
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		7.8	6.9	9.6	7.1	8.3
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		<0.1	0.5	<0.1	<0.1	<0.1
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		6.8	5.7	73.2	6.2	9.6
ANC as CaCO3	----	0.1	% CaCO3		0.7	0.6	7.5	0.6	1.0
Fizz Rating	----	0	Fizz Unit		0	0	2	0	1
EA031: pH (saturated paste)									
pH (Saturated Paste)	----	0.1	pH Unit		7.2	7.4	8.2	7.2	7.8
EA032: Electrical Conductivity (saturated paste)									
Electrical Conductivity (Saturated Paste)	----	1	µS/cm		940	367	4010	2390	1550
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		650	3710	530	380	540
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)									
Sulfate as SO4 2-	14808-79-8	50	mg/kg		180	80	210	100	<50
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	0.13	<0.01	<0.01	0.01
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		<0.01	<0.01	<0.01	<0.01	<0.01
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		0.02	0.05	3.20	<0.02	0.50

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WKG006	WKG007	WKG008	WKG009	WKG010
				Client sampling date / time	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]
Compound	CAS Number	LOR	Unit		EB1403485-006	EB1403485-007	EB1403485-008	EB1403485-009	EB1403485-010
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		26.7	-2.8	-1.5	-7.4	21.8
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		3.5	6.3	6.4	7.5	3.3
NAG (pH 4.5)	----	0.1	kg H2SO4/t		8.3	<0.1	<0.1	<0.1	10.8
NAG (pH 7.0)	----	0.1	kg H2SO4/t		15.8	2.9	3.7	<0.1	16.1
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		0.8	2.8	1.8	7.4	3.0
ANC as CaCO3	----	0.1	% CaCO3		<0.1	0.3	0.2	0.8	0.3
Fizz Rating	----	0	Fizz Unit		0	0	0	0	0
EA031: pH (saturated paste)									
pH (Saturated Paste)	----	0.1	pH Unit		5.5	6.9	7.0	8.4	6.9
EA032: Electrical Conductivity (saturated paste)									
Electrical Conductivity (Saturated Paste)	----	1	µS/cm		896	724	589	355	530
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		2510	770	870	210	910
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)									
Sulfate as SO4 2-	14808-79-8	50	mg/kg		810	60	70	<50	270
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.90	<0.01	0.01	<0.01	0.81
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		0.82	<0.01	<0.01	<0.01	0.78
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		0.07	0.60	0.90	<0.02	0.53

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	WKG011	WKG012	WKG013	WKG014	WKG015
			Client sampling date / time	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]
Compound	CAS Number	LOR	Unit	EB1403485-011	EB1403485-012	EB1403485-013	EB1403485-014	EB1403485-015
EA009: Nett Acid Production Potential								
Net Acid Production Potential	----	0.5	kg H2SO4/t	-8.0	-7.8	0.6	-6.2	-6.4
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.3	7.5	6.0	7.1	7.1
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	3.5	<0.1	<0.1
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	8.0	7.8	<0.5	6.2	6.4
ANC as CaCO3	----	0.1	% CaCO3	0.8	0.8	<0.1	0.6	0.6
Fizz Rating	----	0	Fizz Unit	0	0	0	0	0
EA031: pH (saturated paste)								
pH (Saturated Paste)	----	0.1	pH Unit	7.6	7.8	5.9	7.3	7.1
EA032: Electrical Conductivity (saturated paste)								
Electrical Conductivity (Saturated Paste)	----	1	µS/cm	63	288	396	189	314
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	200	180	580	190	210
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	<50	150	<50	<50
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	0.02	<0.01	<0.01
EK085M: Sulfide as S2-								
Sulfide as S	----	0.01	%	<0.01	<0.01	<0.01	<0.01	<0.01
EP003TIC: Total inorganic Carbon (TIC) in Soil								
Total Inorganic Carbon	----	0.02	%	0.02	0.03	0.38	0.06	0.15

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WKG016	WKG017	WKG018	WKG019	WKG020
				Client sampling date / time	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]
Compound	CAS Number	LOR	Unit		EB1403485-016	EB1403485-017	EB1403485-018	EB1403485-019	EB1403485-020
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		4.6	364	-8.0	-9.0	9.1
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		3.9	3.0	7.4	7.6	4.4
NAG (pH 4.5)	----	0.1	kg H2SO4/t		1.7	17.8	<0.1	<0.1	0.3
NAG (pH 7.0)	----	0.1	kg H2SO4/t		4.0	176	<0.1	<0.1	3.4
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		1.5	3.2	8.0	9.0	5.6
ANC as CaCO3	----	0.1	% CaCO3		0.1	0.3	0.8	0.9	0.6
Fizz Rating	----	0	Fizz Unit		0	0	0	0	0
EA031: pH (saturated paste)									
pH (Saturated Paste)	----	0.1	pH Unit		7.5	6.9	8.1	7.9	6.7
EA032: Electrical Conductivity (saturated paste)									
Electrical Conductivity (Saturated Paste)	----	1	µS/cm		886	1220	265	390	293
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		720	15300	180	160	1360
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)									
Sulfate as SO4 2-	14808-79-8	50	mg/kg		220	1860	<50	<50	120
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.20	12.0	<0.01	<0.01	0.48
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		0.18	11.5	<0.01	<0.01	0.43
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		<0.02	0.43	<0.02	0.04	0.06

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WKG021	WKG022	WKG023	WKG024	WKG025
				Client sampling date / time	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]
Compound	CAS Number	LOR	Unit		EB1403485-021	EB1403485-022	EB1403485-023	EB1403485-024	EB1403485-025
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		2.3	9.6	<0.5	6.6	54.9
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		6.6	5.8	6.7	4.6	2.7
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	39.8
NAG (pH 7.0)	----	0.1	kg H2SO4/t		0.7	1.7	0.6	2.0	55.6
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		4.1	2.0	3.7	9.6	1.4
ANC as CaCO3	----	0.1	% CaCO3		0.4	0.2	0.4	1.0	0.1
Fizz Rating	----	0	Fizz Unit		0	0	0	0	0
EA031: pH (saturated paste)									
pH (Saturated Paste)	----	0.1	pH Unit		6.8	7.1	6.2	7.8	6.5
EA032: Electrical Conductivity (saturated paste)									
Electrical Conductivity (Saturated Paste)	----	1	µS/cm		429	427	1350	510	1480
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		5470	9020	380	960	2600
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)									
Sulfate as SO4 2-	14808-79-8	50	mg/kg		140	110	170	420	570
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.21	0.38	0.13	0.53	1.84
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		0.03	0.08	0.12	0.50	1.75
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		0.48	0.60	<0.02	<0.02	1.10

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	WKG026	WKG027	WKG028	WKG029	WKG030
				Client sampling date / time	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]	[02-FEB-2014]
Compound	CAS Number	LOR	Unit		EB1403485-026	EB1403485-027	EB1403485-028	EB1403485-029	EB1403485-030
EA009: Nett Acid Production Potential									
Net Acid Production Potential	----	0.5	kg H2SO4/t		-3.3	3.3	-2.0	-66.3	-77.8
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		6.6	4.5	6.4	9.4	10.0
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		1.8	3.1	0.7	<0.1	<0.1
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		3.6	2.2	2.0	66.3	102
ANC as CaCO3	----	0.1	% CaCO3		0.4	0.2	0.2	6.8	10.4
Fizz Rating	----	0	Fizz Unit		0	0	0	2	2
EA031: pH (saturated paste)									
pH (Saturated Paste)	----	0.1	pH Unit		6.1	6.0	8.0	7.7	8.1
EA032: Electrical Conductivity (saturated paste)									
Electrical Conductivity (Saturated Paste)	----	1	µS/cm		330	283	933	3880	1760
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		390	300	250	450	4810
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)									
Sulfate as SO4 2-	14808-79-8	50	mg/kg		160	130	60	200	1790
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		0.01	0.18	<0.01	<0.01	0.79
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		<0.01	0.17	<0.01	<0.01	0.63
EP003TIC: Total inorganic Carbon (TIC) in Soil									
Total Inorganic Carbon	----	0.02	%		<0.02	0.06	0.80	3.40	1.31

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Finalized Date: 3- MAR- 2014
Account: LINMIN

CERTIFICATE BR14013084

Project: KG Wasterock

This report is for 30 Percussion samples submitted to our lab in Brisbane, QLD, Australia on 3- FEB- 2014.

The following have access to data associated with this certificate:

JOHN PARKER	DWAYNE POVEY	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI- 21	Received Sample Weight
PUL- 21	Pulverize entire sample
SPL- 21	Split sample - riffle splitter
BAG- 01	Bulk Master for Storage

ANALYTICAL PROCEDURES

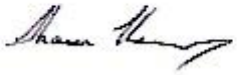
ALS CODE	DESCRIPTION	INSTRUMENT
ME- OG46	Ore Grade Elements - AquaRegia	ICP- AES
Pb- OG46	Ore Grade Pb - Aqua Regia	VARIABLE
Zn- OG46	Ore Grade Zn - Aqua Regia	VARIABLE
ME- MS41	51 anal. aqua regia ICPMS	

To: **LINCOLN MINERALS LIMITED**
ATTN: DWAYNE POVEY
28 GREENHILL ROAD
WAYVILLE SA 5034

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:



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Project: KG Wasterock

CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	WEI- 21	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Recvd Wt.	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs
	Units	kg	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
	LOR	0.02	0.01	0.01	0.1	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05
WKG001		0.76	0.03	4.88	0.3	<0.2	<10	100	1.22	0.25	0.01	0.05	140.0	27.9	78	10.80
WKG002		0.68	0.04	3.88	0.2	<0.2	<10	60	1.35	0.30	0.04	0.12	66.2	11.2	58	6.09
WKG003		0.41	0.12	0.71	0.7	<0.2	<10	90	0.45	1.99	0.89	0.02	63.0	1.7	48	0.33
WKG004		0.61	0.02	4.36	0.2	<0.2	<10	110	1.30	0.36	0.02	<0.01	98.5	11.8	51	13.00
WKG005		0.91	0.09	1.65	0.4	<0.2	10	40	4.12	1.20	0.21	0.25	23.1	15.4	257	1.77
WKG006		0.89	0.17	3.50	0.2	<0.2	<10	100	0.65	0.33	0.02	1.95	43.8	38.7	37	2.98
WKG007		0.43	0.15	0.97	0.4	<0.2	<10	60	0.64	1.12	0.02	0.13	76.9	12.1	27	0.39
WKG008		0.45	0.17	1.13	0.6	<0.2	<10	60	0.70	1.13	0.02	0.12	78.4	12.7	35	0.30
WKG009		1.32	0.03	3.05	0.3	<0.2	<10	100	0.76	0.17	0.13	0.04	78.8	15.0	55	9.42
WKG010		1.36	0.23	1.82	0.1	<0.2	<10	40	1.45	0.26	0.04	0.01	80.6	20.8	35	2.31
WKG011		0.48	0.03	4.19	0.2	<0.2	<10	140	0.77	0.28	0.05	0.07	86.8	16.5	59	16.40
WKG012		0.64	0.03	4.13	0.3	<0.2	<10	140	0.79	0.24	0.05	0.07	89.2	16.4	56	15.95
WKG013		1.42	0.02	2.06	0.1	<0.2	<10	50	0.86	0.19	0.01	<0.01	54.3	0.4	29	1.35
WKG014		1.49	0.01	4.48	0.2	<0.2	<10	90	0.64	0.26	0.03	0.01	84.3	7.6	73	9.60
WKG015		1.05	0.02	3.11	0.4	<0.2	<10	190	0.83	0.08	0.16	0.03	85.8	7.0	38	4.15
WKG016		0.90	0.38	0.83	0.4	<0.2	<10	80	0.68	0.80	0.01	<0.01	42.6	2.0	32	2.72
WKG017		0.38	56.6	0.37	62.1	<0.2	10	20	0.90	0.35	0.33	830	9.28	5.7	11	5.04
WKG018		0.73	0.05	4.42	0.3	<0.2	<10	130	0.96	0.22	0.02	0.10	86.7	16.5	64	11.45
WKG019		0.81	0.03	4.15	0.2	<0.2	<10	110	1.55	0.22	0.13	0.10	97.6	19.9	52	9.20
WKG020		0.94	0.12	4.60	0.3	<0.2	<10	60	1.11	0.19	0.02	0.10	51.0	12.7	58	7.73
WKG021		0.91	0.68	3.24	0.2	<0.2	<10	70	1.03	0.21	0.02	0.06	58.9	1.8	70	5.17
WKG022		0.79	0.27	1.23	0.4	<0.2	<10	90	0.50	0.78	0.04	0.07	65.4	4.6	62	2.80
WKG023		0.74	0.01	4.15	0.2	<0.2	<10	80	0.73	0.42	0.01	0.02	83.9	6.6	46	8.71
WKG024		0.77	0.10	3.92	0.3	<0.2	<10	80	1.48	0.31	0.25	0.07	39.1	15.7	68	9.92
WKG025		0.58	0.40	1.87	0.9	<0.2	<10	50	0.56	1.88	0.01	0.06	45.8	19.4	78	6.67
WKG026		0.70	0.01	4.79	0.1	<0.2	<10	90	1.05	0.21	0.01	0.01	78.9	3.1	52	8.80
WKG027		0.64	0.03	4.17	0.1	<0.2	<10	40	0.92	0.16	0.02	0.01	60.4	6.1	42	1.82
WKG028		0.70	0.22	0.24	0.3	<0.2	<10	60	0.14	1.01	0.01	0.10	49.2	2.5	25	0.25
WKG029		0.54	0.13	0.68	0.6	<0.2	<10	90	0.53	2.02	0.88	0.02	64.0	1.5	48	0.36
WKG030		0.38	3.00	1.52	908	1.6	<10	120	0.48	4.84	2.96	3.80	28.6	42.2	94	2.11

***** See Appendix Page for comments regarding this certificate *****

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Project: KG Wasterock

CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Cu	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm
	LOR	0.2	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05
WKG001		98.9	4.81	17.60	0.28	0.86	<0.01	0.095	2.34	76.7	30.2	1.58	1640	1.30	0.11	0.57
WKG002		107.5	4.31	13.90	0.14	1.06	<0.01	0.067	1.53	34.8	28.2	1.13	389	1.74	0.09	0.56
WKG003		15.4	2.48	10.85	0.09	0.61	<0.01	0.048	0.20	75.6	0.9	1.47	211	21.3	0.14	0.05
WKG004		28.6	4.58	13.85	0.20	1.06	<0.01	0.058	1.70	47.1	24.3	0.88	338	0.50	0.09	0.39
WKG005		47.9	20.0	35.2	0.26	0.19	<0.01	0.075	0.15	14.2	3.5	0.13	798	60.3	0.06	0.16
WKG006		93.9	1.55	9.12	0.11	0.40	<0.01	0.161	0.52	23.1	11.2	0.29	445	1.89	0.04	0.17
WKG007		150.0	1.31	8.06	0.11	0.93	<0.01	0.025	0.27	42.9	2.4	0.04	74	10.15	0.03	0.06
WKG008		158.5	1.70	8.90	0.11	0.89	<0.01	0.026	0.28	43.9	2.5	0.03	115	9.72	0.04	0.05
WKG009		14.8	4.95	13.40	0.20	1.02	<0.01	0.058	1.40	41.4	23.2	1.08	418	1.04	0.07	0.51
WKG010		206	3.18	6.23	0.09	0.88	<0.01	0.044	0.36	41.7	5.5	0.15	60	3.58	0.05	0.08
WKG011		55.2	4.58	14.75	0.22	1.17	<0.01	0.061	1.64	45.0	23.7	0.99	480	1.83	0.05	0.44
WKG012		55.0	4.59	14.20	0.23	1.14	<0.01	0.061	1.56	46.0	22.6	0.95	599	1.98	0.05	0.38
WKG013		10.0	0.53	11.50	0.07	0.30	<0.01	0.016	0.21	28.5	4.2	0.04	28	11.65	0.03	0.05
WKG014		35.7	4.10	16.75	0.19	1.11	<0.01	0.079	2.20	44.4	26.2	1.52	540	0.61	0.05	0.46
WKG015		22.6	2.45	9.90	0.15	0.89	<0.01	0.033	0.74	44.8	9.3	0.49	765	0.96	0.05	0.39
WKG016		11.3	1.40	7.37	0.12	0.33	<0.01	0.020	0.36	24.6	2.2	0.17	108	42.4	0.03	0.10
WKG017		108.0	1.46	2.61	2.82	0.30	0.77	0.028	0.20	3.3	2.0	0.07	127	14.70	0.02	0.09
WKG018		18.7	5.01	16.95	0.21	0.95	<0.01	0.078	2.15	46.2	30.7	1.25	491	0.40	0.05	0.52
WKG019		13.7	4.48	14.95	0.14	1.10	<0.01	0.065	1.67	50.8	27.6	1.05	292	0.83	0.06	0.36
WKG020		89.1	2.88	16.00	0.15	0.76	<0.01	0.080	1.40	26.9	28.8	0.91	334	2.21	0.05	0.30
WKG021		28.0	2.13	11.20	0.16	0.51	<0.01	0.055	0.85	31.1	11.0	0.47	148	5.52	0.08	0.23
WKG022		20.0	4.07	15.95	0.17	0.59	<0.01	0.041	0.36	36.3	4.0	0.15	133	42.0	0.06	0.06
WKG023		17.3	3.43	13.45	0.20	0.73	<0.01	0.064	1.01	41.0	15.9	0.51	115	0.43	0.10	0.26
WKG024		48.6	4.39	15.75	0.18	0.80	0.01	0.069	1.98	21.7	36.5	1.53	545	1.19	0.05	0.83
WKG025		36.0	3.64	10.10	0.25	0.74	0.01	0.057	0.75	25.6	8.0	0.62	322	42.3	0.04	0.08
WKG026		33.6	2.80	15.15	0.15	0.75	0.01	0.078	0.99	41.0	9.6	0.53	166	1.18	0.12	0.19
WKG027		73.3	0.68	9.33	0.09	0.55	0.01	0.060	0.35	31.6	11.4	0.09	33	5.37	0.05	0.05
WKG028		18.5	1.46	3.39	0.06	0.29	0.01	0.024	0.12	30.0	0.5	0.02	138	2.49	0.04	<0.05
WKG029		15.0	2.44	11.25	0.10	0.62	0.01	0.051	0.17	78.4	0.8	1.42	204	21.3	0.13	0.05
WKG030		1460	4.31	4.57	0.11	0.48	0.62	0.255	0.29	16.8	9.8	1.12	1100	7.69	0.13	0.28

***** See Appendix Page for comments regarding this certificate *****

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CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Ni	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti
	Units	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%
	LOR	0.2	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005
WKG001		35.8	60	6.9	189.5	<0.001	0.01	<0.05	19.1	1.7	2.0	12.7	0.01	0.05	16.0	0.421
WKG002		40.8	350	6.8	107.0	<0.001	0.13	0.05	10.7	0.7	1.3	32.2	<0.01	0.06	13.1	0.239
WKG003		4.2	140	28.0	8.4	0.001	0.02	0.14	5.9	1.1	1.4	119.0	<0.01	0.10	15.9	0.013
WKG004		26.3	120	8.2	139.0	<0.001	0.01	<0.05	14.0	0.5	1.9	7.7	<0.01	0.02	17.5	0.262
WKG005		44.0	760	7.4	10.4	0.001	0.03	<0.05	4.3	5.3	0.5	29.8	<0.01	0.13	11.0	0.018
WKG006		54.8	190	7.1	35.5	0.043	0.69	<0.05	6.9	0.9	1.2	116.5	<0.01	0.09	10.0	0.080
WKG007		24.5	120	23.0	12.1	0.002	0.03	0.05	3.3	7.5	0.9	24.2	<0.01	0.13	15.9	0.023
WKG008		25.4	130	22.7	11.4	0.001	0.03	0.06	3.4	7.9	1.0	24.9	<0.01	0.11	16.3	0.024
WKG009		34.9	440	5.3	120.5	<0.001	0.01	<0.05	6.4	0.3	2.0	8.8	<0.01	0.02	15.8	0.248
WKG010		32.9	360	5.5	34.3	0.011	0.72	<0.05	4.8	1.1	0.3	18.1	<0.01	0.07	19.6	0.011
WKG011		50.5	80	7.4	164.0	<0.001	0.02	<0.05	7.2	0.6	2.2	18.1	0.01	0.02	17.0	0.308
WKG012		50.9	90	7.4	158.5	<0.001	0.01	<0.05	7.0	0.6	2.1	20.3	0.01	0.02	17.2	0.290
WKG013		2.0	100	5.7	15.2	<0.001	0.04	<0.05	2.4	0.7	0.7	28.0	<0.01	0.04	12.5	0.018
WKG014		14.3	60	5.6	161.0	0.001	0.03	<0.05	15.5	0.6	1.7	6.3	<0.01	0.05	18.0	0.366
WKG015		13.6	650	15.9	59.1	<0.001	0.02	<0.05	3.7	2.2	0.7	31.9	<0.01	0.04	17.0	0.148
WKG016		6.1	180	12.8	25.7	0.031	0.21	<0.05	5.2	2.5	0.8	20.9	<0.01	0.10	8.7	0.054
WKG017		19.1	880	>10000	13.8	0.004	11.25	6.27	1.7	4.9	1.0	10.2	<0.01	0.74	5.3	0.005
WKG018		35.4	80	12.0	186.5	<0.001	0.01	<0.05	11.0	0.4	2.6	11.5	<0.01	0.05	17.5	0.363
WKG019		38.1	490	5.0	142.0	<0.001	<0.01	<0.05	9.9	0.4	1.4	10.6	<0.01	0.04	19.8	0.229
WKG020		33.3	90	5.0	109.0	0.003	0.39	<0.05	13.3	0.7	2.0	8.7	<0.01	0.04	11.7	0.221
WKG021		4.7	140	8.5	61.6	<0.001	0.19	<0.05	9.2	1.5	1.0	22.4	<0.01	0.05	14.2	0.100
WKG022		12.6	370	7.4	21.1	0.001	0.30	<0.05	5.5	2.4	1.0	82.1	<0.01	0.11	14.5	0.034
WKG023		16.7	70	8.8	99.9	<0.001	0.02	<0.05	12.4	0.3	1.6	8.2	<0.01	0.03	16.8	0.168
WKG024		37.0	1080	3.0	150.0	0.003	0.41	<0.05	12.0	0.8	1.6	6.3	<0.01	0.05	8.4	0.363
WKG025		29.8	330	9.0	62.2	0.032	1.89	0.07	13.2	5.3	1.7	20.8	<0.01	0.12	10.1	0.114
WKG026		7.8	90	12.6	187.5	<0.001	0.02	<0.05	14.8	0.7	1.3	5.4	<0.01	0.04	19.6	0.151
WKG027		12.2	160	5.1	27.5	0.002	0.17	<0.05	9.0	0.6	0.9	38.7	<0.01	0.04	14.7	0.031
WKG028		4.2	80	11.9	5.7	0.001	0.02	0.07	5.5	0.5	0.8	12.2	<0.01	0.06	10.4	0.017
WKG029		3.3	130	28.3	9.3	0.001	0.02	0.10	6.1	1.0	1.5	124.5	<0.01	0.09	16.0	0.012
WKG030		1800	480	249	29.6	0.003	0.72	59.4	5.1	4.9	3.1	64.0	<0.01	0.44	6.5	0.110

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CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	Pb- OG46	Zn- OG46
	Analyte	Tl	U	V	W	Y	Zn	Zr	Pb	Zn
	Units	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	%
	LOR	0.02	0.05	1	0.05	0.05	2	0.5	0.001	0.001
WKG001		1.25	2.06	114	0.27	25.9	121	27.9		
WKG002		0.67	2.28	79	0.62	11.45	81	47.5		
WKG003		0.07	1.92	59	0.11	19.65	8	19.1		
WKG004		0.85	3.65	61	0.64	15.80	99	42.5		
WKG005		0.94	6.27	1240	0.55	5.52	58	14.9		
WKG006		0.49	8.12	195	0.17	6.50	17	16.6		
WKG007		0.07	7.95	51	<0.05	8.67	14	32.5		
WKG008		0.07	8.25	61	<0.05	8.74	12	32.1		
WKG009		0.71	2.77	68	0.54	12.65	99	38.1		
WKG010		0.18	3.19	47	0.28	7.43	40	36.1		
WKG011		0.97	3.31	75	1.05	11.35	102	42.9		
WKG012		0.93	3.37	71	1.03	12.55	101	44.4		
WKG013		0.09	2.82	20	0.08	5.19	7	13.1		
WKG014		1.09	1.55	104	0.34	8.79	70	40.3		
WKG015		0.40	2.85	45	1.04	11.85	66	41.2		
WKG016		0.14	3.16	108	0.84	4.60	12	16.3		
WKG017		7.52	2.77	21	0.94	7.76	>10000	7.6	9.04	18.45
WKG018		1.09	2.96	76	0.53	15.00	117	37.9		
WKG019		0.83	2.94	63	0.46	12.80	95	45.0		
WKG020		0.86	2.72	81	0.19	5.94	67	28.3		
WKG021		0.41	2.26	85	0.41	5.22	32	20.1		
WKG022		0.13	3.37	226	0.19	6.31	16	24.2		
WKG023		0.60	3.68	54	0.34	8.63	39	27.5		
WKG024		0.90	1.55	97	0.84	12.05	97	31.2		
WKG025		0.42	4.01	236	1.81	5.25	48	31.8		
WKG026		1.37	2.31	68	0.13	8.12	38	29.5		
WKG027		0.18	10.95	175	0.05	8.00	13	21.6		
WKG028		0.04	4.23	21	3.52	6.30	9	14.8		
WKG029		0.08	1.95	57	0.08	20.5	7	19.5		
WKG030		0.37	1.99	56	6.50	10.35	679	18.1		

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Finalized Date: 3- MAR- 2014
Account: LINMIN

Project: KG Wasterock

CERTIFICATE OF ANALYSIS BR14013084

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).
ME- MS41

LABORATORY ADDRESSES

Applies to Method: Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia.

BAG- 01	ME- MS41	ME- OG46	Pb- OG46
PUL- 21	SPL- 21	WEI- 21	Zn- OG46

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www.alsglobal.com

Finalized Date: 3- MAR- 2014
Account: LINMIN

QC CERTIFICATE BR14013084

Project: KG Wasterock

This report is for 30 Percussion samples submitted to our lab in Brisbane, QLD, Australia on 3- FEB- 2014.

The following have access to data associated with this certificate:

JOHN PARKER	DWAYNE POVEY	

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
WEI- 21	Received Sample Weight
PUL- 21	Pulverize entire sample
SPL- 21	Split sample - riffle splitter
BAG- 01	Bulk Master for Storage

ANALYTICAL PROCEDURES

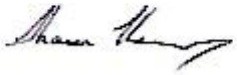
ALS CODE	DESCRIPTION	INSTRUMENT
ME- OG46	Ore Grade Elements - AquaRegia	ICP- AES
Pb- OG46	Ore Grade Pb - Aqua Regia	VARIABLE
Zn- OG46	Ore Grade Zn - Aqua Regia	VARIABLE
ME- MS41	51 anal. aqua regia ICPMS	

To: **LINCOLN MINERALS LIMITED**
ATTN: DWAYNE POVEY
28 GREENHILL ROAD
WAYVILLE SA 5034

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

***** See Appendix Page for comments regarding this certificate *****

Signature:



Shaun Kenny, Brisbane Laboratory Manager

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QC CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
STANDARDS																
GBM398-1																
Target Range - Lower Bound																
Upper Bound																
GBM903-13																
Target Range - Lower Bound																
Upper Bound																
GBM908-10		2.97	0.92	57.9	0.6	<10	100	0.30	1.29	0.68	1.76	89.8	14.3	22	0.88	3610
Target Range - Lower Bound		2.69	0.85	49.4	<0.2	<10	70	0.17	1.12	0.62	1.52	79.3	12.9	20	0.66	3380
Upper Bound		3.31	1.06	60.6	0.9	30	140	0.40	1.39	0.79	1.88	97.0	15.9	27	0.94	3880
GBM908-14																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		4.45	2.61	32.7	<0.2	<10	440	0.85	0.69	1.06	2.35	77.4	19.1	88	11.85	607
Target Range - Lower Bound		4.00	2.44	28.9	<0.2	<10	370	0.66	0.62	1.00	2.01	66.7	17.5	81	9.85	587
Upper Bound		4.92	3.00	35.5	0.6	20	530	0.94	0.78	1.24	2.47	81.5	21.6	102	12.15	675
BLANKS																
BLANK		<0.01	<0.01	<0.1	<0.2	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Target Range - Lower Bound		<0.01	<0.01	<0.1	<0.2	<10	<10	<0.05	<0.01	<0.01	<0.01	<0.02	<0.1	<1	<0.05	<0.2
Upper Bound		0.02	0.02	0.2	0.4	20	20	0.10	0.02	0.02	0.02	0.04	0.2	2	0.10	0.4
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
WKG010		0.23	1.82	0.1	<0.2	<10	40	1.45	0.26	0.04	0.01	80.6	20.8	35	2.31	206
DUP		0.24	1.94	0.1	<0.2	<10	40	1.55	0.27	0.05	0.02	81.8	22.8	37	2.33	223
Target Range - Lower Bound		0.21	1.78	<0.1	<0.2	<10	30	1.38	0.24	0.03	<0.01	77.1	20.6	33	2.15	207
Upper Bound		0.26	1.98	0.2	0.4	20	50	1.63	0.29	0.06	0.02	85.3	23.0	39	2.49	222

***** See Appendix Page for comments regarding this certificate *****

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Project: KG Wasterock

QC CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
STANDARDS																
GBM398-1																
Target Range - Lower Bound																
Upper Bound																
GBM903-13																
Target Range - Lower Bound																
Upper Bound																
GBM908-10		2.58	4.33	0.13	0.69	0.02	0.023	0.42	50.4	6.3	0.52	298	61.5	0.13	0.58	2240
Target Range - Lower Bound		2.35	4.18	0.09	0.62	<0.01	0.012	0.37	43.2	5.6	0.47	259	57.9	0.09	0.38	2030
Upper Bound		2.89	5.22	0.31	0.80	0.04	0.034	0.48	53.2	7.1	0.59	327	70.9	0.15	0.63	2480
GBM908-14																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		3.52	9.70	0.15	0.75	0.06	0.164	1.22	40.3	34.0	1.12	410	15.25	0.33	1.06	680
Target Range - Lower Bound		3.22	8.89	0.10	0.67	0.04	0.142	1.12	33.2	30.2	1.03	378	13.10	0.30	0.79	622
Upper Bound		3.96	10.95	0.32	0.87	0.10	0.184	1.40	41.0	37.2	1.29	473	16.10	0.39	1.09	760
BLANKS																
BLANK		<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Target Range - Lower Bound		<0.01	<0.05	<0.05	<0.02	<0.01	<0.005	<0.01	<0.2	<0.1	<0.01	<5	<0.05	<0.01	<0.05	<0.2
Upper Bound		0.02	0.10	0.10	0.04	0.02	0.010	0.02	0.4	0.2	0.02	10	0.10	0.02	0.10	0.4
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
WKG010		3.18	6.23	0.09	0.88	<0.01	0.044	0.36	41.7	5.5	0.15	60	3.58	0.05	0.08	32.9
DUP		3.34	6.51	0.08	0.89	0.01	0.046	0.38	42.0	5.8	0.16	63	3.71	0.06	0.07	34.0
Target Range - Lower Bound		3.09	6.00	<0.05	0.82	<0.01	0.038	0.34	39.6	5.3	0.14	53	3.41	0.04	<0.05	31.6
Upper Bound		3.43	6.74	0.10	0.95	0.02	0.052	0.40	44.1	6.0	0.17	70	3.88	0.07	0.10	35.3

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QC CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
STANDARDS																
GBM398-1																
Target Range - Lower Bound																
Upper Bound																
GBM903-13																
Target Range - Lower Bound																
Upper Bound																
GBM908-10		820	2000	29.2	0.001	0.37	1.43	2.0	0.6	1.7	32.4	<0.01	0.05	17.1	0.303	0.23
Target Range - Lower Bound		760	1860	27.6	<0.001	0.33	1.06	1.8	0.5	1.2	30.8	<0.01	0.02	15.2	0.276	0.15
Upper Bound		960	2270	34.0	0.003	0.43	1.55	2.4	1.3	2.2	38.0	0.03	0.07	19.0	0.348	0.27
GBM908-14																
Target Range - Lower Bound																
Upper Bound																
MRGeo08		980	1045	138.0	0.009	0.30	3.77	7.6	1.2	3.5	82.9	0.01	0.03	21.7	0.366	0.84
Target Range - Lower Bound		900	959	132.0	0.007	0.27	2.80	6.8	0.9	2.8	73.2	<0.01	<0.01	19.5	0.350	0.66
Upper Bound		1130	1175	162.0	0.011	0.36	3.90	8.6	1.9	4.0	89.9	0.04	0.04	24.3	0.439	0.94
BLANKS																
BLANK		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	0.01	<0.2	<0.005	<0.02
Target Range - Lower Bound		<10	<0.2	<0.1	<0.001	<0.01	<0.05	<0.1	<0.2	<0.2	<0.2	<0.01	<0.01	<0.2	<0.005	<0.02
Upper Bound		20	0.4	0.2	0.002	0.02	0.10	0.2	0.4	0.4	0.4	0.02	0.02	0.4	0.010	0.04
BLANK																
Target Range - Lower Bound																
Upper Bound																
DUPLICATES																
WKG010		360	5.5	34.3	0.011	0.72	<0.05	4.8	1.1	0.3	18.1	<0.01	0.07	19.6	0.011	0.18
DUP		370	5.9	35.3	0.010	0.76	0.09	4.8	1.2	0.3	19.3	<0.01	0.07	19.4	0.012	0.19
Target Range - Lower Bound		340	5.2	33.0	0.009	0.69	<0.05	4.5	0.9	<0.2	17.6	<0.01	0.06	18.3	0.006	0.15
Upper Bound		390	6.2	36.6	0.012	0.79	0.10	5.1	1.4	0.4	19.8	0.02	0.08	20.7	0.017	0.22

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QC CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	Pb- OG46	Zn- OG46
	Analyte	U	V	W	Y	Zn	Zr	Pb	Zn
	Units	ppm	ppm	ppm	ppm	ppm	ppm	%	%
	LOR	0.05	1	0.05	0.05	2	0.5	0.001	0.001
STANDARDS									
GBM398- 1								2.59	2.00
Target Range - Lower Bound								2.58	1.965
Upper Bound								2.77	2.11
GBM903- 13								2.10	0.902
Target Range - Lower Bound								2.07	0.901
Upper Bound								2.23	0.968
GBM908- 10		1.34	48	2.15	20.7	1010	28.7		
Target Range - Lower Bound		1.15	41	1.57	17.55	939	24.0		
Upper Bound		1.51	53	2.24	21.6	1155	33.6		
GBM908- 14								3.35	4.42
Target Range - Lower Bound								3.18	4.12
Upper Bound								3.41	4.42
MRGeo08		5.99	99	3.20	21.8	763	22.4		
Target Range - Lower Bound		4.99	90	2.44	17.85	708	18.1		
Upper Bound		6.21	112	3.42	21.9	870	25.7		
BLANKS									
BLANK		<0.05	<1	<0.05	<0.05	<2	<0.5		
Target Range - Lower Bound		<0.05	<1	<0.05	<0.05	<2	<0.5		
Upper Bound		0.10	2	0.10	0.10	4	1.0		
BLANK								<0.001	<0.001
Target Range - Lower Bound								<0.001	<0.001
Upper Bound								0.002	0.002
DUPLICATES									
WKG010		3.19	47	0.28	7.43	40	36.1		
DUP		3.10	50	0.28	7.71	42	37.2		
Target Range - Lower Bound		2.94	45	0.21	7.14	37	33.4		
Upper Bound		3.35	52	0.35	8.00	45	39.9		

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Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Ag	Al	As	Au	B	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu
	Units	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm
	LOR	0.01	0.01	0.1	0.2	10	10	0.05	0.01	0.01	0.01	0.02	0.1	1	0.05	0.2
DUPLICATES																
WKG030		3.00	1.52	908	1.6	<10	120	0.48	4.84	2.96	3.80	28.6	42.2	94	2.11	1460
DUP		3.03	1.54	917	1.7	<10	120	0.51	4.78	2.99	3.84	28.9	43.1	95	2.15	1470
Target Range -	Lower Bound	2.85	1.44	867	1.4	<10	100	0.42	4.56	2.82	3.62	27.3	40.4	89	1.97	1415
	Upper Bound	3.18	1.62	958	1.9	20	140	0.57	5.06	3.13	4.02	30.2	44.9	100	2.29	1515

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Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	Fe	Ga	Ge	Hf	Hg	In	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni
	Units	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm
	LOR	0.01	0.05	0.05	0.02	0.01	0.005	0.01	0.2	0.1	0.01	5	0.05	0.01	0.05	0.2
DUPLICATES																
WKG030		4.31	4.57	0.11	0.48	0.62	0.255	0.29	16.8	9.8	1.12	1100	7.69	0.13	0.28	1800
DUP		4.36	4.65	0.12	0.48	0.63	0.260	0.29	17.0	9.8	1.14	1120	7.61	0.13	0.28	1785
Target Range - Lower Bound		4.11	4.33	0.06	0.44	0.57	0.240	0.27	15.9	9.2	1.06	1050	7.22	0.11	0.22	1705
Upper Bound		4.56	4.89	0.17	0.52	0.68	0.275	0.31	17.9	10.4	1.20	1170	8.08	0.15	0.34	1880

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QC CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41
	Analyte	P	Pb	Rb	Re	S	Sb	Sc	Se	Sn	Sr	Ta	Te	Th	Ti	Tl
	Units	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm
	LOR	10	0.2	0.1	0.001	0.01	0.05	0.1	0.2	0.2	0.2	0.01	0.01	0.2	0.005	0.02
DUPLICATES																
WKG030		480	249	29.6	0.003	0.72	59.4	5.1	4.9	3.1	64.0	<0.01	0.44	6.5	0.110	0.37
DUP		470	252	30.0	0.003	0.72	60.8	5.1	5.0	3.2	64.8	<0.01	0.42	6.5	0.111	0.38
Target Range - Lower Bound		440	238	28.2	0.002	0.67	55.5	4.7	4.5	2.8	61.0	<0.01	0.40	6.0	0.100	0.33
Upper Bound		510	263	31.4	0.004	0.77	64.7	5.5	5.4	3.5	67.8	0.02	0.46	7.0	0.121	0.42

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QC CERTIFICATE OF ANALYSIS BR14013084

Sample Description	Method	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	ME- MS41	Pb- OG46	Zn- OG46
	Analyte	U	V	W	Y	Zn	Zr	Pb	Zn
	Units	ppm	ppm	ppm	ppm	ppm	ppm	%	%
	LOR	0.05	1	0.05	0.05	2	0.5	0.001	0.001
DUPLICATES									
WKG030		1.99	56	6.50	10.35	679	18.1		
DUP		1.94	56	6.66	10.40	685	18.1		
Target Range - Lower Bound		1.82	52	6.04	9.81	646	16.2		
Upper Bound		2.11	60	7.12	10.95	718	20.0		

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Finalized Date: 3- MAR- 2014
Account: LINMIN

Project: KG Wasterock

QC CERTIFICATE OF ANALYSIS BR14013084

CERTIFICATE COMMENTS

ANALYTICAL COMMENTS

Applies to Method: Gold determinations by this method are semi- quantitative due to the small sample weight used (0.5g).
ME- MS41

LABORATORY ADDRESSES

Applies to Method: Processed at ALS Brisbane located at 32 Shand Street, Stafford, Brisbane, QLD, Australia.

BAG- 01	ME- MS41	ME- OG46	Pb- OG46
PUL- 21	SPL- 21	WEI- 21	Zn- OG46

CERTIFICATE OF ANALYSIS

Work Order	: **EB1442586**	Page	: 1 of 4
Amendment	: **1**		
Client	: **ALS AMMTEC (FORMERLY BURNIE RESEARCH LABORATORY)**	Laboratory	: Environmental Division Brisbane
Contact	: THE RESULTS ADDRESS	Contact	: Customer Services EB
Address	: Unit 3/1 Burma Rd Pooraka Adelaide 5095	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: burnielab@alsglobal.com	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: 03 6431 6333	Telephone	: +61-7-3243 7222
Facsimile	: 03 6431 6896	Facsimile	: +61-7-3243 7218
Project	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 17-Sep-2014 08:55
Sampler	: ----	Issue Date	: 24-Sep-2014 11:56
Site	: ----		
		No. of samples received	: 3
Quote number	: ----	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Inorganics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics
Satishkumar Trivedi	2 IC Acid Sulfate Soils Supervisor	Brisbane Acid Sulphate Soils

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- **ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.**
- **EP071: Sample 'Slime' required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly.**
- **This report has been amended following a request to add Aaron Einthal to the deliverables. All results are as per the previous report.**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Rongber tail	C/nr tail	Slime	----	----
			Client sampling date / time	[16-Sep-2014]	[16-Sep-2014]	[16-Sep-2014]	----	----
Compound	CAS Number	LOR	Unit	EB1442586-001	EB1442586-002	EB1442586-003	--------	--------
				Result	Result	Result	Result	Result
EA009: Nett Acid Production Potential								
^ Net Acid Production Potential	----	0.5	kg H2SO4/t	-9.4	-25.6	-20.4	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	7.6	8.5	8.1	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	<0.1	<0.1	<0.1	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	10.0	26.2	21.6	----	----
^ ANC as CaCO3	----	0.1	% CaCO3	1.0	2.7	2.2	----	----
Fizz Rating	----	0	Fizz Unit	0	1	1	----	----
EA031: pH (saturated paste)								
pH (Saturated Paste)	----	0.1	pH Unit	8.3	8.4	8.2	----	----
EA032: Electrical Conductivity (saturated paste)								
Electrical Conductivity (Saturated Paste)	----	1	µS/cm	273	611	275	----	----
EA055: Moisture Content								
^ Moisture Content (dried @ 103°C)	----	1	%	<1.0	<1.0	<1.0	----	----
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	180	210	----	----
ED040N: Sulfate - Calcium Phosphate Soluble (NEPM)								
Sulfate as SO4 2-	14808-79-8	50	mg/kg	<50	80	<50	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	0.02	0.02	0.04	----	----
EG048: Hexavalent Chromium (Alkaline Digest)								
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	<0.5	<0.5	----	----
EK085M: Sulfide as S2-								
Sulfide as S	----	0.01	%	0.02	0.01	0.03	----	----
EP003TIC: Total inorganic Carbon (TIC) in Soil								
^ Total Inorganic Carbon	----	0.02	%	0.47	3.85	0.41	----	----
EP080/071: Total Petroleum Hydrocarbons								
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<60	----	----
C15 - C28 Fraction	----	100	mg/kg	<100	<100	<110	----	----
C29 - C36 Fraction	----	100	mg/kg	<100	<100	<110	----	----
^ C10 - C36 Fraction (sum)	----	50	mg/kg	<50	<50	<60	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	Rongber tail	C/nr tail	Slime	----	----
				Client sampling date / time	[16-Sep-2014]	[16-Sep-2014]	[16-Sep-2014]	----	----
Compound	CAS Number	LOR	Unit		EB1442586-001	EB1442586-002	EB1442586-003	--------	--------
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	>C10_C16	50	mg/kg		<50	<50	<60	----	----
>C16 - C34 Fraction	----	100	mg/kg		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	mg/kg		<100	<100	<100	----	----
^ **>C10 - C40 Fraction (sum)**	----	50	mg/kg		<50	<50	<60	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	50	mg/kg		<50	<50	<60	----	----

Appendix J

Mine access road assessment

Lincoln Minerals Pty Ltd

Kookaburra Gully Graphite Mine Access Roads Assessment and Budget Cost Estimate

8 October 2014

PARSONS BRINCKERHOFF

Document information
Client: Lincoln Minerals Pty Ltd Title: Kookaburra Gully Graphite Mine Access Roads Subtitle: Assessment and Budget Cost Estimate Document No: 14-0023-01-2200002A Date: 8 October 2014

Rev	Date	Details
00	11/02/2014	Draft report
01	08/10/2014	Final

Author, Reviewer and Approver details			
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Approved by:	Lissa van Camp	Date: 08/10/2014	Signature: pp

Distribution
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A GRI Rating: Sustainability Report 2011

8 October 2014

Our ref: 14-0023-01-2200002A

Mr A John Parker
Lincoln Minerals
Managing Director
28 Greenhill Road
WAYVILLE SA 5034

Dear John

Kookaburra Gully Graphite Mine Access Roads Assessment and Budget Cost Estimate

Parsons Brinckerhoff has prepared a Road Assessment and Cost Estimate for upgrading of access roads to the mine site linking with the Lincoln Highway on the Eyre Peninsula from the north and south.

A field assessment of the roads between the Lincoln Highway and Mine Site was conducted in the company of Lincoln Minerals Senior Geologist Dwayne Povey and District Council Tumby Bay Engineer Damien Windsor.

Based on this site inspection, advice on necessary site work is included that would provide safety, amenity and a serviceable pavement for the period of at least seven years of mine operation. Due to the number of transport options available to Lincoln Minerals, several alternative routes have been considered and costed.

The estimate is based on use of local materials and contractors and receiving approval and cooperation from the local District Council of Tumby Bay, under whose jurisdiction most of the route presides, and the State Government Department of Planning Transport and Infrastructure which manages the Lincoln Highway and Bratten Way.

Yours sincerely

Colin Best

Colin Best
Study Manager - Infrastructure

Contents

Page number

1. Introduction 1
2. Methodology 2
3. Appreciation of the tasks involved 3
   - 3.1 Information defining the scope 3
   - 3.2 The study 3
4. Estimate 5
   - 4.1 Cost of construction – base price 5
   - 4.2 Contingency allowance 5
   - 4.3 Costs of engineering, procurement and construction management 5
   - 4.4 Final price 5
5. Conclusions 6

List of tables

Page number

Table 4.1 Base price cost of construction 5
Table 4.2 Recommended budget price 5

List of appendices

Appendix A Locality plan
Appendix B Upgrading of northern intersection
Appendix C Estimating cost breakdowns

1. Introduction

Parsons Brinckerhoff was commissioned by Lincoln Minerals to review the current state of roads leading from the north and south to the Kookaburra Gully mine site, and report on their general condition and suitability to carry both car and truck traffic, and supply high level cost estimates for any upgrading considered necessary.

At this stage of the development process, Lincoln Minerals was keen not to be too prescriptive on their preferences of access routes, so that the author could present a totally independent assessment that could be used as a framework for future decisions relating to car access and transport of graphite, and enable Lincoln Minerals to consider the maximum number of transport routes.

Due to timelines and the primary need at this stage to highlight the major factors affecting transport planning, a high level estimate of 40% accuracy has been prepared based on relatively limited information. This report's recommendations can also be used in early discussions with Council and DPTI, providing an opportunity to fully determine the scope of upgrading deemed necessary by statutory authorities for the various transport options available to Lincoln Minerals.

2. Methodology

The study was performed in the following manner:

- Preparatory work on mapping to assist with the gathering of site information.
- A site visit to familiarize ourselves with the local conditions and state of the road, to better define the scope of work necessary to upgrade the current road up to the required standard.
- Discussions with local contractors on likely rates, to be used in formulating the estimate.
- Discussions with the local Council Engineer to discuss available materials and the likely limits of work.
- Formulation of a breakdown of likely work in the various sections of the three route options to assist in the estimating process.
- Formulation of the estimate.
- Completion of the report, with recommendations for going forward.

3. Appreciation of the tasks involved

3.1 Information defining the scope

The Consultants Brief issued to Parsons Brinckerhoff outlined the general scope of the works and also called for Parsons Brinckerhoff to consider three optional road alignments heading north and south from the Kookaburra Gully Mine Site (refer Appendix A Locality Plan).

The first option, to the north traverses Bratten Way from the Lincoln Highway near Tumby Bay. This includes a distance of 11 km from Tumby Bay along Bratten Way to the turnoff onto Pillaworta Road. The mine site at Kookaburra Gully is 7.9 km further along Pillaworta Road.

The second and third options leading from the mine site to the south continue along Pillaworta Road a distance of 4.6 km to the intersection of Bailla Road and White Flat Road. Option 2 follows Bailla Road a distance of 9.3 km to the intersection of Lincoln highway. Option 3 follows White Flat Road a distance of 17.7 km until it intersects with the Lincoln Highway at Pooninde.

Lincoln Minerals provided information on expected production rates. This translated into transport requirements of 27T payload semi-trailers leaving every two hours during daylight hours. The absolute peak would be one per hour later in the life of the mine.

The author considers that the use of conventional semi-trailers would be the most appropriate for this project. The site visit confirmed that the local roads are not of high grade and extensive road reconstruction would be needed to improve realignment and sight distance to accommodate a B-Double configuration.

Other traffic to the mine would include services vehicles delivering reagents and fuel (1–2 per week) and mine workers travelling to site (expected 20–30 per day). During the construction stage this number would increase however this would be balanced no haulage vehicles carrying graphite to market.

It is anticipated that a high percentage of workers would be local, accessing the site from Tumby Bay, however there is the expectation that some could be coming from Port Lincoln.

3.2 The study

The study at this relatively early stage of development made the following assumptions:

- Limestone based materials for road making will be available from Council quarries located nearby, or from a commercial quarry (Cave Quarries). Council has indicated that it may be able to facilitate the process of winning rubble from local field pits, which would be the cheapest option, however due to the uncertainty of location and availability, the estimates included in this report are based predominantly on using commercial quarries.
- Native vegetation is encroaching on the existing alignment and will have to be cleared or trimmed to a reasonable extent from the verges to enable road widening and particularly to provide adequate sight distance.
- Road pavements have been designed for “fit for purpose” and have no extra contingency on pavement thickness. This has been based on the assumption that Lincoln Minerals would prefer to keep

expenditure to a minimum in the early stages of the project. In time, if some rework is necessary in some sections of the road, this can be easily done at that stage, as part of the maintenance procedure.

- No bridging structures have been allowed for. Flood ways are evident along Pillaworta Road, and several more have been allowed for in the estimate. Due to the relatively low numbers of transport vehicles accessing the mine, it is anticipated that trucking operations could be delayed during periods of very high rainfall when the roads would be most prone to damage.
- No sealing of roads is recommended except for a short distance near the intersection of Bratten Way and Pillaworta Road where trucks heading north will be coming down a relatively steep section to Bratten Way. In the estimate, an allowance has been made for the use of a bitumen based dust suppressant in areas where dust could cause a problem for surrounding neighbours.
- No allowance has been made for services relocation. No services were observed as needing relocation, however this could become evident during final design.

The Routes that have been costed are as follows.

Route 1

- Trucks heading south from mine along Pillaworta Road then along Howard and White Flat Roads to Poonindie; plus
- Cars travelling along same route south plus some also travelling north to Tumby Bay by way of Pillaworta Road and Bratten Way.

Route 2

- Trucks heading south from mine along Pillaworta Road then along Bailla Road to the Lincoln Highway; plus
- Cars travelling along same route south plus some also travelling north to Tumby Bay by way of Pillaworta Road and Bratten Way.

Route 3

- Trucks heading north from Mine along Pillaworta Road then along Bratten Way to the Lincoln Highway / Tumby Bay; plus
- Cars traveling same route but also some travelling south using Bailla Road.

4. Estimate

4.1 Cost of construction – base price

Table 4.1 Base price cost of construction

Route	Description	Base price cost
Route 1	Trucks south to Poonindie, cars north and south.	$2.031m
Route 2	Truck south via Bailla Road, cars north and south.	$1.382m
Route 3	Trucks and cars north via Bratten Way and some cars south along Bailla Road	$0.945m

Full details of the makeup of these prices are shown in Appendix C.

4.2 Contingency allowance

At this early stage of project development, where a concept design has been sufficiently developed primarily to give an indicative cost, a contingency allowance needs to be added to cover unknowns and the variability of site conditions relating to strength of existing pavements and drainage conditions.

We recommend that a + 20% allowance should be made as a contingency.

4.3 Costs of engineering, procurement and construction management

In normal circumstances, an allowance for a consultant to handle Engineering, Procurement and Construction Management (EPCM) would be in the range of 15–20%.

In this case, due to what would appear to be a relatively straight forward project, an allowance at the lower end of the scale of 15% should be made.

4.4 Final price

The final recommended budget price (excluding GST) for the options, based on assumptions outlined in Item 2.2 would therefore be:

Table 4.2 Recommended budget price

Route	Base price	Including Contingency	EPCM Allowance	Total (excl. GST)
Route 1	$2.031m	$2.4m	$0.36m	$2.76m
Route 2	$1.382m	$1.66m	$0.25m	$1.91m
Route 3	$0.945m	$1.13m	$0.17m	$1.30m

Mention has been made of the need to minimize dust outside farms along the route. An effective solution that has economical maintenance costs involves the use of Polymers that have a bitumen base that is worked into the unsealed pavement outside the farm entrances. This is accomplished using a water cart and reworking the pavement with a grader. A length of 100 m is recommended, and would cost $9,000 to install each location. Maintenance would involve a top up water cart application once per year with an occasional reworking of the surface.

5. Conclusions

The costings show that transport of product is most economically done by accessing roads to the north. The northern access route would be made even more economical if no cars from the mine were permitted to travel south. This would decrease the $945,000 base price by $285,000, to $660,000, due to the fact that there would be no impact on that section of the road due to the development of the mine.

Not only is the upgrade of the road through White Flat the most expensive option, it is also probably the least safe, due to the reported extra use made of this route by local traffic.

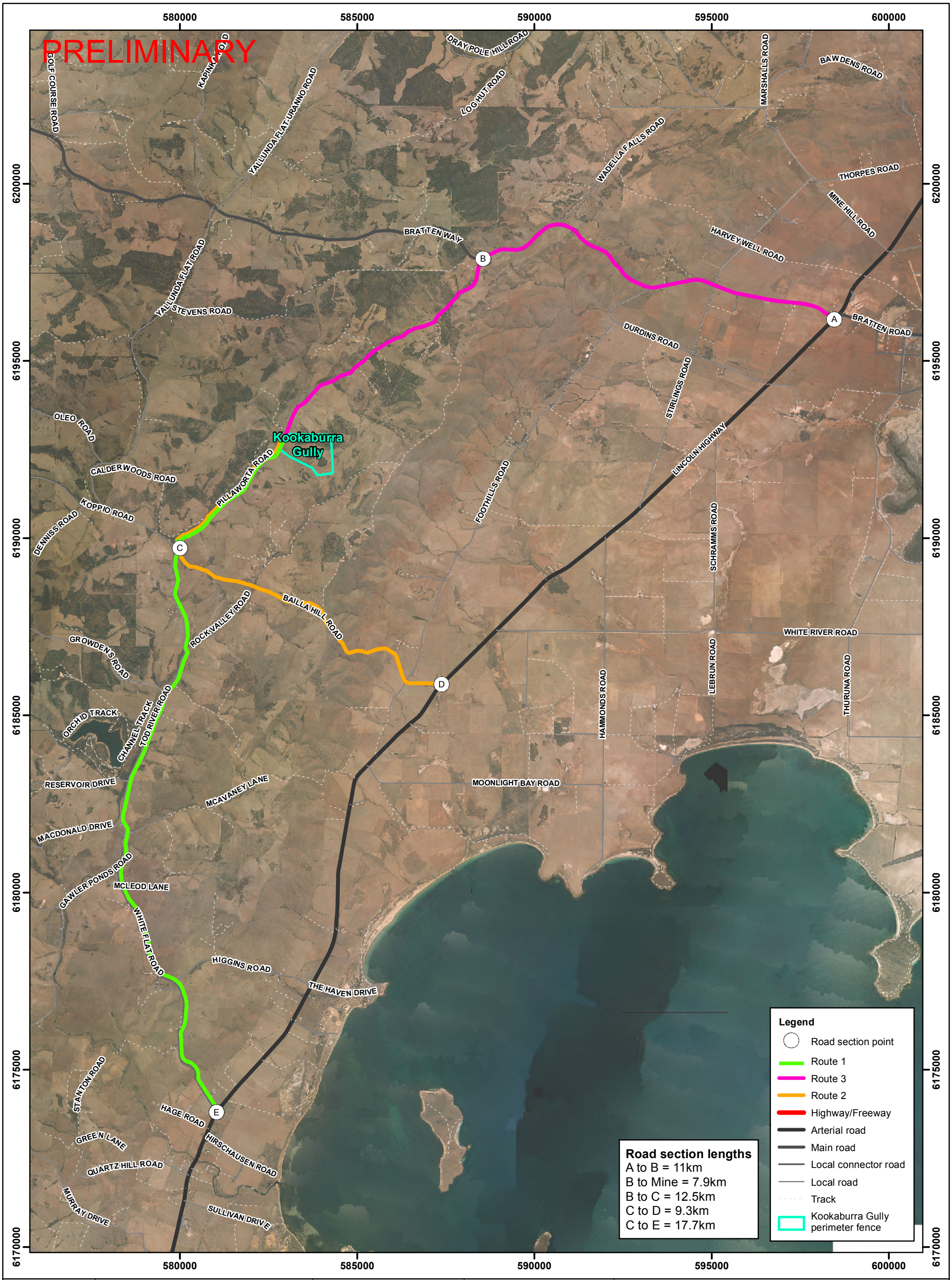
Therefore, if a transport option to the south was to be contemplated, the whole of transport costs including shipping and trucking would need to be analysed. Factors such as extra truck time taken by the more indirect route to the north would need to be evaluated, as well as the cost of road upgrading of the road options.

It is recommended that Council and DPTI should be consulted at an early stage if it is expected that transport of ore is contemplated in the near future. The time to manage the design and construction of the northern option (Route 3) would be far shorter than the alternatives, but still involve at least 6 to 12 months to complete the approvals and construction phase once a decision has been made to proceed.

Appendix A

Locality plan

PRELIMINARY



Road section lengths
A to B = 11km
B to Mine = 7.9km
B to C = 12.5km
C to D = 9.3km
C to E = 17.7km

Legend
- Road section point
- Route 1
- Route 3
- Route 2
- Highway/Freeway
- Arterial road
- Main road
- Local connector road
- Local road
- Track
- Kookaburra Gully perimeter fence

PARSONS BRINCKERHOFF

Data source: Lincoln Minerals, Geoscience Australia, Mapland

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esri Partner Network Silver

Map no: 2200002A_GIS_003_A2
Author: RP
Approved by: -
Date: 11/02/2014

0 1,000 2,000 m
1:100,000
N

Scale ratio correct when printed at A3
Projection: Transverse Mercator
Coord sys: GDA 1994 MGA Zone 53

Kookaburra Gully Graphite Mine Access Roads
Figure 1
Locality Plan

LINCOLN MINERALS

\\APADLFIL01\proj\L\Lincoln_Minerals\2200002A_KOOKABURRA_KOPPIO_ENVIRONMENT\10_GIS\Projects\Maps\2200002A_GIS_003_A2.mxd

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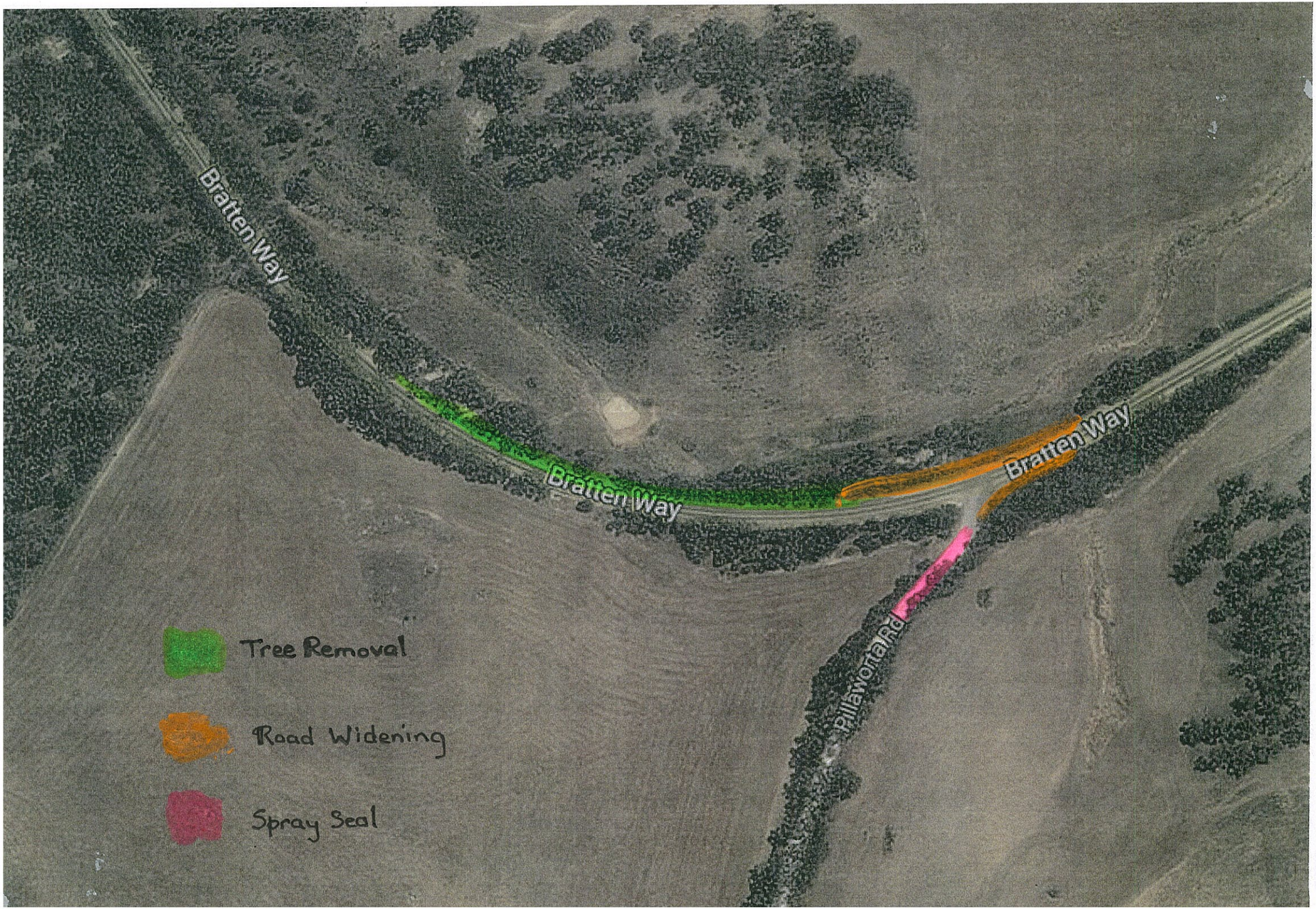
Appendix B

Upgrading of northern intersection


Bratten Way
Bratten Way
Bratten Way
Pillawonta Rd
Tree Removal
Road Widening
Spray Seal

Appendix C

Estimating cost breakdowns

C1. Estimating cost breakdowns

C1.1 Basis of estimate

The cost of Plant, Labour and Materials used in the estimating process was based on rates supplied by Cave Quarries, (see attached), Contractor located closest to the site and with quarries capable of supplying all road making materials. The Company also has a proven ability to perform the works.

The works can be broken down into two main processes, road upgrading and bulk earthworks.

Using the rates provided, a typical crew was costed at approximately $1,000 per hour for both types of operation.

The various options for road transport routes were then considered. Each route was analysed as to its general state and level of upgrading necessary. Particularly unusual and more complex areas requiring specialized earthworks were analysed separately. The road upgrading range was divided into “good” to “poor” current standard, with two different thicknesses of base course stipulated according to each particular area, as well as different rates of progress for the work necessary in each area.

The classifying of the existing quality of roads and necessary improvement in alignment and pavement improvement, including drainage was based on the site visit where a large number of photographs were taken along with a voice recording of the drive-through.

A consequence of the visit being undertaken in fine weather meant that the quality of drainage of the road could only be determined from reports by others, and witnessing tell-tale signs of past storm activity. For that reason an accuracy of ±40% was seen as reasonable and appropriate; the differential between the prices of the various options was also seen of use in determining the best options going forward.

C1.2 Estimating process and results

The analysis showed that the range of costs of road upgrading per km varied according to the level of service and the type of vehicle and the current state of the road, and these values corresponded closely to past experiences of similar studies undertaken by the author.

Travelling north

Much of the route uses sealed DPTI roads that currently carry grain haulage trucks and no costs have been included for normal car and semi-trailer use of those roads. At the Intersection of Bratten Way and Pillaworta Road an allowance for expenditure of $300,000 has been made to carry out the works as outlined in Appendix B. These works include widening of the carriageway to create a slipway on the southern entrance to Pillaworta Road and added width to accommodate whatever lane design deemed necessary for protection of trucks entering Bratten Way from the south. Allowance has also been made for sealing of a steep section leading into Pillaworta Road and for tree removal on the verge of Bratten Way to improve sight distance to the west.

It is the author’s opinion that a warrant currently exists for this tree removal, independent of the mine application process, to enhance the safety for grain carrying trucks exiting from Pillaworta. The considerable amount of fill required to create the extra carriageway width could be obtained from the excavation of a steep crest currently existing immediately south of the intersection in Pillaworta Road.

The rest of the 7.9 km of Pillaworta Road requires relatively little work in some areas but considerably more in others where road widening and reshaping were required. Trimming of overhanging vegetation is also required in a number of areas as well.

Travelling south

The southern roads present several challenges, and rates for costs of upgrading varied considerably in different areas. In Pillaworta Road, close to the intersection with the White Flat Road there exists an unusual and potentially dangerous alignment over a concrete drainage structure that would require close attention.

On leaving Pillaworta Road, the two route options present themselves. These are Bailla Road and White Flat Road. Due to problems with drainage reportedly along White Flat Road, the extra length, and extra interfacing with local traffic, this option was not only more expensive, but also seen as less safe. Bailla Road on the other hand was shorter, more independent of other traffic and had better drainage as a consequence of following ridge lines over sections of its route. No allowance was made for any upgrading of the intersection of Bailla Road with the Lincoln highway because it is understood that DPTI has authorized that route as suitable for quarry traffic accessing from the nearby quarry off Bailla Road.

Cave Quarries

PO Box 26, Tumby Bay SA 5605
Office 08 8688 2247
Anthony Cave 0427 882 247
cavequarries@internode.on .net

07/02/2014

Attention: Colin Best
cbest@pb.com.au

QUOTE

All Machines with Operators

Labour	$55	per Hour
Loader	$135	per Hour
Grader (Final Trim)	$145	per Hour
14t Vibe Roller	$130	per Hour
30t Dozer	$185	per Hour
Rigid Water Cart	$125	per Hour
Semi Water Cart	$145	per Hour
Side Tipper	$145	per Hour
30t Excavator	$145	per Hour
Bobcat with Lazer Box	$135	per Hour

Materials Price “at Pit”

PM 2/20 Quarry Rubble	$23	per Tonne

All Prices quoted are GST Exclusive

Kind Regards,

_____
Anthony Cave
Managing Director
CAVE QUARRIES

Appendix K

Greenhouse gas assessment

K1 Greenhouse Gas Emission Calculations

A1.1.1 Construction equipment – combustion emissions

Type	Activity	Purpose	QUANTITY	No of trips per year per vehicle	Total km travelled per year	Fuel consumption rate (l/km)	Total fuel used per year kL	Total tCO2-e	Assumptions	Referring website
Transport	Transport	Light vehicles (workforce commuting to and from site)	N/A	N/A	1,603,800	0.081	129.91	347.00	See Workforce commuting to site caluclations and assumptions below.	Fuel consuption based on Toyota Hilux 4x2 Diesel double cab from www.greenvehicleguide.gov.au
Type	Activity	Purpose	QUANTITY	No of km per day average per vehicle	Total km of operation per unit of equipment per year	Fuel consumption rate (l/km)	Total fuel used per year kL	Total tCO2-e	Assumptions	Referring website
Transport	Transport	Light vehicles (around the site only)	30	80	14640	0.102	44.80	58.03	All light vehicle numbers and daily kilometers return Lincoln to site	Fuel consumption based on Toyota Hilux 4x4 single cab diesel from www.greenvehicleguide.gov.au
Transport (Scope 3)	Transport of equipment, materials, supplies and consumables	Truck transport of construction materials and equipment, supplies and consumables	5	1100	143000	0.53	357.50	73.14	Assume 4.75 trucks (combination of B-doubles (or equivalent) and single trailers) delivering construction equipment, supplies and consumables to site, with deliveries occurring 5 days a week for 26 weeks during construction. All considered to be scope 3 emissions as they are outside the project boundaries and performed by external parties on external roads. Assume 50% from Port Augusta and 50% from Adelaide.	Fuel consumption based on Bunker Freight study, Figure 1 (http://www.ret.gov.au/energy/Documents/energyefficiencyopps/bunker_web20080702155954.pdf) 1.9km/litre converted to 53litres/100km.
Type	Activity	Purpose	QUANTITY	No of trips per year per vehicle	Total hours of operation per unit of equipment per year (12/7 x 26 wks operations)	Fuel consumption rate (l/hour)	Total fuel used per year kL	Total tCO2-e	Assumptions	Referring website
Stationary	Mining prestrip	Portable lighting towers	4	N/A	585.6	1.67	3.91	10.45	Number of lighting towers assumed as not specified in PFS. Assume lighting towers used on average for 4 hours per day at 80% availability for safety and compliance with EPA conditions.	Fuel consumption for a typical lighting tower taken from http://www.wanco.co

										m/products/detail.php?prd_id=90&type_id=4#details
Stationary	Construction	Portable lighting towers	4	N/A	585.6	1.67	3.91	10.45	Number of lighting towers assumed as not specified in PFS. Assume lighting towers used on average for 12 hours per day at 80% availability.	Fuel consumption for a typical lighting tower taken from http://www.wanco.com/products/detail.php?prd_id=90&type_id=4#details
Type	Activity	Equipment	QUANTITY	Weekly operating hours per unit of equipment	Total hours of operation per unit of equipment per year	Fuel consumption rate (l/hour)	Total fuel used per year kL	Total tCO2-e	Assumptions	Referring website
Stationary	Mining prestrip	150t Excavator	1	63.00	1638.00	60.00	98.28	262.52	Assumed operation 12/7 with 75% availability for 10.5months of pre-strip activities.	No fuel consumption data available. Assume 60l/h.
Stationary	Mining prestrip	CAT 777 haul truck	2	63.00	1638.00	65.50	214.58	573.16	Assumes trucks operate 50% of the time at low application and 50% of the time at medium application. Assumes 12/7 operation and 75% overall fleet availability for 10.5months of pre-strip activities.	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012)
Stationary	Mining prestrip	Grader (assume CAT 14M)	1	67.20	1747.20	20.00	34.94	93.34	Grader data based on CAT14M as no model specified. Assumes grader operates at medium application and assumes 12/7 operation and 80% availability for full 12months of construction period (preparing for prestrip and maintaining pit, near pit and haul roads).	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012)
Stationary	Mining prestrip	Water cart (assume CAT 777G WTR)	1	67.20	1747.20	56.00	97.84	261.35	Assumes water truck only operates 12/7 with 80% availability for full 12months of construction period (preparing for prestrip and maintaining pit, near pit and haul roads, plus supporting pre-strip operation).	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012) based on CAT 777 haul truck at low application as no specific water truck fuel consumption data availabile.
Stationary	Mining prestrip	CAT D11 dozer	1	63.00	1638.00	84.40	138.25	369.27	Dozer fleet model and numberasusmed. Assumes dozers operate at low application. Assumes 12/7 operation and 75% overall fleet availability for 6months of pre-strip activities.	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012)
Stationary	Mining prestrip support vehicles	Fuel trucks and maintenance vehicles - LPG	6	67.2	1747.2	12.00	125.80	192.69	General allowance only. Assumes 12/7 operation and 80% overall availability for 10.5months of pre-strip activities.	No fuel consumption data available. Assume 12//h as an approximate fuel consumption only to cover assorted vehicles.

Stationary	Civil construction	Water cart	1	67.20	1747.20	56.00	97.84	261.35	Assumes water truck only operates 12/7 with 80% availability for full 12months of construction period (access road, airstrip, general site roads and hardstand areas).	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012) based on CAT 777 haul truck at low application as no specific water truck fuel consumption data availabile.
Stationary	Civil construction	Grader	1	67.20	1747.20	20.00	34.94	93.34	Assumes grader operates at medium application and assumes 12/7 operation and 80% availability for full 12months of construction period (access road, airstrip, general site roads and hardstand areas).	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012) based on CAT14M.
Stationary	Civil construction	Dozer	1	63.00	1638	100.00	163.80	437.53	Assumes dozer operates at 50% low application and 50% medium application. Assumes 24/7 operation and 75% overall availability for 8months of civil construction period (access road, airstrip, generatl site roads, hardstands areas and bulk earthworks).	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012) based on CAT D11 dozer.
Stationary	Civil construction	Impact roller	1	67.20	1747.20	13.00	22.71	60.67	Assumes roller operates at low application. Assumes 12/7 operation and 80% overall availability for 8months of civil construction period (access road, airstrip, generatl site roads, hardstands areas and bulk earthworks).	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012) based on CAT CS-423E.
Stationary	Construction equipment	20t crane	1	44.8	537.6	42.00	22.58	60.31	Fuel consumption taken from Wallumbilla Gas Treatment Facility Project EIS GHG assessment - data based on 20t franna crane from Terex Cranes. Assumes crane operates 8/7 at 80% availability for 12weeks only during the construction period.	
Stationary	Construction equipment	20t forklift	1	22.4	582.4	20.00	11.65	31.11	Estimate of fuel consumption only. No consumption data availabile. Assumes operation 4/7 at 80% availability for full month construction period.	Unable to locate data on forklift fuel consumptions. As a guide CAT telehandlers (with lower lift capacity) have fuel consuption between 10 and 17L/hr, therefore 20L/hr is a reasonable assumption.
Stationary	Construction	Fuel trucks	6	67.2	1747.2	12.00	125.80	192.69	General allowance only. Assumes 12/7 operation and 80% overall availability for full 12month construction period.	No fuel consumption data available.

	equip ment	and mainten ance vehicles - LPG								Assume 12//h as an approximate fuel consumption only to cover assorted vehicles.
Type	Activity	Purpose	QUANTITY	kW per unit	Total kWhs of operation per unit of equipment per year	Fuel consumption rate (l/kWh)	Total fuel used per year kL	Total tCO2-e	Assumptions	Referring website
Statio nary	Power genera tion	Tempor ary diesel generat ors to provide electricit y for the process plant and general site infrastru cture.	2	500	1098000	0.30	658.80	1,759.73	No accurate data available. Assume 500kW sufficient to meet site temporary power requirements. Assume operating 12*6mo at full capacity.	Fuel consumption per kWh based on Parsons Brinkerhoff Infrastructure PFS documentation and cost estimate. Is based on a 20% increase in the fuel consumption of the main power station (0.25L/kWh) due to operating inefficiencies.
Statio nary	Power genera tion	Remote diesel generat or for mine pre-strip facilities	1	25	109800	0.30	32.94	50.45	Assume small generator required to provide minor power to temporary pit facilties (office, airconditioner etc). Assume operate 24*6mo at full capacity.	
Statio nary	Power genera tion	Remote diesel generat ors for road construc tion facilities.	1	25	384300	0.30	115.29	176.59	Assume small generator required to provide minor power to temporary road construction facilties (office, airconditioner etc). Assume operate 12* at full capacity for 6 months	

Transport	
GRAND TOTAL kL	175
GRAND TOTAL GJ	
Scope 1	
Total diesel (kL)	130
Total LPG (kL)	45
Total (GJ)	
Total emissions diesel (t CO2-e) scope 0	347
Total emissions LPG (t CO2-e) scope 1	58
Scope 3	
Total diesel (kL)	358
Total (GJ)	
Total emissions (t CO2-e) scope 3	73

Stationary	
GRAND TOTAL kL	2004
GRAND TOTAL GJ	
Scope 1	
Total diesel (kL)	1752
Total LPG (kL)	252
Total (GJ)	
Total emissions diesel(t CO2-e) scope 1	4512
Total emissions LPG (t CO2-e) scope 1	385
Scope 3	
Total diesel (kL)	
Total (GJ)	
Total emissions (t CO2-e) scope 3	

Overall	
GRAND TOTAL kL	2,536.08
GRAND TOTAL GJ	
Scope 1	
Total fuel (kL)	2179
Total (GJ)	

Total emissions (t CO2-e) scope 1	5302
Scope 3	
Total fuel (kL)	358
Total (GJ)	
Total emissions (t CO2-e) scope 3	73

A1.1.2 Municipal waste (Wastewater)

Municipal wastewater calculation	**Scope 1 emissions**
Emissions from WWTP	9.078264
Emissions from sludge	4.315896
Total emissions	**13.4**

Type emission	**t CO2-e**
Total emissions generated from municipal solid waste of unknown composition pa	1.2t*31.8t CO2-e = 38.16 t CO2-e
Total from WWTP	13.4
Total from Municipal waste	38.16
Total	**51.55**

A1.1.3 Materials

Construction material	**Quantity (t)**	**MJ/t**	**Carbon (t CO2-e)**	**Reference**
Concrete	7,680	8.52	1.4	http://www.greenspec.co.uk/embodied-energy.php
Steel	2,200	44.22	60.6	http://www.greenspec.co.uk/embodied-energy.php
HDPE (pipe)	74.610	6.30	12.6	http://perigordvacance.typepad.com/files/inventoryofcarbonandenergy.pdf
		Total	**74.53**	

A1.1.4 Vegetation loss FullCAM simulations

Year	Month	Day	Dec.	Year	C	mass	complete	C
	tC	tC	tC	tC	tC			
2014	12	31	2015	267.72	267.72	0	0	267.72
2015	12	31	2016	259.1775	259.1775	0	0	259.1775
2016	12	31	2017	253.2877	253.2877	0	0	253.2877
2017	12	31	2018	247.8199	247.8199	0	0	247.8199
2018	12	31	2019	242.6917	242.6917	0	0	242.6917
2019	12	31	2020	237.8664	237.8664	0	0	237.8664
2020	12	31	2021	233.3041	233.3041	0	0	233.3041
2021	12	31	2022	228.9989	228.9989	0	0	228.9989
2022	12	31	2023	224.9186	224.9186	0	0	224.9186
2023	12	31	2024	221.0443	221.0443	0	0	221.0443
2024	12	31	2025	217.3514	217.3514	0	0	217.3514
2025	12	31	2026	213.8416	213.8416	0	0	213.8416
							SUM OF Carbon loss	2195.785

A1.1.5 Operational equipment – combustion emissions

Type	Activity	Purpose	QUANTITY	No of trips per year per vehicle	Total hours of operation per unit of equipment per year	Fuel consumption rate (l/hour)	Total fuel used per year kL	Energy content (GJ)	Total tCO2-e	Assumptions	Referring website
Transport	Flights	Return flights Adelaide to Port Lincoln	1	52	N/A	N/A			2.55	See flight schedule for transport tab for calculations and assumptions.	
Type	Activity	Purpose	QUANTITY	No of km per day average per vehicle	Total km of operation per unit of equipment per year	Fuel consumption rate (l/km)				Assumptions	Referring website
Transport	Transport	Light vehicles (around the site only)	4	10	3650	0.102	3.72	97.54	5.81	Light vehicle numbers and daily kilometers estimated only - to be refined during subsequent study phases	Fuel consumption based on Toyota Hilux 4x4 single cab diesel from www.greenvehicleguide.gov.au
Transport	Transport	Bus to transport workers between airfield, village and main site.	1	30	10950	0.16	52.56	1377.07	70.51	Zero buses provided	Fuel consumption based on a Deluxe Toyota Coaster bus from http://www.bus4wdhire.com.au/22seat.htm
Transport - Scope 3	Transport of supplies and consumables	Truck transport of supplies and consumables from Port Lincoln	1	76	22192	0.53	887.68	34264.45	181.60	Assume 2 B-doubles (or equivalent) delivering supplies and consumables to site with deliveries occurring once per week for 50% of the year. All considered to be scope 3 emissions as they are outside the project boundaries and performed by external parties on external roads. Assumed all from Port Lincoln.	Fuel consumption based on Bunker Freight study (http://www.ret.gov.au/energy/Documents/energyefficiencyopps/bunker_web20080702155954.pdf) 1.9km/litre converted to 53litres/100km.
Type	Activity	Purpose	QUANTITY	No of trips per year per vehicle	Total hours of operation per unit of equipment per year (24/7 x 52 wks operations)	Fuel consumption rate (l/hour)	Total fuel used per year kL	Energy content	Total tCO2-e	Assumptions	Referring website
Stationary	Mining	Portable lighting towers	4	N/A	4380	1.67	29.26	1129.37	78.15	Number of lighting towers included for noise but no nighttime operations	Fuel consumption for a typical lighting tower taken from http://www.wanco.com/products/detail.php?prd_id=90&type_id=4#details
Stationary	Mineral processing	Diesel for mobile equipment	1	N/A	8760	1.67	14.63	564.69	39.08	180kL of diesel used per annum in the process plant	
Type	Activity	Equipment	QUANTITY	Weekly operating hours per unit of equipment	Total hours of operation per unit of equipment per year	Fuel consumption rate (l/hour)	Total fuel used per year kL	Energy content	Total tCO2-e	Assumptions	Referring website
Stationary	Mining equipment	150t Excavator	1	63.00	3276.00	60.00	196.56	7587.22	525.04	LML specified 1 x 150t excavators. Assumes operation 12/7 with 75% availability.	No fuel consumption data available. Assume 60l/h.

Stationary	Mining equipment	CAT 777 haul truck	2	63.00	3276.00	65.50	214.58	8282.71	573.16	Truck fleet model and number assumed. Assumes trucks operate 50% of the time at low application and 50% of the time at medium application. Assumes 12/7 operation and 75% overall fleet availability.	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012)
Stationary	Mining equipment	Grader (assume CAT 14M)	1	63.00	3276.00	20.00	65.52	2529.07	175.01	Grader data based on CAT14M a. Assumes grader operatesat medium application and assumes 12/7 operation and 75% availability. Grader to cover in pit and haul roads, plus mine access road.	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012)
Stationary	Mining equipment	Drill rig	1	63.00	3276.00	50.00	163.80	6322.68	437.53	Assume operation 12/7 with 75% availability.	No fuel consumption data available. Assume 50l/h.
Stationary	Mining equipment	Water cart (assume CAT 777G WTR)	1	42.00	2184.00	56.00	122.30	4720.93	326.69	Assumes water truck only operates 12/7 with 50% availability for seasonality.	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012) based on CAT 777 haul truck at low application as no specific water truck fuel consumption data availabile.
Stationary	Mining equipment	CAT D11 dozer	1	63.00	3276.00	84.40	276.49	10672.68	738.55	Dozer fleet model and number assumed. Assumes dozers operate at low application. Assumes 12/7 operation and 75% overall fleet availability.	Hourly fuel consumption from Caterpilla Performance Handbook - 42 (January, 2012)
Stationary	Support vehicles	Fuel trucks and maintenance vehicles	4	42	2184	12.00	26.21	673.55	40.14	General allowance only. Assumes 12/7 operation and 80% overall availability.	Approximate fuel consumption only.

Type	Activity	Purpose	QUANTITY	kW per unit	Total kWhs of operation per unit of equipment per year	Fuel consumption rate (l/kWh)	Total fuel used per year kL	Energy content	Total tCO2-e	Assumptions	Referring website
Stationary	Mine dewatering	Portable dewatering pumps (40kW total)	4	10	70080	0.30	21.02	811.53	56.16	Dewatering requirements not specified at time of assessment. Minimal GW therefore assumed 40kW sufficient to meet pit detwatering needs. Assume dewatering pumping 24/7 with 80% availability.	Fuel consumption per kWh based on Parsons Brinkerhoff Infrastructure PFS documentation and cost estimate based on a 20% increase in the fuel consumption of the main power station due to operating inefficiencies.
Stationary	Power generation	Main diesel power station to provide electricity for the process plant and general site infrastructure.	1	4000	35040000	0.25	8760.00	338.14	23.40	2MW annual power generation.	Fuel consumption estimated at 0.25L per kWh.
Stationary	Emergency power generation	Emergency (back-up) diesel generator at the accommodation village.	1	500	N/A	N/A				Village back-up generator only used when power station or transmission line out of service. GHG assessment for powerstation assumes full operation (24/7/365days), therefore village back-up not required.	

Transport	
GRAND TOTAL kL	944
GRAND TOTAL GJ	35,739
Scope 1	
Total diesel (kL)	56
Total (GJ)	1,475
Total emissions (t CO2-e) scope 1	76
Scope 3	
Total diesel (kL)	888
Total (GJ)	34,264
Total emissions (t CO2-e) scope 3	184

Stationary	
GRAND TOTAL kL	9,890
GRAND TOTAL GJ	43,633
Scope 1	
Total (kL)	9,890
Total (GJ)	43,633
Total emissions (t CO2-e) scope 1	2,896
Scope 3	
Total (kL)	
Total (GJ)	
Total emissions (t CO2-e) scope 3	

Overall	
GRAND TOTAL kL	10,834
GRAND TOTAL GJ	79,372
Scope 1	
Total diesel (kL)	9,947
Total (GJ)	45,107
Total emissions (t CO2-e) scope 1	3,089
Scope 3	
Total diesel (kL)	888
Total (GJ)	34,264
Total emissions (t CO2-e) scope 3	184

A1.1.6 Flight emissions

CARBON CALCULATOR FOR FLIGHTS	Amount	Unit
Flights	52.00	everyone, annual
Distance Adelaide to Lincoln	251.06	km
Emission Factor	0.00019518	t CO2 per/km per/person
	2.55	t CO2 e per annum

A1.1.7 Municipal waste

Table 43: NGA Factors (DCC, 2012)	Waste emission factor for total waste disposed to landfill by broad waste stream category (t CO_2-e/t)
Municipal solid waste	1.2
Commercial and industrial waste	1.1
Construction & demolition waste	0.2
Total emissions generated from municipal solid waste of unknown composition pa	30x1.05x31.5=37.8
Total emissions generated from municipal solid waste of unknown composition pa	37.8
Total emissions generated 7.5 L.O.M.	283.5

Assumptions

Assume all general site waste is diposed of at an on-site landfill. Waste oils, greases etc and recyclables will be transported off site for off site disposal. Emissions from off-site disposal or recycling are not assessed here (scope 3 emissions).

Average of 30 person on site during regular operation

A1.1.8 Explosives

		2015	2016	2017	2018	2019	2020	2021	2022
Annual explosive requirement	tonnes	0	0	100	500	1000	1500	2000	2500
Emissions (Scope 1) (pa)	tonnes CO2-e	0	0	17	85	170	255	340	425
Emissions (Scope 1) (average pa)	**tonnes CO2-e**	**172**							
Explosives (average pa)	**tonnes**	**1013**							

Appendix L

Material safety data sheets

PQ Corporation

MSDS

MATERIAL SAFETY DATA SHEET

Trade Name: **D™ Sodium Silicate Solution**
Date Prepared: **06/09/06**

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product name:	**D™ Sodium silicate solution**
Product description:	**A 2.0 weight ratio sodium silicate, 44.1% solution in water**
Manufacturer:	**PQ Corporation** **P. O. Box 840** **Valley Forge, PA 19482 USA**
Telephone:	**610-651-4200**
In case of emergency call:	**610-651-4200**
For transportation emergency Call CHEMTREC:	**800-424-9300**

2. COMPOSITION/INFORMATION ON INGREDIENTS

Chemical and Common Name	*CAS Registry Number*	*Wt. %*	*OSHA PEL*	*ACGIH TLV*
Water	**7732-18-5**	**55.9%**	**Not Established**	**Not Established**
Silicic acid, sodium salt; Sodium silicate	**1344-09-8**	**44.1%**	**Not Established**	**Not Established**

3. HAZARDS IDENTIFICATION

Emergency Overview:	**Clear to hazy, colorless, odorless, thick liquid. Causes severe irritation to eyes and moderate skin irritation. Spray mist causes irritation to respiratory tract. Due to high pH of product, release into surface water is harmful to aquatic life. Noncombustible. Spills are slippery. Reacts with acids, ammonium salts, reactive metals and some organics.**
Eye contact:	**Causes severe irritation to the eyes.**
Skin contact:	**Causes moderate irritation to the skin.**
Inhalation:	**Spray mist is irritating to respiratory tract.**
Ingestion:	**May cause irritation to mouth, esophagus, and stomach.**
Chronic hazards:	**No known chronic hazards. Not listed by NTP, IARC or OSHA as a carcinogen.**
Physical hazards:	**Dries to form glass film which can easily cut skin. Spilled material is very slippery. Can etch glass if not promptly removed.**

4. FIRST AID MEASURES

Eye:	**In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Get medical attention.**
Skin:	**In case of contact, immediately flush skin with plenty of water. Remove contaminated clothing and shoes. Get medical attention.**

Inhalation:	**Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.**
Ingestion:	**If swallowed, DO NOT induce vomiting. Get medical attention immediately. If victim is fully conscious, give a cupful of water. Never give anything by mouth to an unconscious person.**

5. FIRE FIGHTING MEASURES

Flammable limits:	**This material is noncombustible.**
Extinguishing Media:	**This material is compatible with all extinguishing media.**
Hazards to fire-fighters:	**See Section 3 for information on hazards when this material is present in the area of a fire.**
Fire-fighting equipment:	**The following protective equipment for fire fighters is recommended when this material is present in the area of a fire: chemical goggles, body-covering protective clothing, chemical resistant gloves, and rubber boots.**

6. ACCIDENTAL RELEASE MEASURES

Personal protection:	**Wear chemical goggles, body-covering protective clothing, chemical resistant gloves, and rubber boots. See section 8.**
Environmental Hazards:	**Sinks and mixes with water. High pH of this material is harmful to aquatic life, see Section 12. Only water will evaporate from a spill of this material.**
Small spill cleanup:	**Mop up and neutralize liquid, then discharge to sewer in accordance with federal, state and local regulations or permits.**
Large spill cleanup:	**Keep unnecessary people away; isolate hazard area and deny entry. Do not touch or walk through spilled material. Stop leak if you can do so without risk. Prevent runoff from entering into storm sewers and ditches which lead to natural waterways. Isolate, dike and store discharged material, if possible. Use sand or earth to contain spilled material. If containment is impossible, neutralize contaminated area and flush with large quantities of water.**
CERCLA RQ:	**There is no CERCLA Reportable Quantity for this material. If a spill goes off site, notification of state and local authorities is recommended.**

7. HANDLING AND STORAGE

Handling:	**Avoid contact with eyes, skin and clothing. Avoid breathing spray mist. Keep container closed. Promptly clean residue from closures with cloth dampened with water. Promptly clean up spills.**
Storage:	**Keep containers closed. Store in clean steel or plastic containers. Separate from acids, reactive metals, and ammonium salts. Storage temperature 0-95º C. Loading temperature 45-95 º C. Do not store in aluminum, fiberglass, copper, brass, zinc or galvanized containers.**

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering controls:	**Use with adequate ventilation. Keep containers closed. Safety shower and eyewash fountain should be within direct access.**
Respiratory protection:	**Use a NIOSH-approved dust and mist respirator where spray mist occurs. Observe OSHA regulations for respirator use (29 C.F.R. §1910.134)**
Skin protection:	**Wear body-covering protective clothing and gloves.**
Eye protection:	**Wear chemical goggles.**

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance:	**Thick liquid.**
Color:	**Clear to hazy white.**
Odor:	**Odorless or musty odor.**
pH:	**Approximately 12.9**
Specific gravity:	**1.53 g/cm^3 (20°C), 50.4° Bé, 12.79 lbs/gal**
Solubility in water:	**Miscible.**

10. STABILITY AND REACTIVITY

Stability:	**This material is stable under all conditions of use and storage.**
Conditions to avoid:	**None.**
Materials to avoid:	**Gels and generates heat when mixed with acid. May react with ammonium salts resulting in evolution of ammonia gas. Flammable hydrogen gas may be produced on contact with aluminum, tin, lead, and zinc.**
Hazardous decomposition products:	**Hydrogen.**

11. TOXICOLOGICAL INFORMATION

Acute Data:	**When tested for eye and skin irritation potential, a similar material caused severe irritation to the eyes and moderate irritation to the skin. Human experience indicates that skin irritation occurs, particularly, when sodium silicates get on clothes at the collar, cuffs or other areas where contact and abrasion may occur.** **The acute oral toxicity of this product has not been tested. When sodium silicates were tested on a 100% solids basis, their single dose acute oral LD_{50} in rats ranged from 1500 mg/kg to 3200 mg/kg. The acute oral lethality resulted from nonspecific causes. This product contains approximately 44% sodium silicate.**
Subchronic Data:	**In a study of rats fed sodium silicate in drinking water for three months, at 200, 600 and 1800 ppm, changes were reported in the blood chemistry of some animals, but no specific changes to the organs of the animals due to sodium silicate administration were observed in any of the dosage groups. Another study reported adverse effects to the kidneys of dogs fed sodium silicate in their diet at 2.4g/kg/day for 4 weeks, whereas rats fed**

the same dosage did not develop any treatment-related effects. Decreased numbers of births and survival to weaning was reported for rats fed sodium silicate in their drinking water at 600 and 1200 ppm.

Special Studies: **Sodium silicate was not mutagenic to the bacterium E. Coli when tested in a mutagenicity bioassay. There are no known reports of carcinogenicity of sodium silicates. Frequent ingestion over extended periods of time of gram quantities of silicates is associated with the formation kidney stones and other siliceous urinary calculi in humans. Sodium silicate is not listed by IARC, NTP or OSHA as a carcinogen.**

12. ECOLOGICAL INFORMATION

Eco toxicity: **The following data is reported for sodium silicates on a 100% solids basis: A 96 hour median tolerance for fish (Gambusia affnis) of 2320 ppm; a 96 hour median tolerance for water fleas (Daphnia magna) of 247 ppm; a 96 hour median tolerance for snail eggs (Lymnea) of 632 ppm; and a 96 hour median tolerance for Amphipoda of 160 ppm. This product contains approximately 44% sodium silicate.**

Environmental Fate: **This material is not persistent in aquatic systems, but its high pH when undiluted or unneutralized is acutely harmful to aquatic life. Diluted material rapidly depolymerizes to yield dissolved silica in a form that is indistinguishable from natural dissolved silica. It does not contribute to BOD. This material does not bioaccumulate except in species that use silica as a structural material such as diatoms and siliceous sponges. Where abnormally low natural silica concentrations exist (less than 0.1 ppm), dissolved silica may be a limiting nutrient for diatoms and a few other aquatic algal species. However, the addition of excess dissolved silica over the limiting concentration will not stimulate the growth of diatom populations; their growth rate is independent of silica concentration once the limiting concentration is exceeded. Neither silica nor sodium will appreciably bioconcentrate up the food chain.**

Physical/Chemical: **Sinks and mixes with water. Only water will evaporate from this material.**

13. DISPOSAL CONSIDERATIONS

Classification: **Waste material is a RCRA Hazardous waste because it exhibits the corrosive characteristic (pH greater than or equal to12.5) as defined in EPA rules at 40 C.F.R. §261.22 (a)(1).**

Disposal Method: **Dispose in accordance with federal, state and local regulations.**

14. TRANSPORT INFORMATION

DOT UN Status: **This material is not regulated hazardous material for transportation.**

15. REGULATORY INFORMATION

CERCLA:	**No CERCLA Reportable Quantity has been established for this material.**
SARA TITLE III:	**Not an Extremely Hazardous Substance under §302. Not a Toxic Chemical under §313. Hazard Categories under §§311/312: Acute**
TSCA:	**All ingredients of this material are listed on the TSCA inventory.**
FDA:	**The use of sodium silicate is authorized by FDA as a boiler water additive for the production of steam that will contact food pursuant to 21 CFR §173.310; as a component of zinc-silicon dioxide matrix coatings on food contact surfaces pursuant to 21 CFR §175.390(c); as a GRAS substance when migrating from cotton fabric used in dry food packaging pursuant to 21 CFR §182.70; and as a GRAS substance when migrating to food from paper and paperboard products pursuant to 21 CFR §182.90.**

16. OTHER INFORMATION

Prepared by:	**John G. Blumberg**
Supersedes revision of:	**03/19/05**

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MX-EX-EV

ECOBULK MX-EX-EV
antistatic

SCHÜTZ INDUSTRIAL PACKAGING
The Future's Technology. Today.

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No chance for permeation – even in ex-zones.

With the new EVOH permeation barrier

- Highly effective barrier against gases like oxygen, carbon dioxide, and nitrogen
- Safely protects the filling product from permeation
- Odours or flavours cannot escape
- Suitable for utilisation on explosive endangered operation premises classified as zone 1 and zone 2 (while complying with statutory and company-specific safety precautions and regulations)
- The antistatic outer layer protects the container from hazardous electrostatic charge
- The earthed outlet valve discharges the electrostatic charge of the filling product
- Electrostatically safe within the context of the Cenelec Report CENELEC TR50404 (2003) and TRBS 2153

Please do not hesitate to contact us regarding any technical concerns or questions.

MATERIAL

Inner bottle

- Inner and intermediate layer: high-molecular, high-density polyethelene (HDPE)
- EVOH permeation barrier
- Antistatic outer layer
- Additional UV and light protection of the filling product (optional)

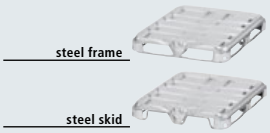
Outer container

- Welded tubular steel grid, galvanized

Bottom plate

- Made of steel plate to provide stability and to facilitate minimum residual contents from the inner container

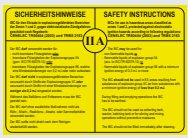
PALLETS (4-way entry)



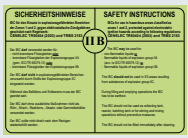
CERTIFICATIONS

UN 31 HA1/Y (optional)

- Maximum density 1.6
- Tested for electrostatic safety
- Suitable for use in ex-zones 1 & 2



IIA



IIB (optional)

FDA (optional)

- Safe for food products

CAPACITY

MX-EX-EV antistatic 1000

- 1,000 litres (275 gal)

OUTLET VALVES

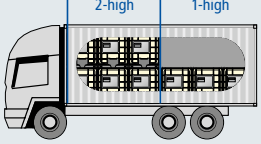
- Earthed screwable butterfly valve DN 50

FILLING OPENING

- DN 150 with screw cap
- DN 225 with screw cap

DYNAMIC LOAD

Filled ECOBULK according to the specific weight of the filling goods



DIMENSIONS

- 1,200 x 1,000 x 1,160 (L x W x H)

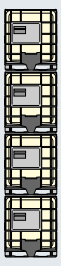
WEIGHT

MX-EX-EV antistatic 1000

- 57 kg with steel pallet

STATIC LOAD

Max. 4-high



Recochem Inc.
Your Partner in Formulating Solutions

SOLVENTS / PENETRANTS

Recosol L70

DESCRIPTION

A mixed, aromatic, paraffinic, hydrocarbon solvent that combines good solvency for solvent degreasing applications or specialised formulations. **Recosol L70** can be used when effective, low-cost cleaning is required.

FEATURES

Combustible liquid regulated for storage only.

Slow evaporation rate minimises waste.

Good solvency for many organic compounds.

Competitively priced.

Ideal slow drying solvent degreaser for heavy work.

Versatility – **Recosol L70** can be included in any formulation where high flash point and low evaporation is required and is miscible with all other organic solvents.

Solvency – **Recosol L70** has good solvency for greases, oils and many other organic compounds.

User-Friendly – **Recosol L70** has a low aromatic content making it more pleasant to use than solvents with high aromatics. The high flash point also makes it a lower risk to use.

PACKAGING

Recosol L70 is available in bulk, IBCs (1500 litre bulk containers), drums and 20 litre containers.

SAFETY

Please consult the MSDS on **Recosol L70** before use.

The information and recommendations contained herein are based on data believed to be correct at this time. However, no guarantee of any kind, expressed or implied is made with respect to the information contained herein.

Typical Characteristics

Appearance	clear liquid
Specific Gravity	0.795
Flash Point	min 62°C
Boiling Range	205–300°C (90% recovery)
Aromatic Content	~11%
Ash	max 0.01% w/w
Sulphur	max 0.02% w/w

MSDS available

QUEENSLAND
Tel +61 7 3308 5200
Fax +61 7 3308 5201

NEW SOUTH WALES
Tel +61 2 8709 9600
Fax +61 2 9791 5066

VICTORIA
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Your Partner in Formulating Solutions

SOLVENTS / PENETRANTS

Recosol V80

DESCRIPTION

High flash point hydrocarbon solvent that is extensively used in degreasing formulations and is ideal for parts baths due to its low evaporation rate and high flash point. **Recosol V80** is a proven solvent extraction diluent in base metal mines.

FEATURES

Slow evaporation rate.

Good solvency for many organic compounds.

Minimum residue on drying.

Competitively priced.

Does not leave an oily residue like heating oil.

Versatility – **Recosol V80** can be included in any formulation where controlled evaporation is required and is miscible with many other organic solvents.

Solvency – **Recosol V80** has good solvency for greases, oils and many other organic compounds.

User-Friendly – **Recosol V80** low aromatic content makes its use much more pleasant than solvents with high aromatics. The high flash point also makes it a lower risk to use.

PACKAGING

Recosol V80 is available in bulk, IBCs (1500 litre bulk containers), drums and 20 litre containers.

SAFETY

Please consult the MSDS on **Recosol V80** before use.

The information and recommendations contained herein are based on data believed to be correct at this time. However, no guarantee of any kind, expressed or implied is made with respect to the information contained herein.

Typical Characteristics

Appearance	clear liquid
Specific Gravity	0.806
Flash Point	min 79°C
Boiling Range	198–237°C
Aromatic Content	<19%
Aniline Point	69°C

MSDS available

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MATERIAL SAFETY DATA SHEET

SECTION 1 IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: KEROSENE

Company: Recochem Inc. ABN: 69 010 485 999
Address : 1809 Lytton Road, Lytton, Queensland 4178
Phone: (07) 3308 5200 Fax: (07) 3308 5201
Emergency Telephone Number: (07) 3308 5200 Day, After Hours 1300 131 001

Other Names: Lighting Kerosene, Home Kerosene
Manufacturer's Product Code: 16000
Recommended Use: Heating fuel, Solvent, Degreasing, Fuel Oil

SECTION 2 HAZARDS IDENTIFICATION

CLASSIFIED AS HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA
A DANGEROUS GOODS ACCORDING TO THE CRITERIA OF THE ADG CODE

Symbol: Xn - Harmful
Risk Phrases: R10 - Flammable
R65 - Harmful: May cause lung damage if swallowed
Safety Phrases: S2 - Keep out of the reach of children
S23 - Do not breathe vapour
S24 - Avoid contact with skin
S45 - In case of accident or if you feel unwell, seek medical advice immediately (show label where possible)
S53 - Avoid exposure-obtain special instructions before use
S62 - If swallowed, do not induce vomiting: seek medical advice immediately and show container or label

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous Ingredients

Chemical Entity	*CAS Number*	*Proportion (%)*
Naphtha (petroleum), hyrosulphurised heavy	64742-82-1	100
Contains < 0.1% w/w benzene		

SECTION 4 FIRST AID MEASURES

FIRST AID TREATMENT
Swallowed: If swallowed, do NOT induce vomiting. Transport to nearest medical facility for additional treatment. If vomiting occurs spontaneously, keep head below hips to prevent aspiration.
Eye: If in eyes, hold eyes open, flood with water for at least 15 minutes. If irritation persists seek medical attention.
Skin: If skin contact occurs, remove contaminated clothing and wash skin thoroughly with water and follow by washing with soap if available.
Inhaled: Remove victim from exposure if safe to do so. If rapid recovery does not occur, transport to nearest medical facility for additional treatment.

First Aid facilities: Potable water should be available to rinse eyes or skin. Provide eye baths and safety showers.
Advice to Doctor: Treat symptomatically.
Additional Information: None available.

SECTION 5 FIRE FIGHTING MEASURES

Suitable Extinguishing Media: Foam, water spray or fog. Dry chemical powder or carbon dioxide for small fires only. Do not use water in a jet.

Hazards from combustion products: Carbon monoxide may be evolved if incomplete combustion occurs. Will float and can be reignited on surface water. Vapour is heavier than air, can spread along ground and distant ignition is possible.

Precautions for Fire Fighters and Special Protective Equipment: Wear full protective clothing and self-contained breathing apparatus.

Additional Information: Hazchem code 3Y.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Observe all local and national regulations.

Spills and Disposal: Avoid contact with spilled or released material. Shut off leaks, if possible without personal risks. Remove all sources of ignition in the surrounding area. Use appropriate containment to avoid environmental contamination. Prevent from spreading and entering waterway using sand, earth or other appropriate barriers. Take precautionary measure against static discharge. Ensure electrical continuity by bonding and earthing all equipment.

Methods and Materials for Containment and Clean Up Procedures: For small spills (<1 drum), transfer by mechanical means to a labelled, sealable container for product recovery or safe disposal. Allow any residues to evaporate or use an appropriate absorbent material and dispose of safely. For larger spills (> 1 drum), transfer by means such as a vacuum truck to a salvage tank for recovery or disposal. Do not flush residues with water. Retain as contaminated waste. Allow any residues to evaporate or use an appropriate absorbent material and dispose of safely.

SECTION 7 HANDLING AND STORAGE

Precautions for Safe Handling and Storage: Avoid contact with skin, eyes and clothing. Avoid breathing vapours. Wash thoroughly after handling. Handle and open container with care in well ventilated area. Ensure that the workplace is ventilated such that the Occupational Exposure limit is not exceeded. Do not empty into drains. Do not eat, drink or smoke in contaminated areas. Before eating, drinking or smoking, remove contaminated clothing and wash hands. Do not store near aerosols, flammables, strong oxidants and corrosives.

Dispensing: Electrostatic charges may be generated during transfer. Electrostatic discharge may cause fire. Ensure electrical continuity by earthing all equipment. Remove any ignition sources and avoid sparks and any other sources of heat.

Flammability: Flammable.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Standards: In the absence of occupational exposure standards for this product, it is recommended that the following be adopted: Mineral Spirits 150-200, HSPA 350mg/m^3 TWA (8hr).

Biological Limit Values: No biological limit allocated.

Personal Protective Equipment:

Respiratory Protection: If work practices do not maintain airborne level below the exposure standard, use appropriate respiratory protection equipment. When using respirators, select an appropriate combination of mask and filter. Select a filter for organic gases and vapours (boiling point > 65 Deg C). Respirators should comply with AS1716 or an equivalent approved by a state/territory authority.

Hand Protection: Use solvent resistant gloves (nitrile for longer term protection or PVC and neoprene for incidental splashes).

Eye Protection: Wear safety goggles.

Protective Clothing: Use chemical resistant glove/gauntlets, boots and apron. Skin protection not ordinarily required beyond standard issue work clothes.

Engineering Controls: Ensure that adequate ventilation is provided. Maintain air concentrations below recommended exposure standards. Avoid generating and inhaling mists. Keep containers closed when not in use.

SECTION 9 PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL DESCRIPTION / CHEMICAL PROPERTIES

Appearance	Blue clear liquid
Odour	Aromatic

pH:	N/A
Vapour Pressure:	Typical 0.3 kPa
Vapour Density (air = 1):	4.35 @ 15 Deg C
Boiling Point (°C):	Typical 145 - 300
Freezing/Melting Point (°C):	Data not available
Solubility in Water:	Not miscible with water
Specific Gravity (g/ml @ 15°C):	0.80 Typical
Flashpoint (°C):	38 (Abel)
Flammability Limits (%):	1.0 - 6.0
Auto Ignition Temperature (°C):	Data not available
Percent Volatiles:	100

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: Stable under normal conditions of use.
Conditions to Avoid: Avoid heat, sparks, open flames and other ignition sources.
Incompatible Materials: Strong oxidising agents.
Hazardous Decomposition Products: Thermal decomposition is highly dependant on conditions. A complex mixture of airborne solids, liquids, gases, including carbon monoxide, carbon dioxide and other organic compounds will be evolved when this material undergoes combustion or thermal or oxidative degradation.

SECTION 11 TOXICOLOGICAL INFORMATION

HEALTH EFFECTS

Acute:

Swallowed: Expected to be of low toxicity: LD50>2000mg/kg, Rat. Aspiration into lungs when swallowed or vomited may cause chemical pneumonitis which can be fatal.
Eye: Mild irritant.
Skin: Mild irritant. Prolonged contact may cause defatting of skin which can lead to dermatitis.
Inhaled: Expected to be of low toxicity: LC50 greater than near-saturated vapour concentration / 4 hours, Rat. High concentrations may cause central nervous system depression. Continued inhalation may result in unconsciousness and/or death.
Chronic: Auditory system: prolonged and repeated exposures to high concentrations have resulted in hearing loss in rats. Solvent abuse and noise interaction in the work environment may cause hearing loss. Central nervous system: repeated exposure affects the nervous system.

SECTION 12 ECOLOGICAL INFORMATION

Ecotoxicity:

Fish	: Expected to be harmful: 10 < LC/EC/IC50 <= 100mg/l
Aquatic Invertebrates	: Expected to be harmful: 10 < LC/EC/IC50 <= 100mg/l
Algae	: Expected to be toxic: 1 < LC/EC/IC50 <= 10mg/l
Microorganisms	: Expected to be harmful: 10 < LC/EC/IC50 <= 100mg/l

Mobility: Floats on water.
Persistance/degradability: Readily biodegradable. Oxidises by photo-chemical reactions in air.
Bioaccumulation: Has the potential to bioaccumulate.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal Methods: Ensure waste disposal conforms to local waste disposal regulations.

SECTION 14 TRANSPORT INFORMATION

UN Number:	1223	Proper Shipping Name:	Kerosene
Class:	3	Subsidiary Risk:	None allocated
Packing Group:	III	Hazchem Code:	3Y
Special Precautions for User:	None		

SECTION 15 REGULATORY INFORMATION

Poisons Schedule : 5
AICS : Listed
Dangerous Goods Initial Emergency Response Guide (SAA/SNZ HB76:2010): 15

SECTION 16 OTHER INFORMATION

Further Information may be obtained by contacting Recochem on (07) 3308 5200

The information sourced for the preparation of this document was correct and complete at the time or writing to the best of the writer's knowledge. The document represents the commitment to the company's responsibilities surrounding the supply of this product, undertaken in good faith. This document should be taken as a safety guide for the product and its recommended uses but is in no way an absolute authority. Please consult the relevant legislation and regulations governing the use and storage of this type of product.

Recochem Inc.
Incorporated in Canada
A.B.N. 69 010 485 999

Head Office
1809 Lytton Road
Lytton QLD 4178
Phone: 07 3308 5200
Fax: 07 3308 5201
www.recochem.com.au

Product Data Sheet

Recofroth 1000N

SPECIALTY NON REGULATED FROTHER FOR MINERAL PROCESSING IN BASE METALS AND NON METALLIC PLANTS

DESCRIPTION

Recofroth 1000N is a specialized proprietary frother based on mixed alcohol and glycol ether chemistry. Recofroth 1000N is a stronger frother than MIBC however having the added benefit of having a high flash point.

SUMMARY OF BENEFITS

- A high flash point frother that is not classified dangerous goods for transport or storage, and has low odour.
- A highly refined chemical which has been proven in a variety of frother applications.

PERFORMANCE FEATURES

Versatility – Recofroth 1000N can be used in many frother applications both in low and high pH slurries, and is particularly effective for flotation of fine particles.
Efficiency – Recofroth 1000N has very low application rates and has a high degree of selectivity and recovery, as it is a stronger frother. Typical application rates vary between 5-50g per ton, dependent on the characteristics of the ore, grind size and water chemistry.

TYPICAL CHARACTERISTICS

Specific Gravity @ 20 C……..0.84
Flash Point…….. 95 ºC
Boiling Range……..204ºC-318ºC
pH ……6.5

PACKAGES

Recofroth 1000N is available in bulk, 1000 litre IBCs and 200 litre drums.

HEALTH & SAFETY

Please consult the MSDS on Recofroth 1000N before use.

Sydney
65 Fairford Road
Padstow NSW 2211
Phone: 02 8709 9600
Fax: 02 9791 5066

Melbourne
55-57 Miller Street
Epping VIC 3076
Phone: 03 9408 4144
Fax: 03 9408 4155

Adelaide
12 Moss Road
Wingfield SA 5013
Phone: 08 8222 1333
Fax: 08 8260 7883

Perth
4 Norlin Street
Kewdale WA 6105
Phone: 08 9352 3000
Fax: 08 9352 3033

MATERIAL SAFETY DATA SHEET

SECTION 1 IDENTIFICATION OF THE MATERIAL AND SUPPLIER

Product Name: RECOFROTH 1000N

Company: Recochem Inc. ABN: 69 010 485 999
Address : 1809 Lytton Road, Lytton, Queensland 4178
Phone: (07) 3308 5200 Fax: (07) 3308 5201
Emergency Telephone Number: (07) 3308 5200 Day, After Hours 1300 131 001

Other Names: None
Manufacturer's Product Code: TBA
Recommended Use: Flotation frother

SECTION 2 HAZARDS IDENTIFICATION

NOT CLASSIFIED AS HAZARDOUS ACCORDING TO CRITERIA OF WORKSAFE AUSTRALIA
NOT A DANGEROUS GOODS ACCORDING TO THE CRITERIA OF THE ADG CODE

Symbol: None
Risk Phrases: None
Safety Phrases: S1/2 - Keep locked and out of the reach of children
S26 - In case of contact with eyes, rinse immediately with plenty of water and seek medical advice
S36/37/39 - Wear suitable protective clothing, gloves and eye/face protection
S45 - In case of accident or if you feel unwell, seek medical advice immediately (show label where possible)

SECTION 3 COMPOSITION / INFORMATION ON INGREDIENTS

Components

Chemical Entity	*CAS Number*	*Proportion (%)*
1-Hexanol, 2-Ethyl-, manuf. of by-products from distn. residues	68609-68-7	75 - 95
Polypropylene Glycol Butyl Ether	9003-13-8	5 - 25
Potassium Hydroxide	1310-58-3	< 0.1

SECTION 4 FIRST AID MEASURES

FIRST AID TREATMENT
Swallowed: If swallowed, do NOT induce vomiting. Seek medical attention.
Eye: If in eyes, hold eyes open, flood with water for at least 15 minutes. Seek medical attention.
Skin: If skin contact occurs, wash skin thoroughly with water and follow by washing with soap if available. If irritation persists, seek medical attention.
Inhaled: Remove victim from exposure if safe to do so. If rapid recovery does not occur, seek medical attention.

First Aid facilities: Potable water should be available to rinse eyes or skin. Provide eye baths and safety showers.
Advice to Doctor: Treat symptomatically.
Additional Information: None available.

SECTION 5 FIRE FIGHTING MEASURES

Suitable Extinguishing Media: Use dry chemicals, carbon dioxide, water spray, fog or foam. Do not use water jet.
Hazards from combustion products: Vapours are heavier than air and may spread along floors..
Precautions for Fire Fighters and Special Protective Equipment: Wear full protective clothing and self-contained breathing apparatus.

Additional Information: Cool containers with water spray.

SECTION 6 ACCIDENTAL RELEASE MEASURES

Observe all local and national regulations.

Spills and Disposal, Methods and Materials for Containment and Clean Up Procedures: Isolate area. Keep upwind of spill. Ventilate area of spill. Contain spill if possible, absorb with an inert dry material and place in an appropriate, labelled waste disposal container. Prevent from entering soil and waterways. Dispose of in accordance with regional regulations.

SECTION 7 HANDLING AND STORAGE

Precautions for Safe Handling and Storage: Avoid contact with eyes, skin and clothing. Do not ingest. Avoid breathing dust, keep container closed. Use only with adequate ventilation. Wash thoroughly after handling. Do not eat, drink or smoke in contaminated areas. Before eating, drinking or smoking, remove contaminated clothing and wash hands. Keep container in a cool, well-ventilated area. Avoid all possible sources of ignition. Empty containers may still contain vapours.

SECTION 8 EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure Standards: Worksafe Australia has set an exposure standard for:
Potassium Hydroxide at 2mg/m^3 (peak limitation) TWA
Biological Limit Values: No biological limit allocated.

Personal Protective Equipment:
Respiratory Protection: Wear appropriate respirator when ventilation is inadequate.
Hand Protection: Use chemical resistant gloves (nitrile, PVC or neoprene).
Eye Protection: Wear safety goggles.
Protective Clothing: Use protective clothing chemically resistant to this material.
Engineering Controls: Ensure that adequate ventilation is provided. Avoid generating and inhaling mists.

SECTION 9 IDENTIFICATION

PHYSICAL DESCRIPTION / CHEMICAL PROPERTIES

Appearance:	Yellow/brown liquid
Odour:	Mild
pH:	6.3 (3g/l)
Vapour Pressure (kPa @ 25°C):	Data not available
Vapour Density (air = 1):	Data not available
Boiling Point (°C):	205
Freezing/Melting Point (°C):	-60
Solubility in Water:	Soluble (3g/l)
Specific Gravity (g/ml @ 25°C):	0.83 - 0.95
Flashpoint (°C):	93 (CC)
Flammability Limits (%):	Data not available
Auto Ignition Temperature (°C):	Data not available
Percent Volatiles:	Data not available

SECTION 10 STABILITY AND REACTIVITY

Chemical Stability: Stable under normal conditions of use.
Conditions to Avoid: Avoid contact with heat, sparks, open flame, sources of ignition..
Incompatible Materials: Strong oxidisers.
Hazardous Decomposition Products: Thermal decomposition may give flammable and toxic products (organic vapours).

SECTION 11 TOXOCOLOGICAL INFORMATION

HEALTH EFFECTS

Acute:
Swallowed: Low toxicity. (LD50): > 5000mg/kg (Rat).
Eye: Contact may cause eye irritation.
Skin: Contact may cause irritation.

Inhaled: Single exposure unlikely to be hazardous.
Chronic: Data not available.
Toxicity to Animals: Data not available.

SECTION 12 ECOLOGICAL INFORMATION

Ecotoxicity: Data not available.
Mobility: Data not available.
Persistance/degradability: Readily biodegradable.

SECTION 13 DISPOSAL CONSIDERATIONS

Disposal Methods: Ensure waste disposal conforms to local waste disposal regulations.

SECTION 14 TRANSPORT INFORMATION

UN Number:	Non Regulated	Proper Shipping Name:	N/A
Class:	N/A	Subsidiary Risk:	N/A
Packing Group:	N/A	Hazchem Code:	N/A
Special Precautions for User:			

SECTION 15 REGULATORY INFORMATION

Poisons Schedule : None allocated
AICS : Listed
Dangerous Goods Initial Emergency Response Guide (SAA/SNZ HB76:2010) : N/A

SECTION 16 OTHER INFORMATION

Further Information may be obtained by contacting Recochem on (07) 3308 5200

The information sourced for the preparation of this document was correct and complete at the time or writing to the best of the writer's knowledge. The document represents the commitment to the company's responsibilities surrounding the supply of this product, undertaken in good faith. This document should be taken as a safety guide for the product and its recommended uses but is in no way an absolute authority. Please consult the relevant legislation and regulations governing the use and storage of this type of product.

Recochem Inc.
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A.B.N. 69 010 485 999

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Wingfield SA 5013
Phone: 08 8222 1333
Fax: 08 8260 7883
www.recochem.com.au

Certificate of Analysis

QC No. **: 08213/LABTBM/14**
Description of Goods **: Sodium Silicate B-78230**

NO	PARAMETERS	UNIT	SPECIFICATION	RESULT	METHOD
1	Weight Ratio		2.25-2.35	2.38	
2	Na2O	%	12.70-13.25	12.96	SNI06-0127-1987
3	SiO2	%	29.2-30.6	29.81	
4	Density at 30 Deg C	g/mL	1.4796-1.4948	1.4860	
5	Baume at 30 Deg C	Be	46.50-48.50	47.42	
6	Viscosity at 30 Deg C	cPs		300	

Analysed, August 20, 2014.

Analysed by,

Andri Andi.

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Perth
4 Norlin Street
Kewdale WA 6105
Phone: 08 9352 3000
Fax: 08 9352 3033

Appendix M

Risk register

Kookaburra Gully Environmental Aspects and Risk Assessment Register

The register includes: (a) Detailed Risk Assessment of proposed mining activities; (b) generic consideration of risks associated with activities on surrounding area.

ID	Aspect	Impact	Primary Risk Level			Control and Management Strategies	Residual Risk level			Additional Comments/notes
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
Vegetation, weeds and pathogens										
K_01	Clearing of vegetation for construction and operations	Reduced native species abundance and diversity	Possible	Moderate	High	Topsoil and subsoil stockpiles with seed banks to be retained separately for re-dressing in rehabilitation planning. The suitability of controlled fire-assisted revegetation will be discussed with the CFS. Native vegetation seed collection prior to excavation on site. Provision of SEB offset. Implementation of a program for staged clearance; ensuring clearance occurs immediately prior to development and within designated areas. Site induction of all site personnel to identify areas of vegetation removal/protection. Progressive rehabilitation and revegetation of disturbed areas (where practicable). Develop native vegetation management plan and mine rehabilitation and closure plan. Revegetation of slopes of WRSFs with native species rather than pasture.	Possible	Minor	Moderate	
K_02	Clearing of vegetation for construction and operations	Impact on threatened (EPBC) and state listed threatened flora.	Possible	Minor	Moderate	Avoidance of areas known to provide habitat for threatened flora species, when practicable. Establishment of a Significant Environmental Benefit (SEB) under the Native Vegetation Act 1991. Implementation of a program for staged clearance; ensuring clearance occurs immediately prior to development and within designated areas. Site induction of all site personnel to identify areas of vegetation removal/protection. Progressive rehabilitation and revegetation of disturbed areas (where practicable). Develop native vegetation management plan and mine rehabilitation and closure plan. Conduct bi-annual monitoring of permanent flora survey sites.	Unlikely	Minor	Low	
K_03	Construction and operation	Establishment of existing weed species and introduction of new species in disturbed areas (soil disturbance)	Possible	Minor	Moderate	Implementation of a program for staged clearance; ensuring clearance occurs immediately prior to development and within designated areas. Site induction to include identification of weed species. Active management and control of weeds in newly cleared areas. Inspect construction and operation areas for weed outbreaks after rainfall and regularly monitor areas with high potential for weed outbreak. Protect topsoil stockpiles from weed infestation. Consultation with farmers to identify any further weed species. Conduct annual flora and fauna surveys to demonstrate no increase in invasive species and abundance Restrict traffic to established site roads. Monitor vegetation impacts.	Unlikely	Minor	Low	
K_04	Un-clean plant and equipment	Introduction of new weed species and pathogens	Possible	Minor	Moderate	Earth moving machinery and equipment is cleaned prior to entering and leaving the site. A wheel wash and vehicle inspection regime will be implemented at entry and exit points to the site, including installation of rumble grids in appropriate locations.	Unlikely	Minor	Low	
K_05	Treated sewage discharge to the environment	Weed establishment in artificially wet area	Possible	Minor	Moderate	Sewage treatment facilities designed in accordance with EPA and Department for Health requirements and maintained in accordance with design and manufacturers requirements. Conduct annual flora surveys and note the presence or increase in weed species or diversity. A weed eradication program will be developed and implemented for the site.	Unlikely	Minor	Low	
K_06	Airborne dust from construction and operation	Impact on native vegetation	Possible	Minor	Moderate	Implementation of a program for staged clearance; ensuring clearance occurs immediately prior to development and within designated areas. Restrict traffic to established site roads. High traffic areas around the site will be graded, compacted or covered with road base and/or bitumen-based polymer in accordance with fit for purpose design. Dust suppression using water will be undertaken during construction and operation. Monitor dust deposition impacts on vegetation.	Unlikely	Minor	Low	
K_07	Airborne dust from construction and operation	Impact on crops	Possible	Minor	Moderate	Implementation of a program for staged clearance; ensuring clearance occurs immediately prior to development and within designated areas. Restrict traffic to established site roads. High traffic areas around the site will be graded, compacted or covered with road base and/or bitumen-based polymer in accordance with fit for purpose design. Dust suppression using water will be undertaken during construction and operation. Monitor dust deposition impacts on vegetation.	Unlikely	Minor	Low	
K_08	Saline water use for dust suppression	Adverse effects on flora	Possible	Minor	Moderate	Design roads with appropriate drainage control measures that reduce potential for salt build up in soil and runoff to vegetated areas. Control over-spray and do not spray in wet weather. Areas where saline water was applied will be ripped to assist vegetation establishment and rehabilitation. Conduct annual flora survey to demonstrate no net adverse effect due to salinized soil or over-spray.	Unlikely	Minor	Low	
K_09	Fires as a result of construction and mining operations	Loss of vegetation	Unlikely	Major	High	Compliance with AS 5062-2006. Fire protection of mobile and transportable equipment. Provide emergency response capability at mine. Liaise with local emergency services and nearby mining operations.	Unlikely	Minor	Low	
Fauna										
K_10	Clearing of vegetation for construction and operation	Loss of habitat and impacts on diversity and abundance	Possible	Minor	Moderate	Minimise clearance through careful placement of mine infrastructure and project components. Inspection for hollow bearing trees and habitat prior to clearing will be undertaken, with these structures collected and reinstated at closure. Include fencing where appropriate in consultation with the surrounding farmer(s). A native vegetation management plan and mine rehabilitation and closure plan will be developed to outline the approach for progressive rehabilitation. Significant environmental benefit offset will also be established for the project.	Unlikely	Minor	Low	
K_11	Clearing of vegetation for construction and operation	Significant impact on threatened species abundance and habitat availability.	Unlikely	Major	High	Develop and implement a species specific monitoring and management plan, targeting those EPBC and NPW listed species known, or considered likely, to occur within the region. Protect critical habitat for threatened species. Relocate hollows on site away from active mining operations. Prepare and submit a referral under the EPBC Act. Implement any conditions required as a result of the referral. Conduct bi-annual monitoring of permanent fauna survey sites. Utilise low-impact construction methods when applicable. Provision of funding to support recovery objectives and actions for threatened species. Inclusion of species identification and management practices in site induction training material.	Unlikely	Moderate	Moderate	

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			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
K_12	Noise, vibration and light associated with mine establishment and operations	Reduction in local and/or regional fauna species abundance	Possible	Minor	Moderate	Include noise abatement design measures for on-site infrastructure, generators, machinery and materials handling machinery. Enclose the processing plant, and use noise abatement insulation materials. Restrict open pit mining operations to daylight hours. Use of directional lights targeted to work areas and for safety management. Design blasting activities and limit the frequency as much as practicable to be consistent with Australian standards. Maintain noise abatement devices on mine infrastructure and mobile machinery/vehicles. Service machinery in accordance with manufacturing regulations.	Unlikely	Minor	Low	
K_13	Construction and operation (i.e. trenches, dams and pits)	Fauna entrapment or barriers to movement	Possible	Minor	Moderate	Schedule construction activities to minimise time period of open trenches. Include fencing in design where appropriate. Provide ramps and escape routes for fauna. Inspect open excavations, mine work areas and water storages regularly for trapped fauna.	Unlikely	Minor	Low	
K_14	On-site and off-site traffic movement	Vehicle collisions with fauna	Possible	Minor	Moderate	Design roads to use exiting tracks (as far as practicable). Include fencing in the design where appropriate. Timing of construction vehicle movements to be considered and minimised during early morning/late evening (where possible). Implement speed restrictions for all mine employees and for all mine access roads. Implement traffic movement restrictions to only access and public roads.	Unlikely	Minor	Low	
K_15	Accumulation of water and waste food sources	Increased abundance of introduced pest species	Possible	Minor	Moderate	Site roads and drainage to reduce the potential for water pooling and creation of drinking water source. Implement waste management measures to ensure no sources of food. Consider appropriate disposal design features such as subsoil drip irrigation and waste water ponds. Undertake inspection of mine site areas likely to harbor pest species (buildings, waste storage areas). Liaise with NRM Board in relation to control or eradication measures for introduced pest species. Implement eradication program.	Unlikely	Minor	Low	
K_16	Open water storage on site (including tailings storage facility, process water pond and sewage pond)	Death, injury or illness to fauna consuming contaminated water	Possible	Moderate	High	Design process for sub-aerial deposition of tailings. Include fencing in design where appropriate Monitor water quality. Research avifauna deterrent techniques. Implement avifauna deterrent techniques if required. Recover decant water for use in processing. Consider appropriate disposal design features such as subsoil drip irrigation and waste water ponds. Include fencing in design where appropriate. Monitor and inspect regularly	Unlikely	Minor	Low	The small size of the tailings storage facility and its operation by sub-aerial deposition and recovery of water from the ponded area will result in a small surface area which should not be an attraction to birds.
K_17	Fires as a result of construction and mining operations	Loss of fauna and stock	Unlikely	Major	High	Compliance with AS 5062-2006. Fire protection of mobile and transportable equipment. Provide emergency response capability at mine. Liaise with local emergency services and nearby mining operations.	Unlikely	Minor	Low	
Groundwater										
K_18	Mine dewatering	Reduction in groundwater availability in local pastoral bores and environmental values due to reduction in groundwater levels.	Possible	Moderate	High	Implementation of groundwater monitoring program of water levels in monitoring wells and farming wells. Specifically, monitoring would include the areas to the west and south west of the proposed mine site and all surrounding farm wells within the modelled cone of depression. Implementation of remedial action if there is a reduction in water supply of wells which could include deepening existing water wells or providing alternative water supply	Unlikely	Minor	Low	
K_19	Mine dewatering	Reduction in groundwater availability to maintain GDE in Pillaworta Creek and downstream ponds due to open pit dewatering	Possible	Minor	Moderate	Implementation of groundwater monitoring program Resupple areas affected using pit water, subject to approval and ensuring it meets water quality criteria.	Unlikely	Minor	Low	
K_20	Mine dewatering	Loss of flows to Pillaworta Creek and impact on GDE	Likely	Minor	High	Work with EPNRM Board and SA Water to understand flows in Pillaworta Creek. Implementation of groundwater monitoring program of water level monitoring wells. Resupply the creek using pit water if necessary, ensuring it meets water quality criteria.	Posible	Minor	Moderate	
K_21	Storage and use of fuels, chemicals and waste products	Contamination of groundwater and impact on existing users and GDE	Unlikely	Minor	Low	Design fuel, oil and chemical storage in accordance with EPA and Australian Standards. Maintain fuel, oil and chemical storage areas during operations. Undertake regular inspections of areas to ensure integrity of bunded and spill containment areas, housekeeping and correct use of storage and	Rare	Minor	Low	
K_22	Seepage from TSF	Decrease in groundwater quality due to seepage of heavy metals from from tailings in TSF and impact on existing users and GDE	Unlikely	Minor	Low	Construct TSF upstream of the pit to enable seepage losses (if any) to flow into the pit. Compaction of the clay in the base of the storage area to produce a low permeability liner Subaerial deposition of the tailings to ensure consolidation of tailings thereby reducing in-situ permeability and promoting the volatilisation of hydrocarbons Maintaining a small decant pond thereby reducing the hydraulic head on the tailings Design will include a cut-off trench and downstream drainage collection to minimise the potential for shallow seepage.f groundwater monitoring program of Monitoring of aerial extent of pond around decant. Implementation of appropriate closure. Implementation of a groundwater monitoring program quality in monitoring bores and pastoral bores. Implementation of remedial action if there is a reduction in water quality of pastoral bores (e.g. provide alternative water supply).	Rare	Minor	Low	
K_23	Seepage from TSF	Decrease in groundwater quality due to seepage of kerosene from from tailings in TSF and impact on existing users and GDE	Unlikely	Minor	Low	Construct TSF upstream of the pit to enable seepage losses (if any) to flow into the pit. Compaction of the clay in the base of the storage area to produce a low permeability liner Subaerial deposition of the tailings to ensure consolidation of tailings thereby reducing in-situ permeability and promoting the volatilisation of hydrocarbons Maintaining a small decant pond thereby reducing the hydraulic head on the tailings Design will include a cut-off trench and downstream drainage collection to minimise the potential for shallow seepage.f groundwater monitoring program of Monitoring of aerial extent of pond around decant. Implementation of appropriate closure. Implementation of a groundwater monitoring program quality in monitoring bores and pastoral bores. Implementation of remedial action if there is a reduction in water quality of pastoral bores (e.g. provide alternative water supply).	Rare	Minor	Low	
K_24	Acid rock drainagefrom tailingsstorage facility.	Decrease in ground water quality and consequent impact on existing users and GDE.	Unlikely	Minor	Low	Construct TSF upstream of the pit to enable seepage losses (if any) to flow into the pit. Design TSF to include encapsulation of PAF material. Implement a program to undertake ongoing monitoring of water quality in nearby wells. Undertake progressive rehabilitation where practicable. Implement a program to undertake periodic checking of acid rock drainage potential during mining activities.	Rare	Minor	Low	

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			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
K_25	Acid rock drainage to groundwater from open pit.	Decrease in groundwater quality due to acid rock drainage from open pit and contamination with heavy metals and impact on existing users and GDE	Possible	Minor	Moderate	Implementation of groundwater monitoring program of quality in monitoring bores and pastoral bores. Implementation of remedial action if there is a reduction in water supply of pastoral bores (e.g. provide alternative water supply.	Unlikely	Minor	Low	
K_26	Drainage from ore and low grade stockpiles	Decrease in groundwater quality due to drainage from ore and low grade stockpiles and impact on existing users and GDE.	Unlikely	Minor	Low	Install drainage collection system around perimeter of ore and low grade stockpile areas. Implement a program to undertake ongoing monitoring of water quality in nearby wells. Undertake progressive rehabilitation where practicable	Rare	Minor	Low	
K_27	Waste rock storage facility	Decrease in groundwater quality due to heavy metals from WRSF and impact on existing users and GDE	Unlikely	Minor	Low	Implementation of groundwater monitoring program of quality in monitoring bores and pastoral bores. Implementation of remedial action if there is a reduction in water supply of pastoral bores (e.g. provide alternative water supply.	Unlikely	Minor	Low	
K_28	Seepage of sewage to groundwater	Contamination of ground water quality	Unlikely	Minor	Low	Design septic system in accordance with appropriate standards and ensure the design considers the appropriate Peak Wet Weather Flow. The septic system will be self-contained and designed in accordance with EPA and Department for Health requirements. The septic system will be maintained in accordance with design and manufacturers requirements. Implement a program to monitor groundwater quality including nearby pastoral bores.	Rare	Insignificant	Low	
Surface Water/Hydrology										
K_29	Altered flow regimes due to diversion of local watercourses for mining operations	Impact on WDE and general water quality	Possible	Minor	Moderate	Avoid unnecessary disturbance to existing drainage areas. Hydrological design to incorporate diversion of upstream surface water to protect infrastructure, open pit, overburden stockpiles from surface flows. Undertake visual inspections of surface water control measures immediately after rainfall events to confirm operating in accordance with design and remediate if necessary. Obtain a water affecting activities permit for any alterations to creek flows and water crossings.	Unlikely	Minor	Low	
K_30	Release of sediment laden water from site operations (e.g. stockpile areas, roads, process areas etc.) to surface water system - increased sediment load in local watercourses	Contamination of surface water.	Possible	Minor	Moderate	Run off from site and in particular WRSFs and stockpiles to be collected in diversion channels and directed through sediment traps prior to discharge to the environment. Diversion of upslope surface water runoff. Design of roads to incorporate appropriate drainage (where practicable). Controlled application of saline water for dust suppression and the use of bitumen-based road polymers to reduce the need to dust suppression. Design of operations to include opportunistic use of this water and water caught in the pit back through operations (e.g. processing plant, dust suppression) to minimise the need for off-site release. Undertake visual inspections of surface water control systems immediately after rainfall events and remediate incidents by diverting flows appropriately and/or treating surface water (if required). A surface water quality monitoring program consistent with the risks will be developed and implemented during operations. Developed SEDMP measures.	Unlikely	Minor	Low	
K_31	Drainage from WRSF	Contamination of surface water	Possible	Minor	Moderate	Collection of drainage from WRSF A grade control program to undertake assessment of potentially acid forming (PAF) material during mining activities will be developed and implemented to ensure that waste rock disposed in WRSF is not PAF	Unlikely	Minor	Low	
K_32	Storage and use of fuels, chemicals and storage of waste material.	Contamination of surface water	Possible	Minor	Moderate	Design fuel, oil and chemical storage and bunds in accordance with EPA and Australian Standards. Maintain fuel, oil and chemical storage areas during operations. Undertake regular inspections of areas to ensure integrity of bunded and spill containment areas and correct use of storage and distribution areas. Develop and implement chemical and fuel management procedures including emergency response and clean up requirements. Management of waste management facility in accordance with design and operating procedures. Implementation of a surface water monitoring program consistent with risks.	Unlikely	Minor	Low	
K_33	Acid rock drainage into surface water from ore and low grade stockpiles	Contamination of surface water	Unlikely	Minor	Low	Develop and implement a program to undertake grade control monitoring of potentially acid forming material during mining activities. Develop Acid Rock Drainage Management Plan. Collection of drainage from ore and low grade stockpiles.	Rare	Minor	Low	
K_34	Seepage through TSF embankment	Imapct on surface water	Possible	Moderate	High	The TSF will incorporate a low permeability cut-off trench and external downstream leak detection/collection system (seepage dam). Re-use of collected seepage in process (if feasible) or pump back to TSF. The tailings storage will incorporate a low permeability cut-off trench and HDPE liner on upstream face of embankment. Establishment and implementation of a Tailings Operational and Management Plan.	Unlikely	Minor	Low	
K_35	Overflow of tailings storage facility into surface water catchment	Contamination of surface water	Possible	Moderate	High	Design to incorporate suitable freeboard in accordance with ANCOLD Guidelines that will ensure sufficient storage of tailings and incident rainfall to ensure that there will not be overtopping due to wave action even after a storm event. Any inadvertent overflow will be captured first in the downstream seepage pond or, in the event of that overflowing, it would flow into the pit and cannot overflow into Pillaworta Creek. Embankment lifts undertake well ahead of storage volume reaching capacity. Tailings delivery pipeline will be established in a bunded pipeline corridor. Pipelines equipped with leak detection equipment that will indicate when there is a pipeline leakage or failure. The tailings storage will incorporate a low permeability cut-off trench and external downstream leak detection/collection system. Free water that accumulates around the decant area will be recovered and pumped to the process water dam for re-use. Establishment and implementation of a Tailings Operational and Management Plan.	Unlikely	Minor	Low	
K_36	Overflow of sewage into surface water catchment	Contamination of surface water	Unlikely	Minor	Low	Septic system to be located to avoid potential contamination of surface waters off site. Design septic system in accordance with appropriate standards and ensure the design considers the appropriate Peak Wet Weather Flow. The septic system will be self-contained and designed in accordance with EPA and Department for Health requirements. Septic systems on site will be maintained in accordance with design and manufacturers requirements. Surface water monitoring will be undertaken in accordance with risks.	Rare	Minor	Low	

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			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
Soil and Topsoil										
K_37	Exposure and disturbance of soil during construction and operation.	Loss of soil quantity	Likely	Minor	High	Minimise potential through staged clearing from only the required footprint and progressive rehabilitation. Strip topsoil and excavate subsoil only from those areas that will be disturbed by mining operations. Ensure stockpiles are appropriately surveyed and documented for management and rehabilitation purposes. Use erosion control techniques to protect stockpiles and minimise erosion and sediment loss. Select soil stockpile locations avoiding working areas, areas of natural drainage and on-site traffic routes. Regular inspections and maintenance of sediment and erosion control devices. Operational activities will keep to established and designated roads and work zones.	Possible	Minor	Moderate	
K_38	Saline water use for dust suppression	Adverse effect on soil quality/structure	Possible	Minor	Moderate	Design roads with appropriate drainage control systems and use bitumen-based polymers in high traffic areas. Minimise overspray and implement controlled water application on unsealed surfaces or in wet weather. Management procedures for use of saline water for dust suppression will be developed and implemented.	Unlikely	Minor	Low	
K_39	Leakage of saline water from water supply pipeline (damage from temperature, vehicles)	Adverse effects on soil quality/structure	Possible	Minor	Moderate	Consider design requirements of water supply pipeline e.g. UV tolerant HDPE with white colour coating and flow requirements. Undertake regular inspections and repair any leakages within 24 hours of observation. Regular visual inspections of the pipeline will be undertaken.	Unlikely	Minor	Low	
K_40	Acid rock drainage from ore and low grade stockpilesinto soil	Soil contamination by heavy metals	Unlikely	Minor	Low	Develop and implement a grade control program to undertake systematic checking of potentially acid forming material during mining activities. Implement an Acid Rock Drainage Management Plan. Collection of drainage from ore stockpile area and low grade stockpiles.	Rare	Minor	Low	
K_41	Establishment of roads, laydown aeas, hardstands	Compaction of soil surface	Possible	Minor	Moderate	Removal of hardstand areas. Scarifying of compacted areas Spreading of topsoil	Possible	Minor	Low	
K_42	Storage and use of chemicals and fuels on site and production of waste products	Soil contamination	Possible	Minor	Moderate	Design fuel, oil and chemical storage in accordance with EPA and Australian Standards as appropriate. Regular inspections will be undertaken to ensure integrity of bunded and spill containment areas and correct use of storage and distribution areas. Develop and implement chemical and fuel management procedures including emergency response and clean up requirements. Management of waste storage facility in accordance with design and operating procedures and EPA requirements. Implementation of a groundwater monitoring program.	Unlikely	Minor	Low	
Aboriginal and European Heritage										
K_43	Establishment and operation of mining operation	Disturbance to Aboriginal sites	Possible	Minor	Moderate	Establish project components to avoid disturbance of identified Aboriginal heritage sites. Develop Aboriginal Heritage Management Plan in conjunction with Barngarla representatives with procedures to be implemented in the event a discovery is made. Protocol to also address statutory reporting requirements as per legislation. Restrict vehicle access to site access tracks and project roads to prevent damage to identified or un-known sites. Clearly mark identified sites and, if required, designate as "no go" zones and prohibit access to these sites. Monitor the status of heritage sites and implementation of the Aboriginal Heritage Management Plan. Establish and implement procedures should new sites be discovered during site works. Undertake induction of personnel on responsibilities under the Act, procedures relating to ground disturbance and identified sites, and reporting requirements.	Unlikely	Minor	Low	
K_44	Establishment and operation of mining operation	Disturbance of European heritage sites	Unlikely	Minor	Low	Develop European Heritage Management Plan with procedures to be implemented in the event a discovery is made. Protocol to also to address statutory reporting requirements as per legislation. Restrict vehicle access to site access tracks and project roads to prevent damage to identified and un-known sites. Undertake induction of personnel on responsibilities under the Act, procedures relating to ground disturbance and identified sites, and reporting requirements.				
K_45	Establishment and operation of mining operation	Disturbance of European heritage sites	Not a credible risk							
Air Quality										
K_46	Dust from construction and operation (e.g. material stockpiles, on site roads and traffic movements, open pit)	Impact on amenity and human health (sensitive receptors)	Possible	Minor	Moderate	Manage staged vegetation clearance and ground disturbance. Design of mine haulage, access roads and other trafficable and working areas on site to incorporate sealing with compacted material and/or bitumen-based polymer (as appropriate for design specification) and implement vehicle speed restrictions and restrict traffic to dedicated formed roads. Implement dust suppression measures. Incorporate cover system on external conveyor. Control blasting to reduce dust emissions. Progressive rehabilitation of WRSFs and external slopes of TSF. Incorporate hydro seeding or sprinklers on temporary stockpiles and ROM pad. To prevent drying pre-tailings deposition the surface of the tailings storage area will be kept moist until such time as the tailings cover the entire storage area. Monitor the surface of the TSF for signs of drying out during operation. If the surface dries completely prior to placement of the next layer of tailings apply a water spray to maintain moisture. Install and monitor dust deposition equipment to determine if mining activities are within acceptable levels. Cessation of works in the event of extreme weather and wind conditions. Following cessation of processing and before completion of initial rock cover, monitor the surfae for dusting and consider mitigation options such as use of polymer dust suppressant, silt fences or establishment of hay bales.	Unlikely	Minor	Low	
K_47	Emission of fuel combustion products (associated with vehicles and diesel power generation)	Adverse effects on human health and local / regional air quality	Possible	Insignificant	Low	Fuel combustion facilities for power station, borefield pumps, miming equipment and vehicles to meet EPA requirements, Australian standards and SA regulations (as appropriate). Equipment and vehicles to be maintained and serviced in accordance with manufacturers requirements.	Unlikely	Insignificant	Low	
K_48	Emission of fuel combustion products (associated with vehicles and diesel power generation)	Local/regional increase in greenhouse gas emissions	Possible	Minor	Low	Fuel combustion facilities for power generation, mining equipment and vehicles to meet EPA requirements, Australian standards and SA regulations (as appropriate). Equipment and vehicles to be maintained and serviced in accordance with manufacturer's requirements. Monitor energy consumption and implement energy efficiencies where practicable. Utilise solar and/or wind power where practicable. Use of energy-efficient lighting in all building and work areas.	Possible	Insignificant	Low	
K_49	Production of odour (associated with diesel fuel use, sewage treatment plant, processing agents if applicable)	Adverse effects on human health and local air quality	Unlikely	Minor	Low	All site infrastructure to be designed in accordance with Australian Standards and best practice. Facilities to also meet EPA design requirements. Sewerage system to meet EPA and Department of Health requirements. Mining operations are also not considered to be inherently odorous developments.	Rare	Insignificant	Low	

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			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
Noise and vibration										
K_50	Production of noise and vibration (associated with vehicles, machinery, aircraft, etc.)	Disturbance to sensitive receptors	Possible	Minor	Moderate	Compliance with EP (Noise) Policy. Locating temporary stockpiles between mining operations and sensitive receptors. Compliance with Traffic Management Plan. Locate noisy equipment at the greatest practical distance from sensitive receptors. Monitoring of noise and vibration impacts by complaints register. Locate crushing plant in pit. Restrict open pit mining operations to daytime hours. Maintain vehicle fleet in accordance with manufacturer's requirements. Ensure noise reduction devices such as mufflers are fitted and operating effectively.	Unlikely	Insignificant	Low	
K_51	Production of noise and vibration associated with blasting	Disturbance to sensitive receptors and property	Possible	Minor	Moderate	Blasting activities will comply with AS 2187.2-2006 with respect to human comfort levels for vibration. Compliance with ground vibration overpressure limits. Monitoring of noise and vibration impacts by complaints register.	Unlikely	Rare	Insignificant	
Asbestisform Materials										
K_52	Excavation of materials containing asbestiform minerals during mining operations	Human and eological health impacts	Possible	Moderate	High	Identify the occurrence of mafic dykes and marble units and assess if asbestiform minerals are present. Design WRSFs and TSF to include encapsulation (if required). Dust suppression and personal monitoring.	Possible	Minor	Moderate	
Visual Amenity and Landscape										
K_53	Construction, operation and rehabilitation of the mine	Reduced visual amenity in project area (local and regional) due to change to landscape	Unlikely	Minor	Low	Placement of mine infrastructure determined (as far as practicable) to minimise visual impact. Project design incorporates requirement to minimise land disturbance (i.e. retention and creation of contours). Design of WRSFs and TSF to incorporate elements that assists with progressive rehabilitation and vegetation. Location and revegetation of a soil stockpile and NW WRSF to provide a visual barrier from Pillaworta Road.	Unlikely	Insignificant	Low	
K_54	Construction, operation and rehabilitation of the mine	Disturbance of local residents due to light spill	Possible	Minor	Moderate	Use of directional lights targeted to work areas and for safety management. No open pit, waste rock haulage or trucking operations are night. Process plant to be fully enclosed.	Possible	Insignificant	Low	
Traffic										
K_55	Increased traffic on local and regional roads	Reduced public safety	Possible	Moderate	High	Development and implementation of a Traffic Management Plan. Vehicles (semi-trailers) not to operate during school bus pick up and drop off times. Liaise with DPTI and DCTB to determine requirements for upgrades for site access off of the Lincoln Highway, Bratten Way and Pillaworta Road. Installation of appropriate signage at the site access intersection in consultation with DPTI. All vehicle operators to hold the appropriate drivers licence. Induction into site procedures and driving training for local conditions.	Possible	Minor	Moderate	Noise and dust issues covered in relevant sections above.
K_56	Increased traffic on local and regional roads	Increased road maintenance	Possible	Moderate	High	Reach an agreement with DCTB and DPTI (if required) regarding maintenance requirements for relevant portion of Bratten Way and Pillaworta Road. Implementation of Traffic Management Plan (including speed restrictions, road inspections).	Possible	Minor	Moderate	
K_57	Increased traffic on local and regional roads	Increased road maintenance	Unlikely	Minor	Low	Reach an agreement with DCTB (if required) regarding maintenance requirements for relevant portion of Pillaworta Road.	Unlikely	Minor	Low	
Land use, third party property and safety										
K_58	Heavy vehicle traffic	Collision with stock resulting in injury or death	Unlikely	Minor	Low	Implemenetation of a Traffic Management Plan will reduce the risk of collisions with stock.	Unlikely	Minor	Low	
K_59	Construction of site fences and roads.	Disruption of pastoral activities by preventing traversing of properties.	Unlikely	Minor	Low	Liaison with adjacent landowners on site access to their properties (if required) will be undertaken and if necessary alternative access points will be established.operations can continue alongside the mining and interruptions are minimised. Maintain regular consultation with pastoralists.	Unlikely	Minor	Low	
K_60	Disruption to community	Pressure on local services such as health, education and recreation. Inappropriate worker behaviour in local community.	Unlikely	Minor	Low	Ongoing engagement with the community through implementation of Stakeholder engagement plan. Support for local recreational/sporting groups. Support for local schools and health services. Provide onsite emergency medical response capability during mining operations. Implementation of Company Code of Behaviour and Induction program. Establishment of Complaints Register. Implementation of site newsletter.	Unlikely	Minor	Low	
K_61	Competition for skilled people	Reduction in employees for pastoralist and regional industry	Possible	Minor	Moderate	Liaise with local training providers and support for local training opportunities. Plan for provision of specific training for employees. It should be noted that the increased employment opportunities is a positive impact.	Possible	Minor	Moderate	
K_62	Mining operations	Loss of property values	Unlikely	Minor	Low	To manage the broader impacts LML and AGL would collaboratively develop and distribute communications that build the community's understanding of mining project timeframes prior to commencing construction and operations AGL will discuss landowner compensations with directly affected landowners, which will be identified based on a case-by-case assessment	Unlikely	Minor	Low	
K_63	Emergency Incident during construction and operation on site	Pressure on local emergency services and CFS	Unlikely	Minor	Low	Implementation of comprehensive Site Safety Policy and Procedures. Provide onsite emergency medical response capability during mining operations. Provide emergency response capability during mining operations (including training, mock incidents). Ongoing liaison with local emergency services and nearby mining operations. Compliance with AS 5062-2006. Fire protection of mobile and transportable equipment. Compliance with regulatory requirements.	Unlikely	Minor	Low	
K_64	Fire caused by construction and operation	Death/injury and significant economic loss	Unlikely	Major	High	Compliance with AS 5062-2006. Fire protection of mobile and transportable equipment. Provide emergency response capability at mine. Liaise with local emergency services and nearby mining operations. Implementation of site security (including gates and fences as appropriate) and safety signage. The storage of flammable material will be undertaken in accordance with Australian standards and EPA Guidelines	Unlikely	Minor	Low	

Kookaburra Gully Environmental Aspects and Risk Assessment Register

The register includes: (a) Detailed Risk Assessment of proposed mining activities; (b) generic consideration of risks associated with activities on surrounding area.

ID	Aspect	Impact	Primary Risk Level			Control and Management Strategies	Residual Risk level			Additional Comments/notes
			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
K_65	Unauthorised access	Public safety (injury or death)	Possible	Moderate	High	Implementation of comprehensive Site Safety Policy and Procedures Provide emergency response capability during mining operations and undertake ongoing liaison with local emergency services and nearby mining operations Establishment of security at the main entrance Installation of warning signs Installation of signs prohibiting unauthorised access Escorting unauthorised persons from the site.	Unlikely	Moderate	Moderate	
K_66	Blasting in open pit	Damage to public and private proerty by fly rock	Possible	Minor	Moderate	Angular aggregate utilised for stemming material Controlled face burden through accurate survey Blastholes positioned to design through survey setout Dipping of blastholes to ensure: - correct weight of explosive is charged - design stemming height is achieved.	Unlikely	Moderate	Moderate	
Closure and Rehabilitation										
K_67	Poor vegetation cover	Poor vegetation cover and reduced species abundance and diversity resulting in reduced ecological function.	Possible	Minor	Moderate	Use of plant species appropriate for climatic conditions and soils. Progressively rehabilitate the site conducting trials to investigate best species application. Conduct ecosystem function analysis (EFA), or similar to determine success of rehabilitated sites and adjust rehabilitation activities as appropriate based on the results.	Unlikely	Minor	Low	
K_68	Poor vegetation cover	Increased density of weeds and new introduced species.	Possible	Minor	Moderate	Ongoing monitoring and eradication of weed species	Unlikely	Minor	Low	
K_69	Poor vegetation cover	Reduced species abundance and diversity. Increase of introduced species	Possible	Minor	Moderate	Post mining landforms and exposed surfaces progressively rehabilitated and stabilised. Regular monitoring and eradication of pests.	Unlikely	Minor	Low	
K_70	Inadequate rehabilitation	Impact on post mining agricultural use	Possible	Minor	Moderate	All hardstand surfacing of haul roads, workshop areas, administration/process/storage buildings and ROM pad will be scarified to loosen compacted material and covered with previously stockpiled sub-soil and topsoil and revegetated with grasses to make suitable for return to arable land and/or pasture. If contaminated, the material will be disposed of in the open pit, TSF or a suitable offsite EPA licensed facility	Unlikely	Minor	Low	
K_71	Infrastructure left on site	Impact on post closure agricultural use	Possible	Minor	Moderate	Dismantle and remove ROM pad, conveyors, ore bins, etc, including concrete footings and retaining walls. Dismantle and remove all of the process plant, including tanks and pipework. Dismantle and remove all water and process pipelines, electricity power lines, water wells, tanks/ponds and pipelines. Dismantle and remove all processing, storage and associated buildings. Dismantle and remove the explosives magazine including fences. All geosynthetic lining of water storage ponds and sewage ponds will be removed for off-site disposal to an EPA approved landfill. The walls of ponds will be pushed in to the former pond area then spread and covered with sub-soil and topsoil and revegetated. However, the silt retention ponds adjacent to Pillaworta Road will be retained. All offices, buildings crib rooms and workshop buildings will be removed from the site. All fuel tanks and associated infrastructure will be removed from the site. The septic tank systems and pipelines will be removed from the site. Any hydrocarbon contaminated soils will be excavated and bio-remediated to a level that will enable disposal in the TSF or the open pit. All site fencing introduced by the mining operations will be removed (unless required by a future lessee or for security around the open pit).	Unlikely	Minor	Low	
K_72	Open pit as a groundwater sink	Reduction in groundwater quantity	Possible	Minor	Moderate	Implementation of groundwater monitoring program of water levels in monitoring wells. Implementation of remedial action if there is a reduction in water supply in wells (e.g. deepen existing wells or provide alternative water supply).	Unlikely	Minor	Low	
K_73	Seepage of kerosene and heavy metals from TSF	Impact on groundwater quality	Possible	Minor	Moderate	TSF incorporates low permeability compacted clay in storage area. Consolidation of tailings results in low permeability material. Placement of final cover that limits infiltration of rainfall and runoff water. Implementation of groundwater monitoring program of water levels in monitoring wells.	Unlikely	Minor	Low	
K_74	ARD and seepage from PAF storage in TSFsee	Impact on groundwater quality	Possible	Minor	Moderate	TSF incorporates low permeability compacted clay in storage area. Consolidation of tailings results in low permeability material. Placement of final cover that limits infiltration of rainfall and runoff water. Implementation of groundwater monitoring program of water levels in monitoring wells.	Unlikely	Minor	Low	
K_75	Heavy metals in runoff from WRSF	Impact on groundwater quality	Possible	Possible	Possible	Placement of final cover that limits infiltration of rainfall and runoff water. Implementation of groundwater monitoring program of water levels in monitoring wells	Unlikely	Minor	Low	
K_76	Fuels, chemicals and waste left on site	Impact on groundwater quality	Unlikely	Minor	Low	Any spills cleaned up in accordance with EPA requirements. All infrastructure and remaining amounts of fuels, chemicals and waste material remove from site.	Unlikely	Minor	Low	
K_77	Erosion of TSF and WRSF	Sediment impact on Pillaworta Creek	Possible	Possible	Possible	The external surfaces of all WRSFs including the TSF embankment will be established at a nominal overall 15 to 20 degree slope. Rock armouring will be placed to reduce the potential for erosion and contour benches will be maintained at approximately 5 m widths to mimic existing agricultural contour banks. The final surfaces of the WRSFs after battering down will be covered with subsoil to a depth of approximately 0.5 m then 0.2 m-0.3 m of topsoil and a self-sustaining vegetation cover appropriate to the final slope and proposed long term grazing use. A cover of fresh waste rock of 0.5 m—1.0 m thickness will be placed over the entire surface of the TSF. The final surface of the TSF will be covered with subsoil to a depth of approximately 0.5 m then 0.2 m-0.3 m of topsoil before planting with grasses or a self-sustaining cover suitable for ultimate return to arable land. Drainage channels around the WRSFs and TSF will be retained.	Unlikely	Minor	Low	
K_78	Fuels, chemicals and waste left on site	Surface water contamination by hydrocarbons, waste material	Possible	Minor	Moderate	Any spills cleaned up in accordance with EPA requirements. All infrastructure and remaining amounts of fuels, chemicals and waste material remove from site.	Unlikely	Minor	Low	
K_79	Fuels, chemicals and waste left on site	Reduction in soil quality due to contamination	Possible	Minor	Moderate	Any spills cleaned up in accordance with EPA requirements. All infrastructure and remaining amounts of fuels, chemicals and waste material remove from site.	Unlikely	Minor	Low	
K_80	Near surface seepage from TSF	Reduction in soil quality due to contamination	Possible	Minor	Moderate	Design of TSF for encapsulation of PAF material. Collect seepage in downstream pond..	Unlikely	Minor	Low	

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			Likelihood	Consequence	Risk		Likelihood	Consequence	Risk	
K_81	Dust emission from poorly rehabilitated areas	Impact on air quality	Possible	Minor	Moderate	Progressive rehabilitation and revegetation of exposed surfaces as soon as practical. Ongoing regular monitoring, watering and fertilising as required until established.	Unlikely	Minor	Low	
K_82	Instability of tailings storage and rock storage facilities and open pit.	Health and safety of humans and fauna	Possible	Moderate	High	Final slopes of the WRSFs designed to ensure long term stability consistent with existing topography. TSF to be restored to flat arable land and the final slope of TSF embankment to be designed to ensure long term stability. Bund placed around the pit perimeter and ramps to restrict access. Grade upper pit walls to reduce slope and instability. Assess need for installation of fence and install if necessary. Place signage around the pit warning of the danger.	Unlikely	Moderate	Moderate	
K_83	WRSF and TSF not integrating with surrounding environment	Negative visual impact	Possible	Minor	Moderate	Final slope designed to be generally consistent with regional landscape through shape and form and vegetated with native vegetation or available for grazing.	Unlikely	Minor	Low	