Cowal Gold Project

ENVIRONMENTAL Impact Statement



1 Main Report

ResourceStrategies

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ENVIRONMENTAL IMPACT STATEMENT

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NORTH LIMITED
A.C.N. 005 233 689
Telephone:
(03) 9207 5111
Facsimile:
(03) 9250 1600

Registered Office
North House
476 St. Kilda Road
Melbourne Victoria
Australia 3004

Postal Address
GPO Box 1903R
Melbourne Victoria
Australia 3001

13 March 1998

Director-General
Department of Urban Affairs and Planning
Governor Macquarie Tower
1 Farrer Place
SYDNEY NSW 2000

Dear Madam

The enclosed Environmental Impact Statement for the Cowal Gold Project has been prepared by Resource Strategies Pty Ltd. North Limited believes the EIS to represent an accurate statement of the Company's project development intentions and proposals for environmental management.

Yours sincerely

Richard Knight

Executive Director – Development

Form 2

Submission of Environmental Impact Statement (EIS)

prepared under the Environmental Planning and Assessment Act 1979, Section 77

EIS prepared by

name	Peter Ryan, Principal
qualifications	BSc, MSc
address	Resource Strategies Pty Ltd 1/11 Lang Parade MILTON QLD 4064
in respect of	Cowal Gold Project

development application

applicant name	North Gold (WA) Ltd 476 St Kilda Road MELBOURNE VIC 3004
land to be developed address lot no, DPMPS, vol/fol etc proposed development	As shown in EIS Figure 1.4 Development of a mine to extract by open-cut methods and process gold ore. The development includes mine site buildings, storage dams, water supply system, internal mine roads, waste dumps and associated infrastructure. or ☐ map(s) attached

environmental impact statement

☑ an environmental impact statement (EIS) is attached

certificate

I certify that I have prepared the contents of this Statement to the best of my knowledge

- it is in accordance with clauses 51 and 52 of the Environmental Planning and Assessment Regulation 1994, and
- it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

signature



name	Peter Ryan
date	13 March 1998

NORTH LIMITED
A.C.N. 005 233 689
Telephone:
(03) 9207 5111
Facsimile:
(03) 9250 1600

Registered Office
North House
476 St. Kilda Road
Melbourne Victoria
Australia 3004

Postal Address
GPO Box 1903R
Melbourne Victoria
Australia 3001

STATEMENT OF INTENT BY NORTH LIMITED

Concerning the Proposed Cowal Gold Project

Overall Environmental Intent

North recognises that the proposed Cowal Gold Project lies directly within an area acknowledged for its high conservation status as an inland wetland ecosystem. This Environmental Impact Statement endeavours to address in a comprehensive way the interaction of the proposed mine with that ecosystem, both in terms of the ecosystem's components and as a whole. The design and operation of the proposed mine, as well as final closure objectives, have been developed around ecologically driven principles. This fundamental philosophy has guided the proposed placement of key facilities, their shape, stability, final use and, in particular, the way in which the area is to be rehabilitated. North has recognised that in planning for a development in this area, the long term preservation of critical conservation values must be taken into account. Should development consent be obtained, North are committed to developing, operating, decommissioning and rehabilitating the Cowal Gold Project in such a manner as to ensure that the conservation status of the lake is unaffected and that critical conservation values are preserved for future generations.

Overall Approach to Issues

North's objective is to build consensus on the development of the Cowal Gold Project. In doing so North will engage in a comprehensive Environmental Impact Assessment process, consult openly with all stakeholders, listen genuinely to issues raised and address those issues in a constructive way. Information on the Project will be made as widely available as possible. North will encourage public and government agency review of its proposals as well as conducting a rigorous internal review programme.

Development Concept

In preparing this new Development Application and Environmental Impact Statement for the Cowal Gold Project, North has sought to address concerns raised in the consideration of the original proposal submitted for development consent in 1995. This new proposal for the Cowal Gold Project includes:

- Relocation and ecologically sensitive reformation of a section of the lake foreshore to keep the development separate from Lake Cowal. This will be done to maximise synergy with the existing shoreline features and ecology, ensure long term stability and achieve appropriate noise, dust, water quality and light control outcomes.
- The development of an open pit mine which extends beyond the high water mark of the Lake which has required North to examine in detail the long term options for the final void and the protection of ecological values.
- A significantly different processing proposal for mined gold bearing ore which includes the:
  - use of a flotation (or concentrator) circuit to significantly reduce cyanide use;
  - use of cyanide destruction and recycling technologies;
  - movement of the tailings storages 3.5 km from the lake;
  - reduction in the number of tailings storage cells from four to two.
- The emplacements which will permanently store rock which contains no commercial gold (waste rock) will be developed and rehabilitated in such a way as to both ensure protection of the surrounding environment and provide for enhanced flora and fauna habitat.
- The powerline to the Project has been relocated from the previously proposed route between Lake Cowal and Nerang Cowal and is aligned to avoid migratory waterbird flight paths.

These proposals and how they were derived in preference to other options are addressed in detail in this new Environmental Impact Statement. This new Environmental Impact Statement also provides detail on studies recently undertaken to address the issue of the Cowal Gold Project's long term compatibility with Lake Cowal. In terms of the economic benefits the Cowal Gold Project can bring to rural NSW, North will seek to maximise local employment and use of services.

STATEMENT OF INTENT BY NORTH LIMITED Continued

Specific Environmental Undertakings

Since the last Development Application North has made a number of environmental undertakings. These are reiterated in this Statement of Intent. As part of the new Development Application, North will:

- ensure bird breeding areas at the north of Lake Cowal remain undisturbed by the mine;
- ensure that the quality of water in Lake Cowal is not detrimentally affected by the mine;
- set a new standard in cyanide control which can protect bird life and uses state of the art technology;
- provide appropriate security to the government to ensure the area is fully rehabilitated;
- support activities which promote special interest tourism and long term sustainable development in the Lake Cowal region;
- carry out its activities in a manner which is consistent with the *NSW State Wetlands Management Policy (1996).*

Signed



Richard Knight

Executive Director – Development

Executive Summary

Executive Summary

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1.0 INTRODUCTION

This executive summary provides an overview of the findings of the Environmental Impact Statement (EIS) prepared for the Cowal Gold Project.

The Cowal Gold Project involves the development of an open pit gold mine adjacent to and within a small section of Lake Cowal, 38 kilometres (km) north-east of West Wyalong in New South Wales (Figure ES-1).

The proponent of the Project is North Gold (WA) Ltd (North) a wholly owned subsidiary of North Limited. North is a diversified Australian resources company with operations throughout Australia and in Sweden, Argentina and Canada.

In world terms the Cowal Gold Project ranks as a medium-scale gold mine and a low-medium grade orebody with the proposal based on the production of approximately 2.7 million ounces of gold over thirteen years. There would be a two year construction period. Approximately $210 million would be expended to bring the Project into production. Once in operation the Project would employ about 200 people.

Key features of the development are shown in Figure ES-1. The development also encompasses a water pipeline and a borefield located about 20 km to the east-northeast of the Project (Figure ES-2). Road upgrade works are also encompassed within the environmental assessment (Figure ES-2).

The Project would require the construction of a 132 kilovolt (kV) transmission line, some 90 km in length, from Temora to the south of the Project area for the supply of electricity. The proponent of the electricity line is Great Southern Energy and a separate Environmental Impact Statement has been prepared as part of the overall assessment of the Cowal Gold Project. The estimated cost of the transmission line is $11 million.

A Species Impact Statement (SIS) has been prepared for the Project and its main findings are incorporated into this executive summary.

An overview of the regulatory approvals process required for the Cowal Gold Project, electricity transmission line and access road upgrade is presented in Table ES-1.

The Director-General of Urban Affairs and Planning has issued EIS Director's Requirements for the Cowal Gold Project proposal. Table ES-2 presents a summary of these requirements and the relevant EIS section reference.

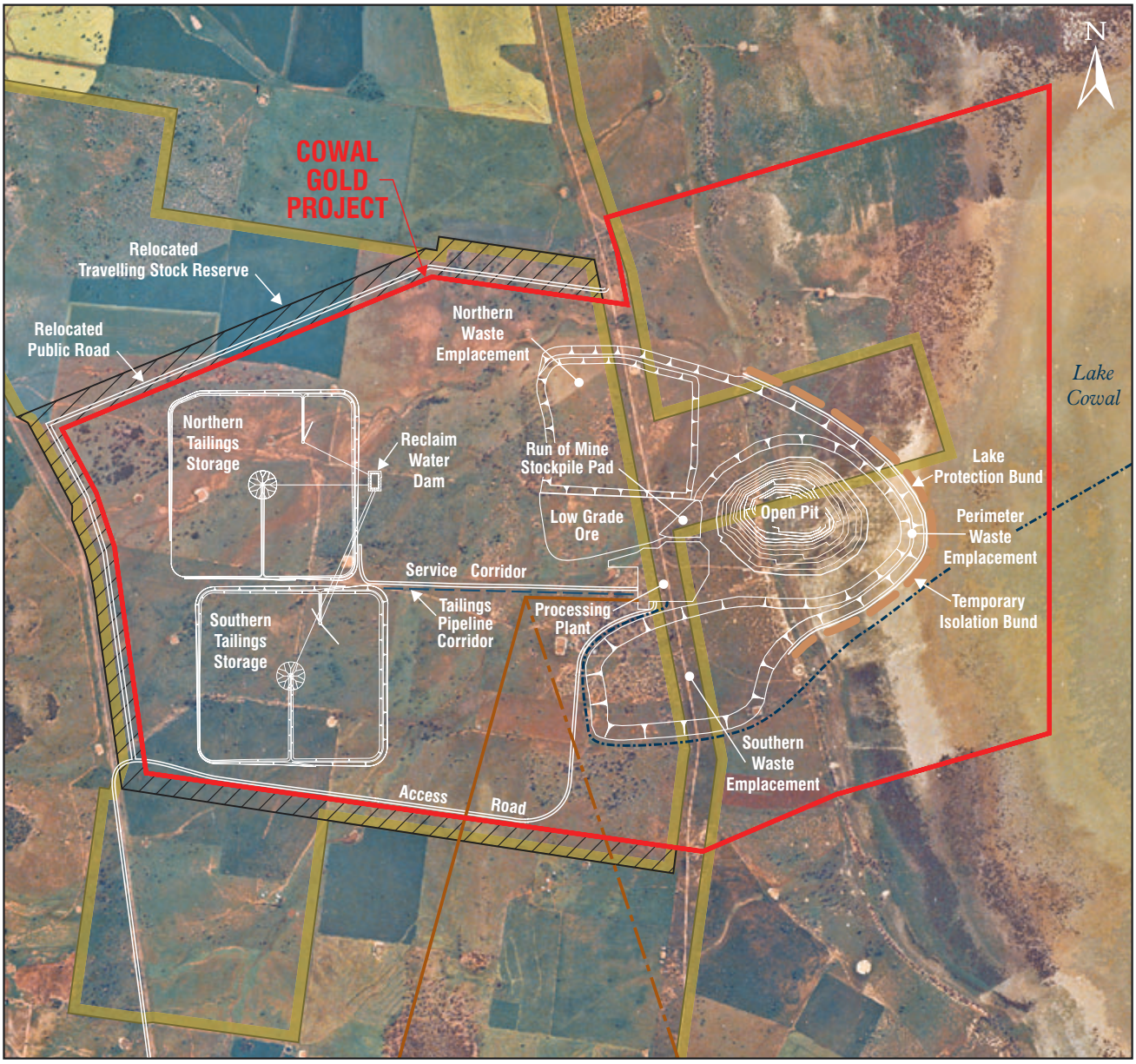
1.1 Major Environmental Issues

The major environmental issues associated with the Cowal Gold Project include:

- proximity of the Project to Lake Cowal which is a recognised wetland habitat with over 270 bird species having been recorded in the area or considered possible to occur in the area;
- water management issues such as runoff from Project facilities and potential connections between the Lake and the Project over the long term;
- the use of cyanide at the Project and measures to remove the potential for impacts on wildlife, notably waterbirds;
- wildlife use of the Project facilities which may contain residues from the processing of gold ore such as cyanide;
- fugitive emissions from the Project including dust, noise and light and their impact on wildlife, particularly the main bird breeding areas to the north of the Project and nearby residences;
- management of identified aboriginal heritage sites;
- other long term impacts of the mine adjacent to a significant wetland area including rehabilitation and management of the final void; and
- the integration of the Project with long term management practices and sustainability objectives for the Lake itself and its greater catchment.

Table ES-1 EIS Road Map - Project Documentation and Approvals Process

	Cowal Gold Project		Temora to Cowal Gold Project 132 kV Electricity Transmission Line	Cowal Gold Project Access Road Upgrade
Proponent	North Gold (WA) Ltd		Great Southern Energy	North Gold (WA) Ltd
Environmental Planning & Assessment Act	Part IV		Part V	Part V
Supporting Environmental Documentation	Environmental Impact Statement	Species Impact Statement	Environmental Impact Statement	Review of Environmental Factors
Location	Volumes 1, 2, 4 and 5	Volume 2 Appendix A	Volume 3 Appendix D	Volume 5 Appendix O
Consent/ Determining Authority	Minister for the Department of Urban Affairs and Planning (DUAP)	Minister for the Department of Urban Affairs and Planning with concurrence of the Director-General of the National Parks and Wildlife Service	Great Southern Energy and Ministers for the nominated determining authorities with concurrence of the Minister for Department of Urban Affairs and Planning (DUAP)	Bland Shire Council (BSC)



LEGEND

- North Optioned Land
- Relocated Travelling Stock Reserve
- Borefield Pipeline
- Preferred Electricity Transmission Line Corridor
- Mid Corridor Alternative
- Proposed Mining Lease Application Boundary

0 0.5 1.0
Kilometres

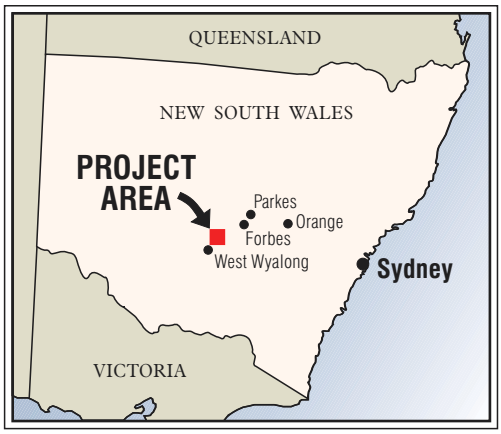
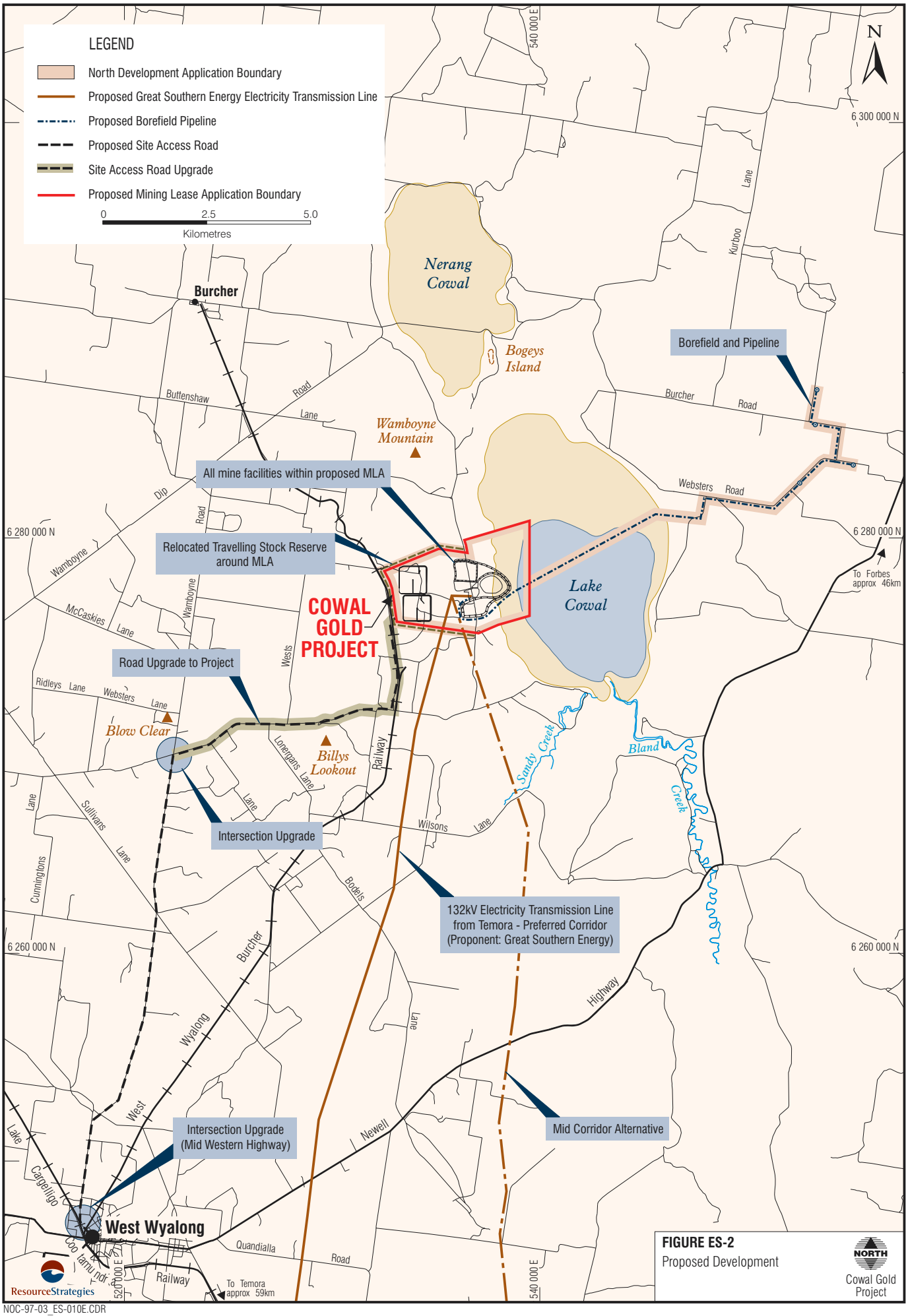


FIGURE ES-1
Project Location and Main Features

NORTH
Cowal Gold Project

ResourceStrategies

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NOC-97-03_ES-010E.CDR

Table ES-2 Director-General's Requirements for the Cowal Gold Project EIS – Reference Summary

Specific Issues to be Addressed	Main Text Reference	Appendix Reference
Long term compatibility of the Project including the results of reports commissioned by North for the Long Term Compatibility Studies for Lake Cowal.	Section 4.0	Appendix N
Identification of mitigation measures proposed to be taken to compensate for losses in ephemeral wetland habitat.	Sections 4.3, 4.4, 5.3	Appendix A
Consideration of options to extract gold and safely store residues and provide a cost benefit analysis of the options.	Sections 1.3, 1.6, 2.7	Appendices C, K, L
Review of all options for managing the final void and selection of a preferred method, together with measures to ensure final void management system provides long term environmental safety and geotechnical stability of the void.	Sections 4.1.5, 4.2	Appendix F, N
Provision of a commitment by North to maintain specified rehabilitation management and monitoring systems in place until the long term environmental safety and management of the site and surrounding land owned by North, is assured to the satisfaction of all relevant Government agencies.	Sections 5.0, 6.5	
Preparation of a final Statement of Intent by North for the Cowal Gold Project including a reference to the State Wetlands Management Policy (1996).	Frontispiece	Appendix A
Assessment of the Aboriginal, cultural and heritage values including burial sites.	Sections 3.8, 3.9, 4.7, 6.5.6	Appendix E
Details of an 8 Part Test of Significance (Section 5A of the *Environmental Planning and Assessment Act*) and if applicable, a Species Impact Statement under the provisions of the *Threatened Species Conservation Act*.	Sections 3.4, 3.5, 4.3, 4.4	Appendix A
Assessment of the economic effects of the proposal and its feasible alternatives, in accordance with the draft guideline 'Economic Effects and Evaluation in Environmental Assessment'.	Sections 1.3, 1.6, 4.8	Appendix K
Description of the development including a discussion of the:		
• extent of exploratory and site works undertaken to date including a review of site geology and a statement of mineral resources and reserves at the site.	Sections 1.1, 2.1	
• stages of development and works associated with each stage.	Section 2.0	
• licences, permits and other approvals required prior to commencement of work.	Section 1.4	
• water supply requirements and works associated with the supply, conveyance, storage, use, recycling, treatment and disposal of water.	Sections 2.8, 2.9	Appendix F
• works proposed to manage local rainfall and run off in the disturbed and adjoining areas.	Sections 2.9, 4.2, 6.4.3	Appendix F
• on-site process water management including tailings dam management and security.	Sections 2.7, 2.9, 4.2, 5.3.5, 6.5.9	Appendices C, F, G
• estimated increased volume of stormwater run off generated by the development from new buildings and hard surfaces.	Section 4.2.3	Appendix F
• chemical characteristics and volume of liquid wastes and the methods for their treatment eg. cyanide, flocculants etc.	Sections 2.6, 2.7	Appendices G, L
• flooding status of the site.	Sections 3.3, 4.2	Appendix F
• operation of the dewatering bore network and the likely volumes and quality of water.	Sections 2.8, 4.2.6	Appendix N
• electricity supply requirements.	Sections 2.10.1, 4.4.6	Appendix D
• on-site sewage treatment.	Section 2.10.3	
• increased number of vehicle movements generated by the proposed development including peak volumes, types of vehicles and expected loads and weights.	Sections 2.4.3, 3.11, 4.9	Appendix J
• dangerous goods transport and an evaluation of the proposal in regard to the storage of any dangerous goods at the site (using the guidelines and standards detailed in the Department publication 'Applying SEPP 33'). If specified thresholds are exceeded, a preliminary hazard analysis should be included in the EIS.	Section 2.11	Appendix L
• relevant environmental planning instruments applying to the proposal.	Section 1.4	
Description of the environment including:		
• the regional and local hydrology of Lake Cowal and the site including connections between surface and groundwaters.	Section 3.3, 4.2	Appendices F, N
• groundwater conditions of the site including depth to watertable, quality and level.	Sections 3.3, 4.2	Appendix N
• adjacent uses which may have the potential to create environmental impacts common with the proposal (eg. bore water use).	Section 4.1.3	
• existing acoustic climate including background noise levels, noise sources and estimated levels from the proposal using (where appropriate), noise modelling under a range of climatic conditions as well as prevailing conditions.	Sections 3.7, 4.6	Appendix H

Table ES-2 Director-General's Requirements for the Cowal Gold Project EIS – Reference Summary Continued

Specific Issues to be Addressed	Main Text Reference	Appendix Reference
• local, regional, national and international significance of Lake Cowal for bird and other fauna use.	Section 3.5	Appendix A, N
• maps clearly identifying:		
- the location of the proposal and the position of surrounding roads	Figures 1-1, 1-2	
- adjoining communities or dwellings and any land use likely to be affected by the development	Figures 1-3, 1-4	
- utilities such as transmission lines, pipelines, cables or easements	Figures 1-2, 2-15, 2-20, 2-21	
- watercourses, water storage, potable water catchments	Figures 3-1, 3-8, 3-9	
- all lands acquired or to be acquired	Figures 1-4	
- surface contours/topography	Figures 2-1 to 2-5	
- sight lines from residences or public places such as roads.	Figure M-2	Appendix M
• analysis of soil characteristics of the area to determine their erosion potential and stability.	Sections 3.2, 4.1.2	Appendix B
• description and list of the fauna and flora occurring on the and around the site.	Sections 3.4, 3.5	Appendix A
• description of Aboriginal relics/artefacts on and around the site.	Section 3.9	Appendix E
• identification of any Crown lands, details of Crown lands status and proposals for occupation and use of Crown land.	Figure 1-4 Section 1.1.5	
Discussion of the likely impact of the development on the environment including:		
• consideration of the economic and social impacts of the proposal during both the construction and post-construction phases.	Section 4.8	Appendix K
• economic costs and benefits of the feasible alternatives.	Section 4.8	Appendix K
• effects of traffic on the Classified Road system.	Section 4.9	Appendix J
• determination of the safety and road maintenance impacts of increased turning movements at the junction of the road at Blow Clear giving access to the site and at the Newell Highway junction in West Wyalong.	Section 4.9	Appendix J
• impacts of the road upgrade from Blow Clear to the site.	Sections 4.3.1, 4.4.6, 4.6	Appendix O
• effects of the development on the travelling stock route which traverses the site.	Section 4.1.3	
• description of the interaction of the existing game reserve uses and the proposed mining operation.	Section 4.1.3	
• discussion of all activities on and off site likely to affect the groundwater resources including:	Section 4	Appendices L, N
- production and dewatering bores		
- the mine pit		
- chemical and petroleum spills		
- liquid waste disposal.		
• consideration of the likely long term impacts to wildlife from low dose exposures to cyanide and other chemicals, particularly in the proposed tailings dams.	Sections 4.4.4	Appendices G, A, N
• discussion of the likely impacts associated with each proposed option for the powerline alignment between the proposed site and link point to the power grid, including reference to the potential for bird strikes.	Sections 1.3.7, 2.10.1, 4.4.6	Appendices D, A
• discussion of the likely impacts associated with each proposed option for the water pipeline alignment between the proposed site and bore field, particularly in relation to Lake Cowal.	Section 1.3.3, 2.8, 2.9, 4.2	Appendix F
• discussion on the stability of bunds, pits and walls including stability in the event of any seismic activity that may occur on the site.	Section 4.1.1	Appendix N
• consideration of the likely environmental impacts during construction and post-construction on:		
- the ecological values of the Lake as a bird habitat of national and international significance (with particular reference to the JAMBA and CAMBA agreements)	Sections 4.3, 4.4	Appendices A, N
- losses to terrestrial and aquatic plant and animal habitats from disturbances on the site	Sections 4.3, 4.4	Appendices A, N
- Aboriginal relics (including burial sites) identified on the site	Section 4.7	Appendix E
- adjoining aquifers, users and surface waters from dewatering	Section 4.2	Appendices F, N
- air quality emissions (particularly dust) on adjacent residences and wildlife	Sections 4.4.5, 4.5	Appendices A, I
- quality of stormwater leaving the site	Section 4.2	Appendix F
- noise from industrial processes, mining operations, blasting and road transport of materials and products particularly on adjacent residences and wildlife (eg. the nesting and breeding behaviour of avifauna)	Sections 4.4.5, 4.6	Appendices A, H
- process waste waters that may be discharged to treatment facilities including odours, toxicity, hazardous compounds etc.	Sections 2.7, 4.2	Appendices F, G, L, N
- visual amenity of the area, particularly around Lake Cowal.	Sections 4.1.6, 5.3	Appendix M

Table ES-2 Director-General's Requirements for the Cowal Gold Project EIS – Reference Summary Continued

Specific Issues to be Addressed	Main Text Reference	Appendix Reference
Description of measures proposed to be taken to:		
• prevent the accession of groundwater to Lake Cowal as a result of the mining operations.	Sections 4.2	Appendix N
• manage the mined void following cessation of mining to safeguard the Lake from the intrusion of saline groundwater.	Sections 4.1.5, 4.2	Appendices B, N
• mitigate environmental impacts associated with the powerline and water supply pipeline, particularly around Lake Cowal.	Sections 4.4.6	Appendices A, D
• protect against contamination of surface and ground waters from spills of toxic and hazardous materials including oil and petroleum products.	Sections 4.1.7, 4.2.2, 4.2.5, 6.4	Appendices L, N
• prevent erosion of natural drainage lines including providing details of an integrated soils and water management plan.	Section 4.1.2	Appendices B, F
• landscape the site to complement the surrounding landscape including details of plant species, sowing and planting schedule and the identification of persons responsible for environmental management.	Section 5.0	Appendix M
• rehabilitate and stabilise areas during and after mining operations including the development of an overall rehabilitation plan and systems to ensure long term environmental safety, geotechnical stability and satisfactory and assured vegetation establishment.	Sections 5.0, 6.0	Appendix N
• handle solid and hazardous wastes including their consideration in a management plan.	Section 6.4	Appendix L
• separate surface water run off originating from outside of the area of operations from any contaminated water in a manner that does not result in either contamination of the water or other environmental impacts eg. erosion.	Section 4.2	Appendix F
• treat all liquid wastes indicating where recycling of waste waters may be used.	Sections 4.2, 6.4	Appendix L
• maintain or rehabilitate existing and proposed exploratory bores to protect integrity of surface and ground waters.	Section 5.3.6	
• achieve acceptable air quality including a description of methods to be used to control dust.	Section 4.5	Appendix I
• achieve acceptable noise levels from both mining and transport operations.	Section 4.6	Appendix H
• mitigate losses to animal habitats and plant communities;	Sections 4.3, 4.4, 5.3	Appendices A, N
• mitigate any fiscal and social impacts.	Section 4.8	Appendix K
• monitor likely impacts including:		
- permeability/leakage problems of the tailings storage	Section 6.4	Appendix N
- impacts on bores in the area and the proposed supply bores	Sections 4.2, 6.5	Appendix N
- impacts on groundwater reserves resulting from the bore supply	Sections 4.2, 6.5	Appendix N
- changes in the surface water quality	Section 6.4	Appendix F
- changes to flood flows resulting from the development	Section 6.4	Appendices A, N
- changes to the ecology of the lake system including sediments and invertebrates of the lake bed, impacts on fishery reserves, water quality (particularly salinity)	Sections 4.4.2, 6.5	
- changes in nesting, breeding and feeding behaviour of avifauna	Section 6.4	Appendix A
- the effects on water quality from waste rock stockpiles.	Section 6.4	Appendix F

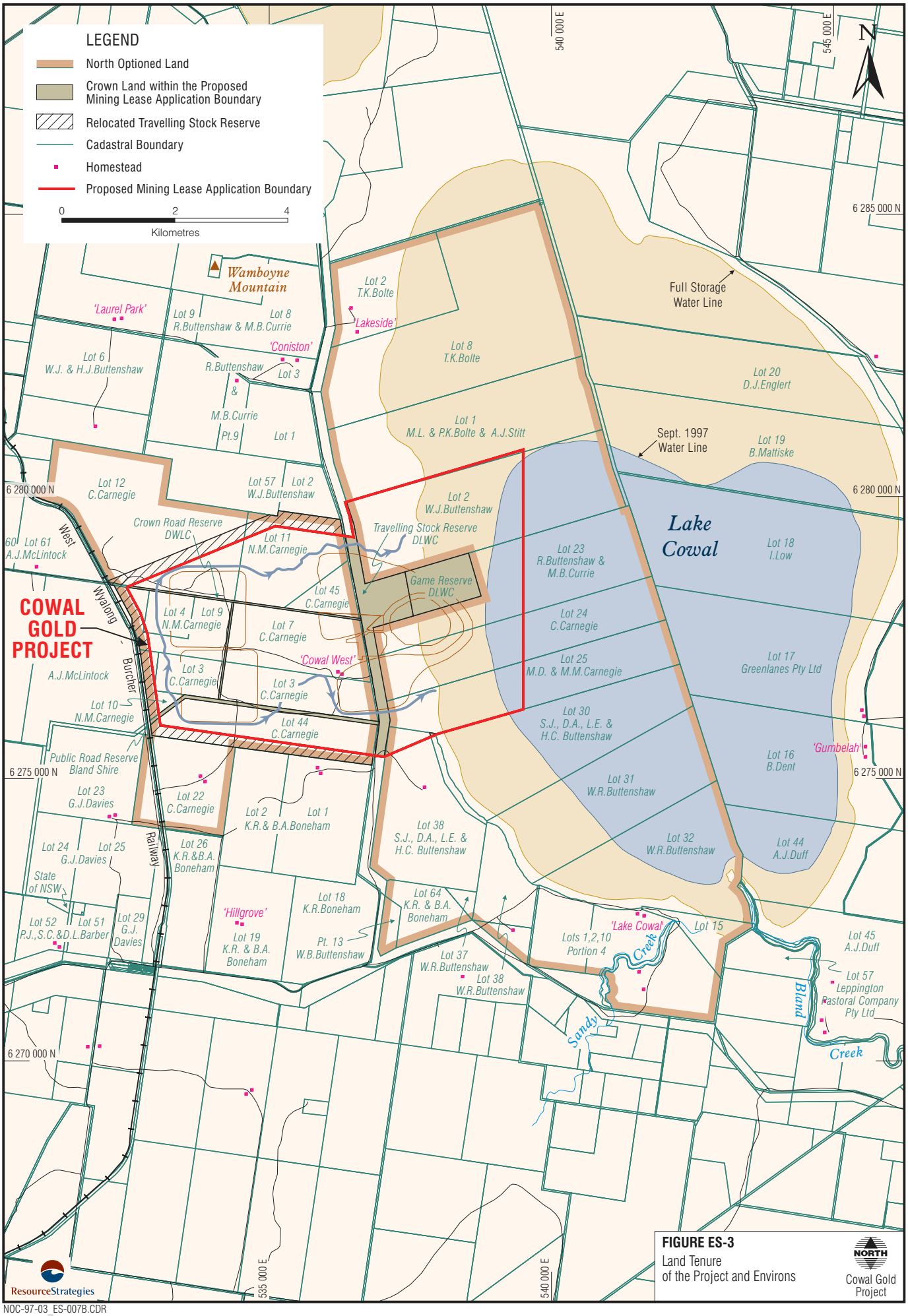
1.2 Land Tenure and Description

Land within the proposed Mining Lease Application (MLA) area for the Project is a mixture of freehold, perpetual leasehold and Crown tenure (Figure ES-3). The proposed MLA for the Project encompasses approximately 2,650 ha and lies within two exploration titles held by North.

The Crown land within the proposed MLA encompasses a travelling stock reserve (TSR), a game reserve and three unformed Crown roads. It is proposed to relocate the TSR around the proposed MLA while the game reserve would be relocated to the north of the proposed MLA to maintain public access to the Lake. The unformed Crown roads would be closed.

The Project is located on agricultural and grazing land. A portion of the Project extends into the high water mark of Lake Cowal. Lake Cowal itself is an ephemeral lake fed by its major tributary (Bland Creek) and by large but infrequent south-westerly floods from the Lachlan River.

Records since the late 1940's indicate that the Lake is substantially full for seven years out of ten. This flooding and drying cycle is a key component of the Lake's conservation status which together with remnant vegetation in the north of Lake, provides significant habitat for waterbirds. The Lake Cowal area has been listed on the Register of the National Estate since 1992.



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Generally the immediate and regional surrounds of the Lake have been substantially cleared of native vegetation. Trees are sparsely scattered throughout paddocks with occasional clumps on drainage lines. Patches of remnant open woodland and open forest are found predominantly on rocky ridges and hills.

1.3 Project History

North commenced exploration in the Lake Cowal area in 1981. Since 1988 exploration effort has concentrated on the "Endeavour 42" (E42) orebody which is the subject of the proposal. Over 550 drill holes have been placed in the orebody to define the mineral resource.

In August 1995 North submitted a Development Application and an EIS for the development of E42. In April 1996, the application was refused consent on environmental grounds. Since this time a range of studies and development scenarios have been investigated by North, leading to the current proposal.

A major outcome from this process was the preparation of a Long Term Compatibility Study which examined the long term impact of the Project on the critical conservation values of Lake Cowal. The findings of this study shaped the scope of EIS studies and are integrated within the EIS and its Project mitigation measures and undertakings. Other outcomes resulting from the review of the Project include:

- a new process being added to the processing plant resulting in a significant reduction in the use of cyanide;
- introduction of cyanide destruction technology and increased recycling of cyanide within the processing plant to reduce cyanide levels in tailings water to levels considered non-toxic to birdlife;
- relocation of the tailings storage further away from the edge of the Lake (approximately 3.5 km west of the Lake shoreline);
- reduction in the number of tailings storage cells from four to two;
- a new electricity transmission line corridor from Temora (instead of from Forbes and running between Lake Cowal and Nerang Cowal); and
- development of improved rehabilitation concepts.

The remaining sections of this summary describe the Project, the existing environment, expected impacts and mitigation measures, proposed rehabilitation and environmental monitoring provisions.

Table ES-3 Approximate Areas of Disturbance Within Proposed Project MLA

Development Component	Area (ha)	Proportion of Proposed MLA (%)
Tailings Storages	350	13
Northern Waste Emplacement	150	6
Southern Waste Emplacement	115	4
Perimeter Waste Emplacement	50	2
Open Pit	70	3
Mill/Administration Area	25	1
Ore Stockpile and ROM Pad	40	2
Topsoil/Subsoil Stockpiles	90	3
Roads/Tracks	50	2
Undisturbed Area	1,710	64
Total	**2,650**	**100**

2.0 PROJECT DESCRIPTION

The major components of the Cowal Gold Project are shown in Figure ES-1 and include:

- an open pit which on completion of mining would measure approximately 1,000 metres (m) by 850 m and 325 m deep;
- a processing plant to extract the gold from the mined ore;
- waste rock emplacements which would contain mined rock which has no commercial quantities of gold;
- two tailings storages which would contain the slurry residue from the processing plant; and
- a lake isolation system between the Project and the Lake to separate the Project from Lake Cowal over the long term.

These features are discussed below. The relative area disturbed by Project facilities is shown in Table ES-3. Table ES-4 shows the relative height of different components of the mine and surrounding environs.

Table ES-4 Approximate Relative Heights of Mine Components and Surrounding Environs

Feature	Relative Level (m)
Wamboyne Mountain	412
Billys Lookout	368
Northern Waste Emplacement	243
Maximum Height of Southern Tailings Embankment	241.5
Maximum Height of Northern Tailings Embankment	233.5
Cowal West Hill	223
Perimeter Waste Emplacement	223
Southern Waste Emplacement	223
Lake Protection Bund	208.25
Temporary Isolation Bund	206.5
Full Storage Lake Cowal	205.65
Lowest Level on Project Area	205
Bed Level – Nerang Cowal	204.3
Bed level – Lake Cowal	201.5
Final Void Equilibrium Water Level	180
Base of Pit	-120

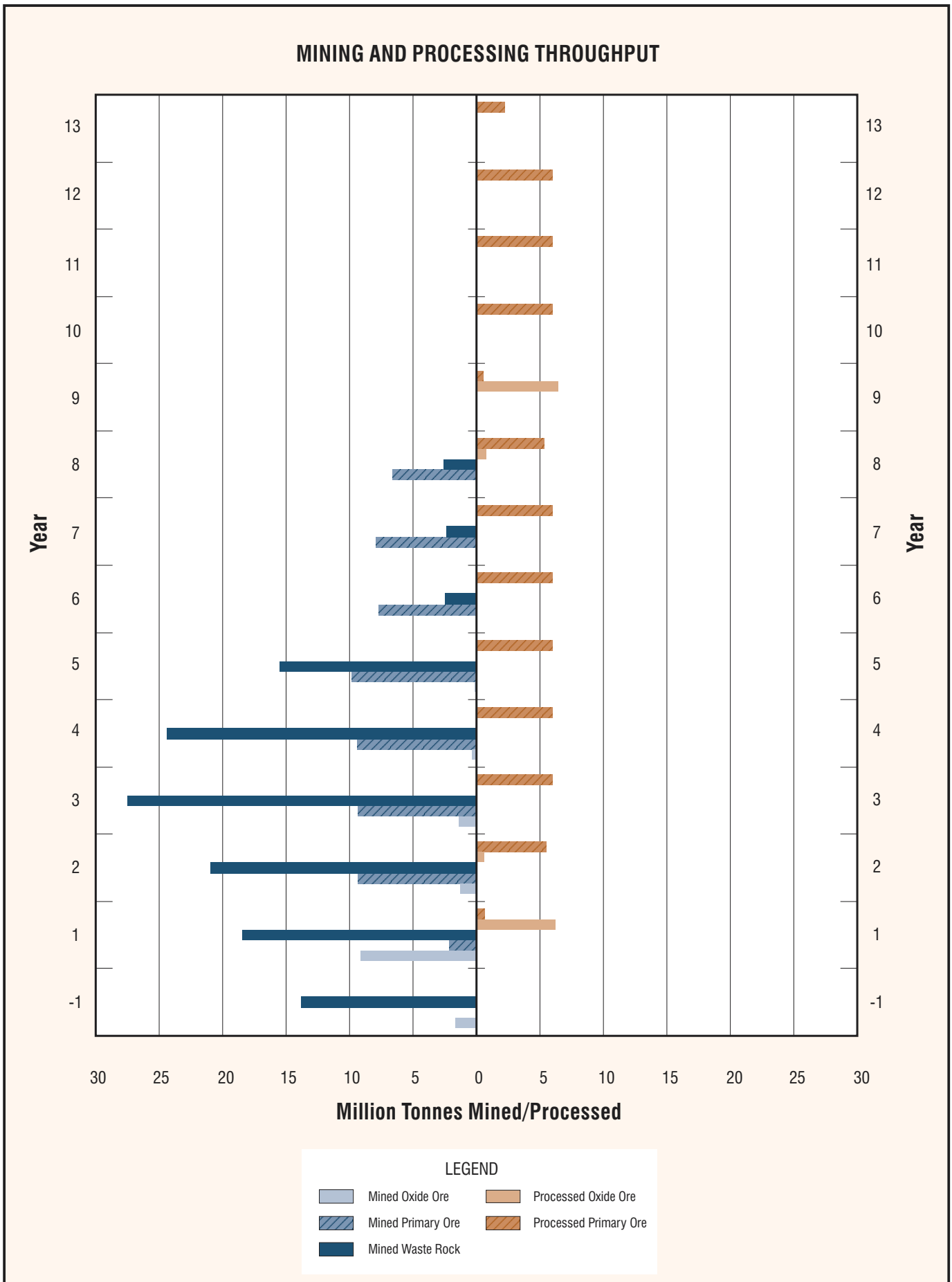


FIGURE ES-4
Mine Production

NORTH
Cowal Gold Project

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2.1 Mine Operation

The proposed mine would be developed by conventional open pit methods. There are two types of ore at the Cowal Gold Project: primary ore which constitutes 80% of the orebody and oxide or weathered ore which comprises the first and upper 20% of the orebody. The quantity of ore mined and its destination is shown in Figure ES-4.

Peak mining activity would occur in year 3 with mining of the open pit expected to be completed in year 8. At this point the Project would then process previously stockpiled ore to about year 13.

The pit intersects three shallow, saline aquifers. Inflows ranging between 2 to 12 megalitres per day (ML/day) over the life of the mine are predicted. A pit dewatering programme would be developed involving five bores to the south of the anticipated pit outline and 21 bores installed in a ring around the open pit. The purpose of these bores is to dewater the pit area adding stability to the open cut and supplying the mine with process water.

2.2 Processing Plant

The process of extracting gold from ore from the open cut is shown in Figure ES-5.

Broken ore from the mine would either be stockpiled or hauled to a primary crusher located near the processing plant. The crushed ore would then be conveyed to the processing plant, the first component of which is a grinding circuit.

The grinding circuit reduces the ore to a finely ground slurry. After being ground, primary ore would pass to a flotation circuit where the gold ore would be floated off as a froth or concentrate. This would then pass to a leaching circuit where cyanide is added to leach gold from the concentrate. The flotation circuit reduces the amount of gold ore required to be leached by about 92% (and hence, greatly reduces cyanide usage).

The ground oxide ore would go directly to a separate leaching circuit.

The gold extracted from the cyanide leaching circuit is recovered and poured as gold bars or doré. The finely ground rock residue left after the flotation and leaching processes (tailings), would be treated to destroy cyanide to prescribed limits and then pumped to one of two tailings storage cells.

2.3 Tailings Storages

The tailings would comprise about 55% solids at discharge. Approximately 76 million tonnes (Mt) of tailings would be produced over the life of the mine. On drying the tailings volume is expected to be about 50 million cubic metres (Mm^3).

The main environmental issues associated with the tailings storages are the impact of residues in the tailings both on wildlife which may use the storages and seepage from the base of the tailings.

The oxide and primary tailings are expected to be non-acid forming. Cyanide levels in the tailings storages would be a maximum of 30 milligrams per litre (mg/L) and, for 90% of the time, would be below 20 mg/L (measured as the "weak acid dissociable" form of cyanide or CN_{WAD}).

The tailings storages would be located about 3.5 km west of the Lake shoreline. Storage embankments would be progressively raised throughout the mine life (Figure ES-6). A pipe network would be installed to facilitate drainage under the tailings mass. The bulk of the water from each tailings storage would, however, drain from the surface of the tailings and collect in the centre of each storage. This water as well as underdrainage water would be reclaimed and used within the processing plant.

Seepage from the base of the tailings over the long term has been assessed and is reported later in this summary.

2.4 Waste Rock Emplacements

There would be three waste rock emplacements (Figure ES-1) *viz.*:

- northern waste emplacement;
- southern waste emplacement; and
- perimeter waste emplacement.

The northern waste emplacement has been designed to contain the majority of waste rock from the mine and would be constructed in years 1-8 to a height of relative level (RL) 243 m (approximately 20 m above Cowal West Hill which it abuts but does not cover). The emplacement would occupy an area of about 150 ha with the outer embankment constructed to a slope of 1:5 (vertical to horizontal).

The southern waste emplacement would be constructed in years 1 – 5 attaining a final height of RL 223 m (approximately 20 m above ground level) and occupying an area of about 115 ha.

The perimeter waste rock emplacement forms an arc on the eastern side of the open pit and would occupy an area of 50 ha reaching a maximum height of RL 223 m (approximately 20 m above ground level).

2.5 Lake Isolation System

The lake isolation system comprises a temporary isolation bund and a permanent lake protection bund (Figure ES-6).

Temporary Isolation Bund

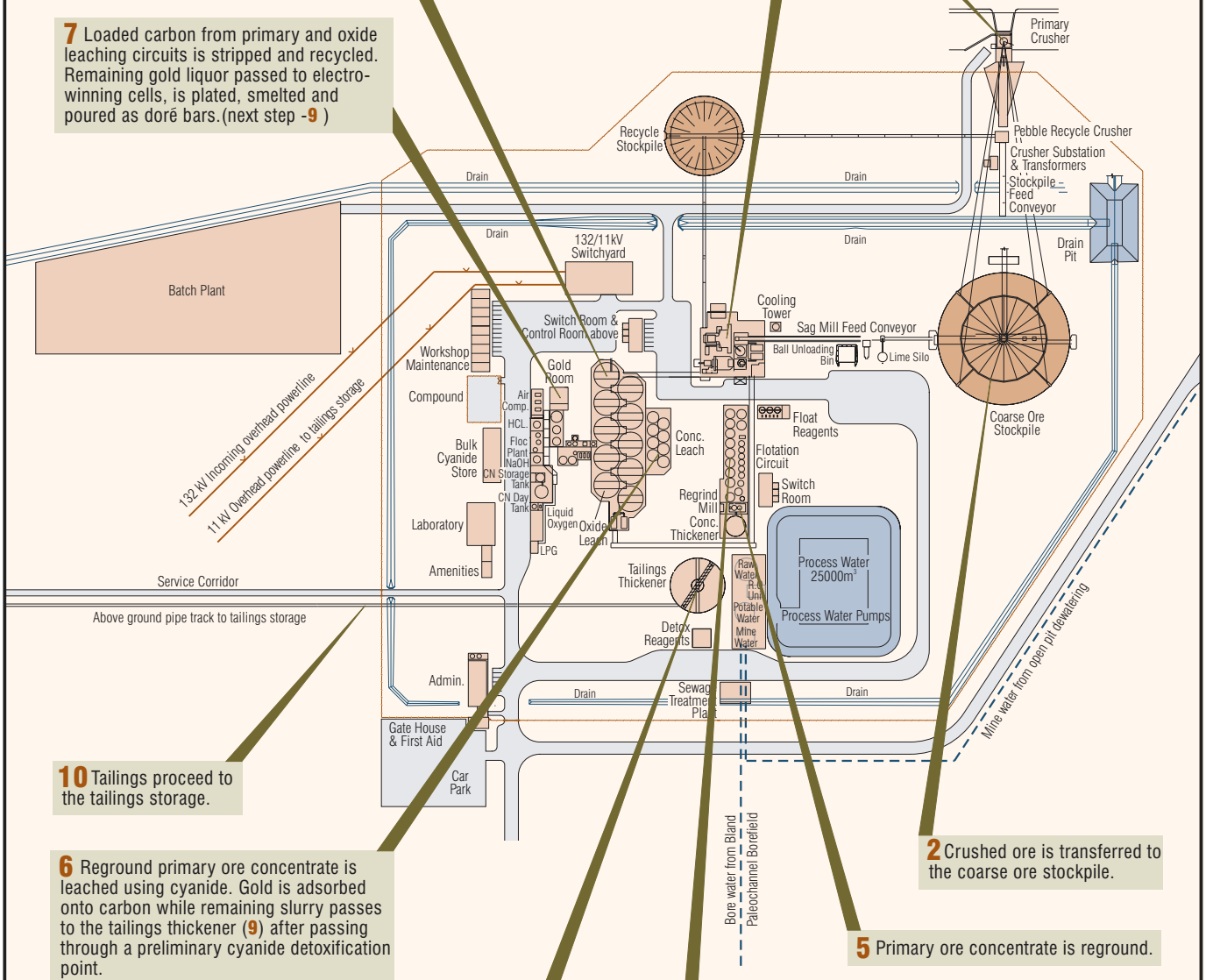
This bund is designed to control water inflow to the pit development area during construction of the permanent lake protection bund. It would be constructed using inert weathered rock likely to be sourced during the pre-stripping of the waste rock emplacements and open pit. Its height would be 2 m and it would be constructed by end tipping fill in an arc toward the centre of the bund. The bund is a short term feature and once the permanent lake protection bund is constructed and revegetated, it would be carefully reshaped and rehabilitated to provide habitat in the longer term.

8 Ground oxide ore (direct from **3**) passes to a larger leach circuit where cyanide is added. Gold is adsorbed onto carbon (**7**). Remaining slurry passes to the tailings thickener.

3 Ore is reclaimed from the stockpile and finely ground in a mill. Water added. Oxide Ore directed to leach circuit (**8**). Primary ore is further processed (**4**).

1 Ore from the mine or run of mine stockpile is crushed to about 175mm.

7 Loaded carbon from primary and oxide leaching circuits is stripped and recycled. Remaining gold liquor passed to electro-winning cells, is plated, smelted and poured as doré bars.(next step -**9**)



10 Tailings proceed to the tailings storage.

6 Reground primary ore concentrate is leached using cyanide. Gold is adsorbed onto carbon while remaining slurry passes to the tailings thickener (**9**) after passing through a preliminary cyanide detoxification point.

2 Crushed ore is transferred to the coarse ore stockpile.

5 Primary ore concentrate is reground.

9 **Primary Ore**: Tailings from the flotation circuit are recombined with tailings from the leach circuit and thickened. Cyanide is destroyed down to regulated levels.
Oxide Ore: Tailings are thickened and cyanide destroyed down to regulated levels.

4 Primary ore only proceeds to a flotation circuit - gold bearing ore (concentrate) is floated off (8% of feed); remainder passes to the tailings thickener (**9**).

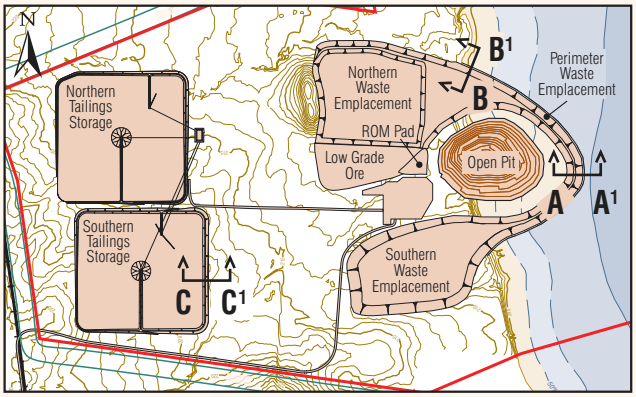
0 50 100
Metres

FIGURE ES-5
Process Plant Flow Sheet

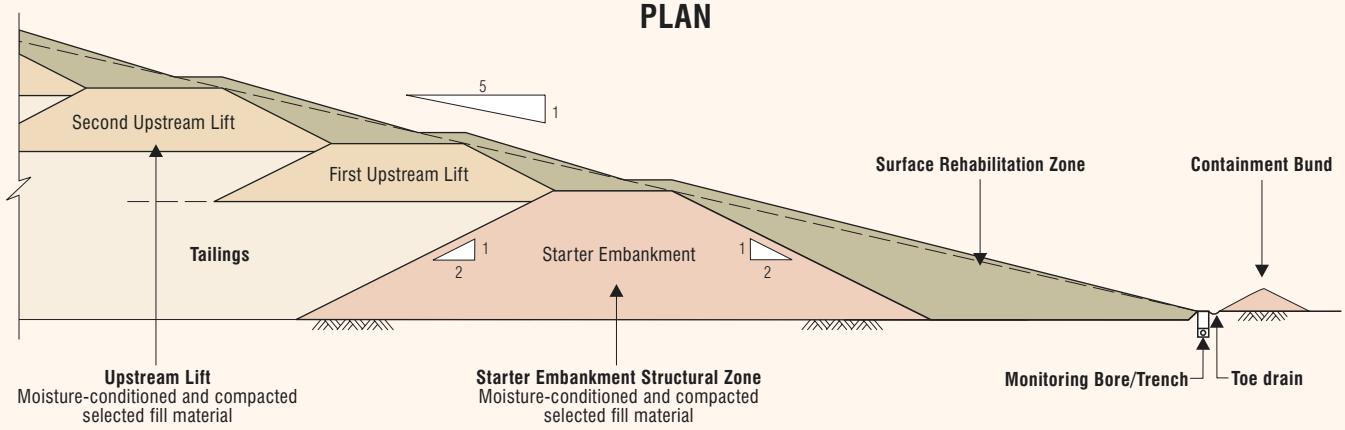
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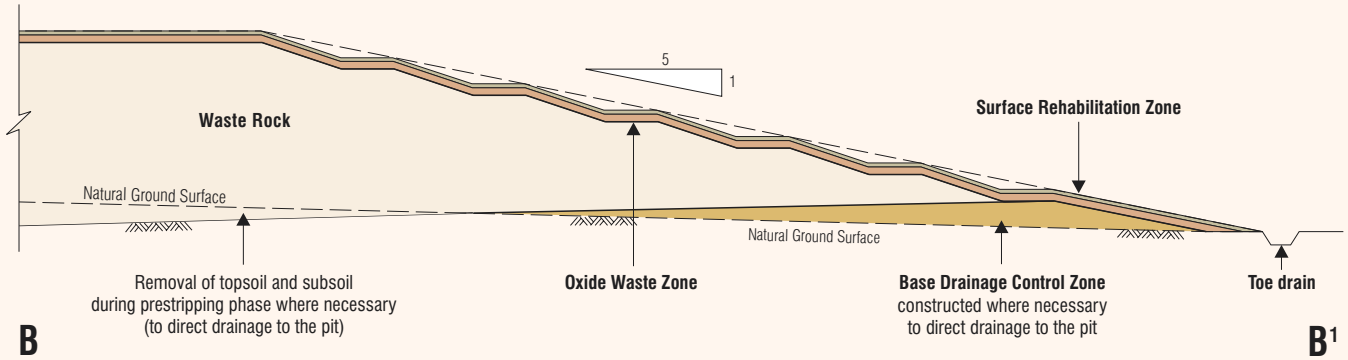
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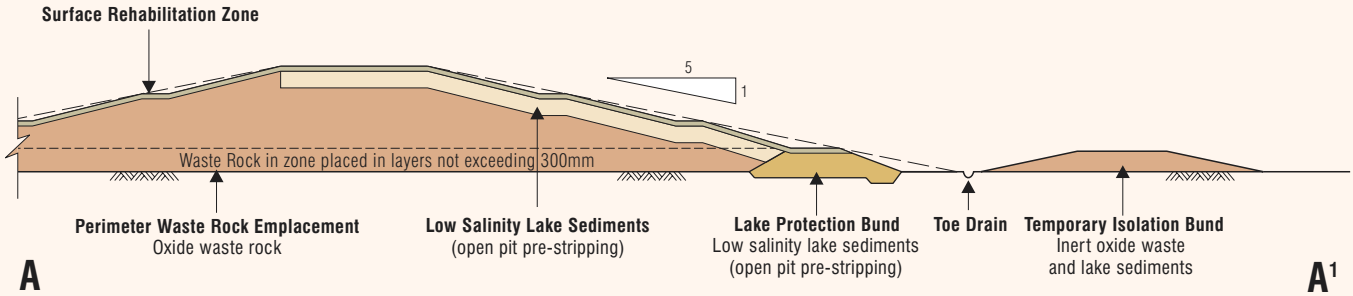
PLAN



TAILINGS STORAGE



MINE WASTE EMPLACEMENT



LAKE ISOLATION SYSTEM

Not to Scale
Source: After Knight Piesold (1995; 1997)

FIGURE ES-6
Profile of Mine Landforms

NORTH
Cowal Gold Project

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NOC-97-03_ES-011D.CDR

Lake Protection Bund
This bund would meet specific engineering criteria for compaction so that it forms a permanent barrier between the Lake and the open pit. Revegetation would occur early in the mine life to permit early re-establishment of foreshore features.

3.0 EXISTING ENVIRONMENT

3.1 Physical Setting

The general landscape of the area is flat to very gently undulating land with occasional hills such as Wamboyne Mountain.

The region currently supports mainly dry land agriculture with irrigation farming practised in the Jemalong/Wyldes Plains to the north-east of the Lake. Grazing and occasional cropping below the Lake's full storage water line occurs when moisture and market conditions are suitable.

All of the proposed mining operations are located within the Bland Creek catchment which falls steadily from west to east and drains into Lake Cowal. Within the proposed MLA the land elevation ranges from about RL 205 m to RL 222 m with slopes of around 1% falling to the east. The ridgeline system to the west reaches a maximum elevation of RL 368 m at Billys Lookout.

3.2 Climate

The Cowal region is located on the boundaries of the south-eastern semi-arid and the south eastern temperate regions of Australia. The air temperatures range from 2.8 degrees centigrade (°C) to 14.2 °C in winter (July) and from 17.4 °C to 32.7 °C in summer (January).

The Project area is strongly influenced by winds from the south-west. Wind speeds during the year are generally moderate and range between 6 and 10 kilometres per hour (km/hr) increasing up to 20 km/hr in summer during the afternoons.

The mean annual rainfalls for Forbes, Condobolin and Wyalong are 527 millimetres (mm), 448 mm and 483 mm respectively. The mean annual evaporation at Condobolin is 2,045 mm.

3.3 Water Resources

Lake Cowal is part of the wider Lachlan River valley. When full (at RL 205.65 m) Lake Cowal overflows into Nerang Cowal to the north which in turn overflows to Manna Creek, Bogandillon Creek and ultimately into the Lachlan River.

The Project overlays three shallow saline aquifers. Flood protection works are common in the Bland Creek catchment and Lachlan – Lake Cowal floodways.

Lake Cowal water is slightly to moderately alkaline with a considerable range in turbidity, typical for inland freshwater waterbodies. Metal concentrations in the Lake are low.

Groundwater conditions within the region are thought to be significantly modified since the initiation of surface water irrigation in the Jemalong/Wyldes Plains area. It is postulated that a saline groundwater mound is extending southwards towards Lake Cowal leading to future dryland salinity issues and increased water table levels.

3.4 Flora

Nine main vegetation communities have been identified in the Project area and surrounds (Figure ES-7) and are shown in Table ES-5.

Overall the proposed area of disturbance for the Project comprises areas:

- dominated by weeds (eg. the lake bed, shore line and understorey of the woodland areas);
- extensively cropped (eg. the tailings storage areas); or
- of relatively high species diversity (eg. northern waste emplacement), however the species identified are common and not restricted to the Lake Cowal region.

In consultation with the National Parks & Wildlife Service (NPWS), a preliminary list of threatened plant species for the Lake Cowal region was prepared and an "Eight Part Test of Significance" under the *Environmental Planning and Assessment Act, 1979*, was used to assess whether the proposed development was likely to have a significant influence on threatened flora species or their habitats.

As an outcome of the Eight Part Test, two species were selected for assessment through the species impact assessment process. These were the Austral Pillwort (*Pilularia novae-hollandiae*) and the Winged Peppercress (*Lepidium monoplocoides*).

Potential habitats within the Project area for P. novae-hollandiae are gilgai areas and areas fringing the Lake shore. A 1993 survey of the Project area recorded this species on the western edge of Lake Cowal and along the riparian zone of Bland Creek near the confluence with the Lake.

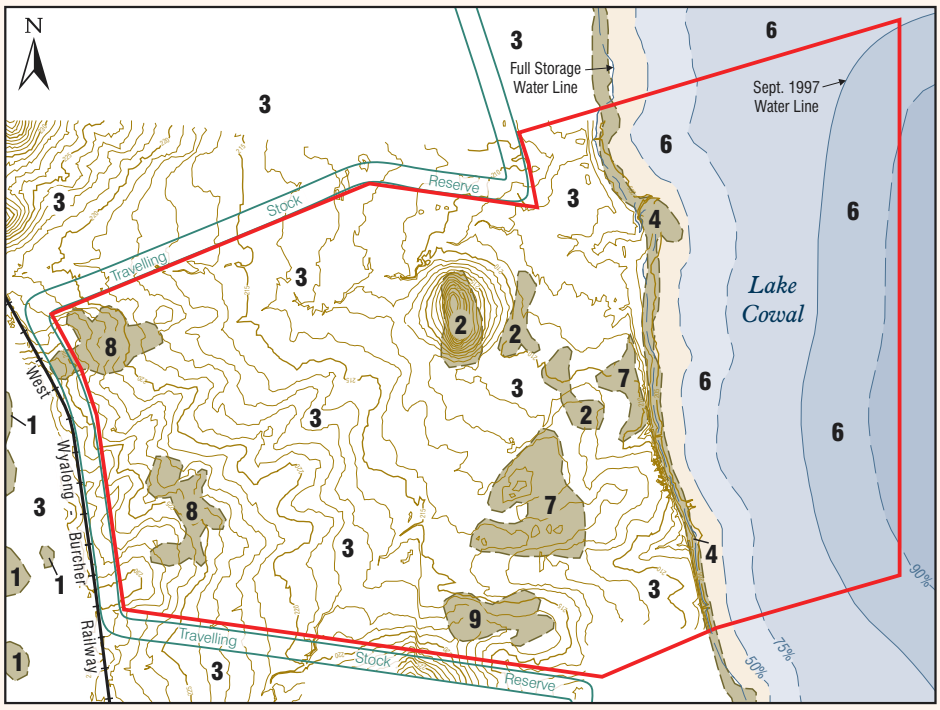
The Winged Peppercress was originally wide spread in the semi-arid regions of NSW and has not been recorded on the Project area or surrounds. Given the historical land use practices in the area, it is considered that potential habitats in the Project area for Winged Peppercress are very limited although suitable habitat does exist in several areas outside the Project area.

P. novae-hollandiae and *L. monoplocoides* were not recorded in the Project area during the 1997 botanical survey.

3.5 Fauna

Birds, mammals, reptiles, amphibians, aquatic macroinvertebrates and fish have been recorded through several fauna surveys in the Lake Cowal area, however it is the bird population which is the most diverse.

A total of 277 bird species have been recorded or are considered as possible occurrences in the Lake Cowal region. The highest overall abundance of waterbirds generally occurs during January. Thirty-six waterbird species have been recorded breeding at Lake Cowal from August 1989 to October 1997. The major breeding areas occur in the



CURRENT VEGETATION COMMUNITIES (September 1997)

LEGEND

1 Remnant Woodland *(E. dwyeri - Acacia doratoxylon - Callitris sp.)*

2 Eucalypt Woodland *(E. dwyeri - E. populnea - E. microcarpa - Callitris glaucophylla - Casuarina cristata)*

3 Predominantly cleared agricultural land with scattered Bimble Box Woodland *(E. populnea)*

4 Fringing River Red Gum *(Eucalyptus camaldulensis)*

5 Lignum *(Muehlenbeckia florulenta)*

6 Lake Bed - Scattered areas of *Medicago polymorpha* and Canegrass *(Eragrostis australasica)*

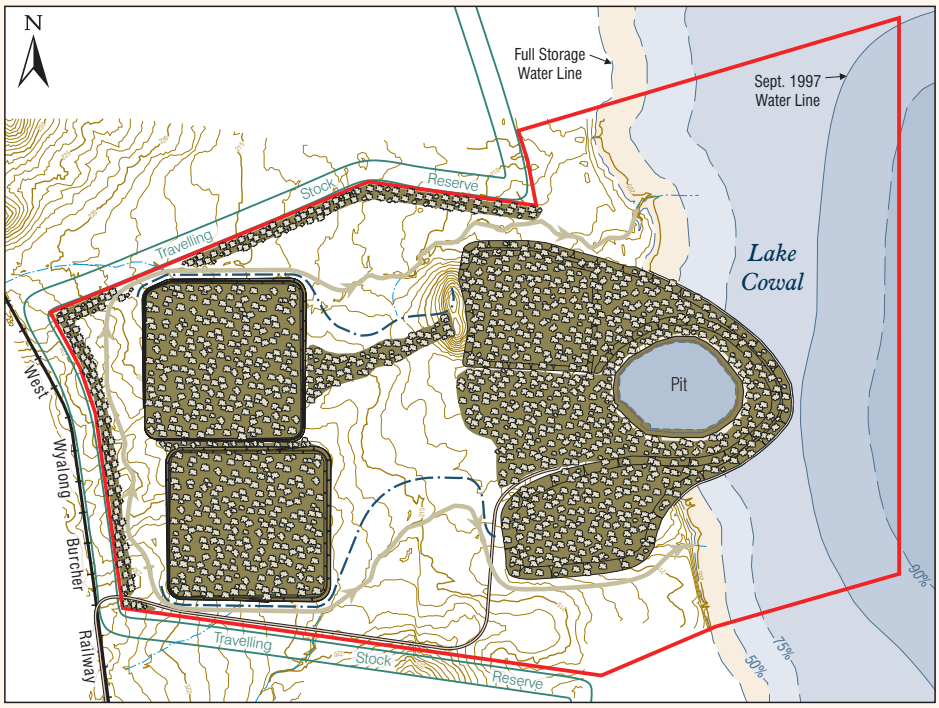
7 Mixed Woodland *(A. pendula - Casuarina cristata)*

8 Wilga Woodland *(Geijera parviflora - C. cristata)*

9 Belah Woodland *(Casuarina cristata)*

Proposed Mining Lease Application Boundary

0 1 2 Kilometres



PROPOSED REVEGETATION END OF MINE LIFE

LEGEND

Remnant Woodland Alliances (Refer Figure ES-10)

Up-catchment Diversion System (permanent)

Permanent Catchment Divide (Internal Catchment Drainage System)

Existing Drainage Line

—50%— Estimated water level exceeded 50% of the time

Proposed Mining Lease Application Boundary

0 1 2 Kilometres

FIGURE ES-7
Current Vegetation Communities and Proposed Revegetation Strategy

NORTH Cowal Gold Project

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Table ES-5 Project Area Vegetation Communities

Community Name	Dominant Species	Description	Approximate area to be disturbed (ha)	Percentage of community within MLA to be disturbed (Approximate)
Remnant Woodland	*Eucalyptus dwyeri, Acacia doratoxylon, Callitris endlicheri*	Occurs on the highly exposed ridges with shallow soils. This community is scattered and because of the poor soils has been relatively free from disturbance. No examples of this community occur within the proposed MLA.	0	–
Eucalypt woodland	*E. dwyeri, E. populnea, E. microcarpa, Callitris glaucophylla, Casuarina cristata*	Occurs on well drained sloping country and ridges such as Cowal West Hill within the proposed MLA. The most common associate here is Bimble Box. Areas of this community have been largely cleared for farming and grazing.	35	70%
Predominantly cleared agricultural land with scattered Bimble Box Woodland	*E. populnea*	A major plant community in the region dominating the flatter landscapes that have been cleared for farming and grazing. Species of this community include large shrubs and small trees (such as Myall, River Cooba, Wilga and Rosewood). Other species include Bimble Box , White Cypress Pine and Grey Box.	700	47%
Fringing River Red Gum	*E. camaldulensis*	Comprises River Red Gums along the edges of Lake Cowal and creek lines. A few River Red Gums occur within the proposed MLA. However as in common with the rest of the Lake's shore River Red Gums have been severely thinned.	20	40%
Lignum	*Muehlenbeckia florulenta*	Comprise dense thickets of Lignum which occur in the northern sections of the Lake and form the basis of breeding habitat for many of the waterbirds. No significant amounts of Lignum occur within the proposed MLA.	0	–
Lakebed	*Medicago polymorpha, Eragrostis australasica*	Comprises the dense Swamp Canegrass and Burr Medic communities which occur in the shallow waters of the Lake. A band of Swamp Canegrass occurs within the proposed MLA area.	100	11%
Mixed Woodland	*Acacia pendula, C. cristata*	Occurs mainly on alluvial flats and Belah is commonly the dominant associate on drainage impeded gilgai areas.	50	70%
Wilga Woodland	*Geijera parviflora, C. cristata*	Widespread in the area, reaching its optimum density on alluvial gilgai soils and other heavy soils on flats or lower slopes. Commonly associated with trees such as Rosewood, Belah and Grey Box. Portions of this community would be affected by the proposed development *viz.* the tailings storages and drainage works.	35	60%
Belah Woodland	*C. cristata*	Occurs on drainage impeded gilgai areas on grey soils. A common associate with many other communities. *C. cristata* occurs in the south of the proposed MLA area and would be traversed by the proposed access road.	1	3%

wooded and vegetated parts of the Lake to the north, some 4.5 km from the Project. Seasonal breeding activity is greatest in October and January.

As part of the assessment of the Project's potential impact on fauna, an Eight Part Test of Significance was completed on 42 threatened fauna species (one amphibian, two reptiles, 25 bird species and 14 mammal species including nine bat species). The Eight Part Test of Significance submitted to NPWS and DUAP in October 1997 found that:

- no local viable populations of threatened fauna species were likely to be placed at risk of extinction from the proposal;
- in relation to the regional distribution of the habitat of the threatened species it was considered unlikely that a significant area of known habitat would be modified/removed as a result of the proposal;
- given the existing ecological condition of the Project area, the proposed development would be unlikely to alienate movement corridors or limit dispersal options for any local viable threatened species population; and
- for a number of selected species – six birds and three bats – the currently available information was inconclusive with respect to potential or identified impacts and Director-General's requirements for a Species Impact Statement (SIS) were requested.

The species investigated by the SIS are the Blue-billed Duck, Freckled Duck, Australasian Bittern, Black-necked Stork, Brolga, Painted Snipe, Yellow-bellied Sheathtail Bat, the Greater Long-eared Bat and the Little Pied Bat.

In addition, species protected by international bird treaties (JAMBA and CAMBA) that are known to occur at Lake Cowal include the Cattle Egret, Great Egret, Glossy Ibis, Painted Snipe, Caspian Tern and Red-necked Stint.

3.6 Air Quality

Ambient air quality in the Project area is determined by local land management activities and climatic conditions. Atmospheric dust represents the majority of particulate matter found in the ambient air. The mean deposition rates of dust are generally low ranging from 1.0 grams per square metre per month (g/m^2/month) to 1.62 g/m^2/month.

3.7 Noise

Background noise levels at the nearest residences to the Project in winter currently range from 31-35 decibels (dBA) during the day time, 21-25 dBA in the evening and 20-25 dBA during night time. During summer, background noise levels at the nearest residences to the Project area range from 30-33 dBA during the day time, 29-35 dBA during the evening and 26-37 dBA at night time.

Nuisance noise levels are considered to occur around 70 dBA (this is equivalent to freeway traffic at 15 m), while sustained noise levels of 85 dBA can cause hearing damage. An accepted critical level for continuous noise during sleep is within the range of 37-45 dBA.

With respect to birdlife, scientific literature suggests noise and blast disturbance occurs at levels in excess of 70 dBA and 130 dB Linear, respectively.

3.8 Archaeology

A range of archaeological sites have been found on and around the Project area through a number of surveys conducted in close association with regional and local Aboriginal land councils.

The sites range from a scarred tree to continuous scatters of artefacts principally comprising unmodified flakes, cores, back blades, small blades and burin. The artefact sites are thought to represent tool making and camping sites.

Lake Cowal is thought to have been important to Aboriginal people in a relatively arid environment. The material identified through the surveys is considered to have interpretative value as an archaeological resource and has cultural value to the local community.

3.9 Social Environment

Agriculture is the dominant industry of the region accounting for over 70% of business within the Bland Shire. The current population of the Bland Shire is around 6,600 however population declines have been experienced over the last ten years (about 0.9% per year compared with an average increase in NSW of 1.4% per year).

About 2,900 people are employed in the Bland Shire with approximately 1,100 engaged in agriculture and forestry related industries. West Wyalong is well serviced with community facilities.

4.0 IMPACT AND MITIGATION

4.1 Landuse, Topography and Visual Character

Potential Impacts

The development of the Cowal Gold Project would require significant but localised modification of the existing topography of the area. The open pit, waste rock emplacements, tailings storages and several water management structures would become permanent features of a rehabilitated landform.

The modified landform would extend into the high water mark of the Lake and form an arc around the open pit effectively creating a new lake foreshore. The northern waste emplacement would abut Cowal West Hill and would have a final sloped surface about 20 m above Cowal West Hill. The perimeter and southern waste emplacements would be lower with final surfaces about 20 m above existing ground surfaces. The tailings storages would involve the construction of embankments ranging from around 5 to a maximum of 20 m above the current land surface.

The total area to be disturbed would be approximately 940 ha.

Existing landuse practices within the proposed MLA area would have to cease and Crown land would be relocated away from the proposed MLA area.

A range of mine components would be visible from surrounding areas including the northern and southern waste emplacements, the perimeter waste emplacement and the tailings storages embankments.

The density of population and level of visitation of the surrounding area is very low.

Outcomes from Studies

All landforms have been restricted in height to lie below topographical highs (ie. the ridge line located immediately west of the Project area). Revegetated outer slopes would be profiled to an overall gradient of 1:5 (vertical to horizontal).

Mitigation Measures

The following range of mitigation measures have been proposed to address the impacts on the surrounding land.

- Pre-stripping of all topsoil and selected subsoils would be undertaken along with progressive landform rehabilitation.
- To fully manage sediment and erosion issues, an integrated Erosion, Sediment and Salinity Control Plan would be developed for the construction and operational phases of the mine.
- The game reserve would be relocated to an equivalent area north of the proposed MLA providing maintenance of public access to the Lake and, where possible, a sample of remnant vegetation and lake habitat. Access tracks onto the reserve would also be provided as well as appropriate signage and fencing.

- In order to maintain the existing function of the travelling stock reserve an equivalent route would be formed around the western edge of the proposed MLA.
- A range of visual mitigation measures are proposed including early rehabilitation of mine landforms, screening of mine views through a tree planting programme, compatible colouring of external buildings and use of unidirectional lighting.

4.2 Water Resources

Potential Impacts

These include:

- alteration of the hydrology of the lake as a result of collecting waters on the Project area that would otherwise flow to the lake;
- increased salinity due to the exposure of saline soil and waste rock materials;
- seepage of Lake water into the open pit (or vice-versa);
- failure of mine landforms over the long term;
- overflow, run-off and seepage from the tailings storage to the lake;
- movement of dust from active mine areas onto the lake;
- increased turbidity from the construction of the temporary isolation bund and lake protection bund;
- increased turbidity as a result of the construction of the water pipeline from the Bland Creek Palaeochannel borefield; and
- seepage from the tailings storages to the Lake.

Outcomes from Studies

Assessment of the Project supports the following findings:

- The Project is unlikely to have any measurable influence on the water balance of Lake Cowal. There would be expected to be a very slight increase in the volume of spill from the Lake to Nerang Cowal as a result of the isolation embankments' intrusion into the Lake. Similarly, Lake levels which overlap the perimeter bund, but are below the full storage water line, may be very slightly higher (up to 1 cm).
- Salt loads entering the Lake from the Project (post-closure) should decrease to below pre-mining levels as a result of mitigation works. During the mine life salt loads would be managed through the use of an integrated water management system and selective placement of mined material and stripped soils.
- Infiltration within the emplacements would be directed to the base of the emplacements which would be excavated with a reverse grade and/or compacted where necessary to direct drainage towards the open mine pit.
- Saline water would be extracted from the shallow aquifers intersected by the open pit. Modelling indicates that after several years of continuous pumping, the drawdown at a distance of 10 km east of the pit would be between one and three metres in the aquifers. There are no registered groundwater users within 10 km of the Project.
- The groundwater resource at the Bland Creek Palaeo-channel is partially used by landholders in the area for irrigation and stock watering purposes. The closest two irrigation bores next to the proposed borefield are approximately 20 km to the south. Modelling shows that drawdown at these bores could be approximately 7.5 m after several years of continuous pumping. Other registered stock watering bores are located outside the Palaeochannel or on the channel edge.
- The mine pit (and final void) is hydrogeologically isolated from the Lake water.
- Mine landforms would be stable over the long term even under severe earthquake conditions.
- The tailings storages have been designed with sufficient freeboard to store water from a 1 in 1,000 Average Recurrence Interval (ARI) rainfall. Long term modelling of seepage from the tailings storages shows that seepage is likely to have a negligible impact on existing groundwater levels or quality and would in any event migrate slowly to the final void. Within 30-40 years following Project closure, the tailings storages would be essentially de-saturated and measurable seepage through the floor would cease.
- Dust levels from the Project are expected to have a negligible impact on Lake water quality as a relatively low increased level of dust fallout over the Lake is anticipated. Geochemistry of the dust is expected to reflect natural soil conditions.

Mitigation Measures

- A comprehensive monitoring programme would measure water quality at various points within the water management system (Figures ES-8 and 9). Drawdown effects would be monitored at the borefield.
- A continuous silt curtain would be installed around the construction zone of the temporary isolation bund.
- Where possible it is proposed to bury the water supply pipeline from Bland Creek Palaeochannel borefield to the Project.

4.3 Flora

Potential Impacts

The proposed disturbance to vegetation communities in the Project area is shown in Table ES-5.

Outcomes from Studies

The flora of the Project area has been significantly modified by past and present land use as evidenced by the relatively reduced botanical species diversity and abundance and the proliferation of weed species.

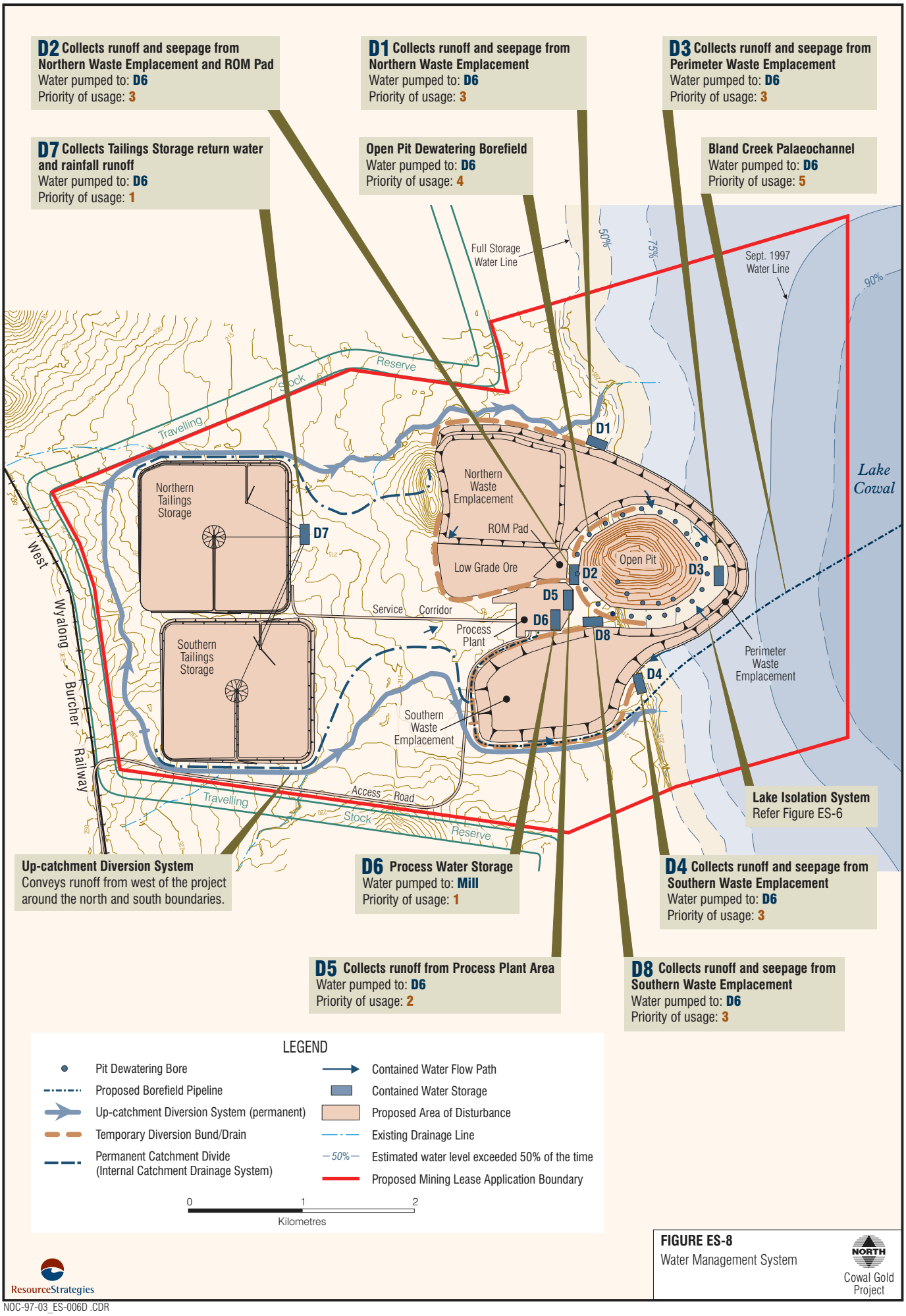


FIGURE ES-8
Water Management System

Cowal Gold Project

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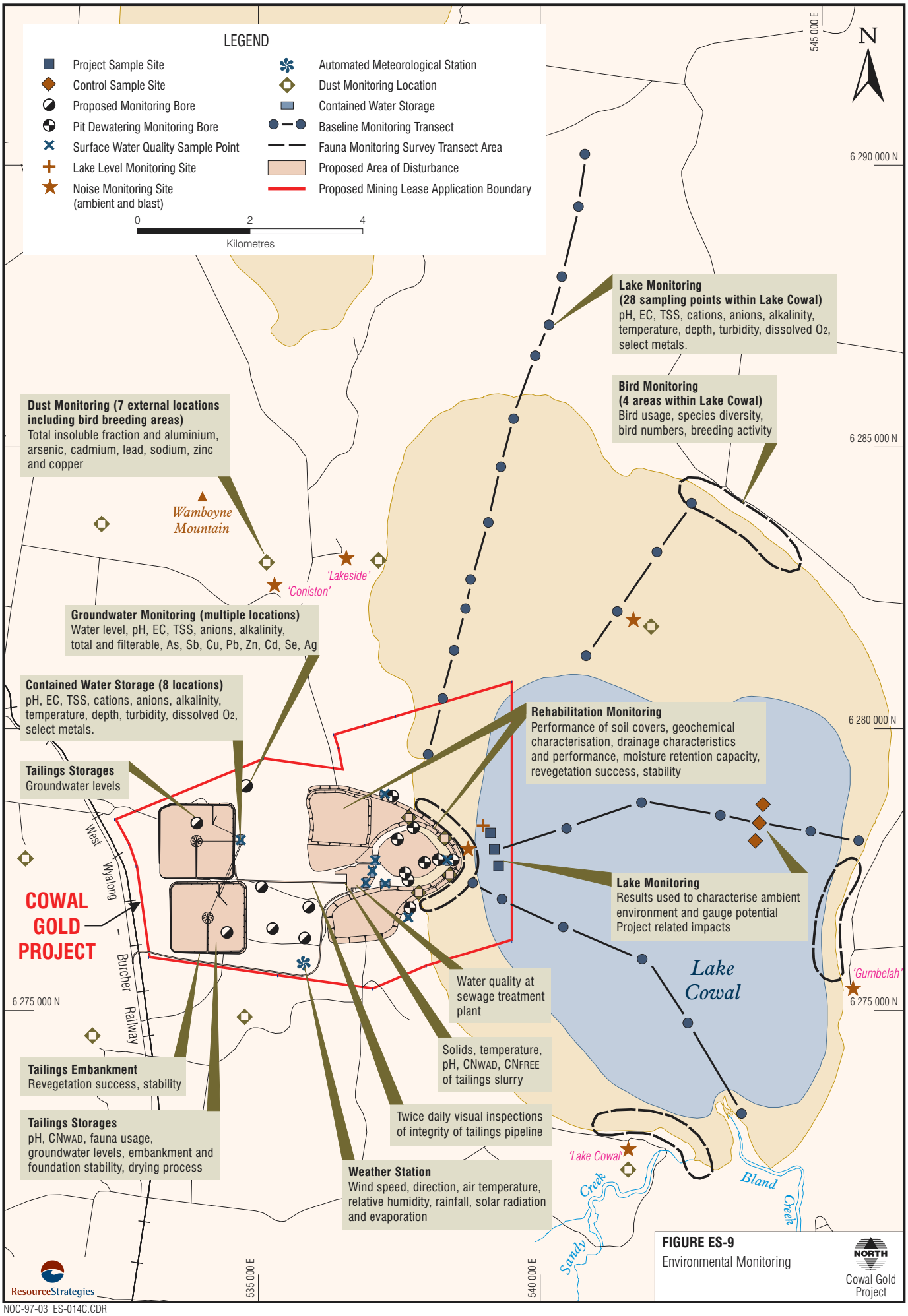


FIGURE ES-9
Environmental Monitoring

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Mitigation Measures

The proposed rehabilitation program provides for the use of endemic native species and threatened species known or considered likely to occur in the Project area surrounds eg. Austral Pillwort and Winged Peppercress. The progressive rehabilitation of some 940 ha is considered to constitute an increase in the botanical conservation value of the Project area.

4.4 Fauna

Potential Impacts

Potential impacts on fauna include:

- removal/modification of habitat;
- potential impacts associated with the tailings storages;
- potential impacts of dust on birds and lake environs;
- potential impacts from noise and blasting on wildlife;
- potential impacts from artificial lighting;
- bird strike and electricity transmission lines; and
- salinity of the final void.

Outcomes from Studies

- Cyanide levels at the point of discharge to the tailings storages are to be at all times less than 30 mg/L CN_{WAD} and less than 20 mg/L for 90% of the time. Natural decay and other cyanide reducing processes that are expected to occur following discharge at the edge of the storages and in the small water pond in the centre of the storages should further reduce these levels to between 5-15 mg/L (as measured in the water pond itself and contained storage D7 – refer Figure ES-8). These levels are significantly lower than the concentrations known to affect birds and smaller wildlife.
- Dust fallout from soils, subsoils and from tailings storage areas are expected to be within the normal range of acceptability for birds and livestock.
- Potential dust deposition in areas accessible to birds or grazing stock outside the MLA is expected to be well within tolerable levels.
- Acoustic studies conducted for noise and blast impacts on bird habitats at Lake Cowal have found that mine contributed noise, some 1.5 km from the Project, would be many times below the levels recorded as affecting bird behaviour. This is a considerable distance away from the main bird breeding areas (which lie some 4.5 km from the Project area).
- Blast levels at the main bird breeding areas are expected to be many times lower than disturbance levels for people.
- Bird strike risk can be largely overcome by avoiding flight path areas and incorporating certain design features into proposed transmission lines such as reducing the vertical profile and enhancing the visibility of conductors.

Mitigation Measures

Mitigation measures proposed to overcome these impacts include the following:

- Rehabilitation objectives have been designed to improve fauna habitat (Figure ES-10).
- Cyanide levels in the tailings storages are to be maintained as prescribed by the EPA and NPWS with twice daily patrols.
- Automated shutdown of the tailings discharge will occur if levels of cyanide exceed the maximum permissible level.
- A specific monitoring programme for bat usage of the tailings storages will be conducted and will include development of bat exclusion mechanisms if necessary.
- All roads and active construction areas will be regularly watered.
- Unidirectional lighting techniques will be applied, where appropriate, to mitigate artificial lighting impacts.
- Monitoring of environmental conditions at the bird breeding areas will be conducted (Figure ES-9).

4.5 Air Quality

Potential Impacts

Potential impacts on air quality as a result of the Project include the movement of dust away from active construction areas and mine operation areas to nearby residences and to the lake environs.

The EPA specify that a mean annual increment of 2 g/m^2/month is the maximum acceptable increase for such a project in a rural environment like Lake Cowal. In terms of Total Suspended Particulates (TSP) the maximum permissible level is 90 $\mu g/m^3$.

Outcomes from Studies

Modelling indicates that at all stages of development predicted levels of less than 0.5 g/m^2/month are expected with only a single small portion of land immediately adjacent to the proposed MLA receiving greater than 2 g/m^2/month.

In terms of TSP, modelling shows that at all stages of the development, TSP levels are expected to be less than 10 $\mu g/m^3$ with only a small strip of land outside the proposed MLA modelled to exceed the 90 $\mu g/m^3$ level.

Investigations conducted for the Project have concluded that dust emissions from the Project would have no adverse influence on waterbirds, livestock or plants.

Mitigation Measures

Active management of dust through regular watering of roads and active construction areas would occur.

4.6 Noise

Potential Impacts

Potential noise impacts on residences and birdlife during construction and over the mine life include nuisance noise from mining, traffic noise as well as blasting noise and vibration.

SHALLOW LAKE	WATERCOURSES - RIVER FLOODPLAIN	FLAT - GENTLY UNDULATING SLOPES	LOW RIDGES - HILLS	HILLTOPS - ELEVATED LAND
EXAMPLE OF LANDFORM: Lake Cowal and new lake foreshore	EXAMPLE OF LANDFORM: Fringing lake vegetation and drainage line vegetation	EXAMPLE OF LANDFORM: Footslopes below Cowal West; waste emplacement batters and surrounds	EXAMPLE OF LANDFORM: Cowal West tops and upper slopes of new landforms	EXAMPLE OF LANDFORM: Tailings and waste emplacements top surfaces
VEGETATION ASSOCIATION: Freshwater Plants	VEGETATION ASSOCIATION: River Red Gum Woodland	VEGETATION ASSOCIATION: Eucalypt Woodland Alliance No.1	VEGETATION ASSOCATION: Eucalypt Woodland Alliance No. 2	VEGETATION ASSOCIATION: Eucalypt Woodland Alliance No.3
TYPICAL SPECIES: **WATER ZONE** Foxtail Pond Weed *Phacelia tanacetifolia* **RUSH ZONE** Cumbungi Rush **LITTORAL ZONE** White Water Lily Canegrass *Gonocarpus elatus* **FLOOD ZONE** Lignum Canegrass	TYPICAL SPECIES: Windmill Grass Lignum River Red Gum Yellow Box Grey Box Belah Rosewood Blackbox	TYPICAL SPECIES: Poplar Box Yellow Box Fuzzy Box Grey Box Blakely's Red Gum White Cypress Pine Belah Myall River Cooba Wilga Rosewood	TYPICAL SPECIES: Windmill Grass Redleg Grass Daphne Heath Red Stringybark Mugga Ironbark Tumble-down Red Gum Black Cypress Pine Lancewood	TYPICAL SPECIES: Windmill Grass Redleg Grass Daphne Heath Mugga Ironbark Yellow/Red Box Long-leaved Box Black Cypress Pine Lancewood



Not to Scale

Source: Adapted from Braithwaite (1975), Briggs & Thorton (1995), Bower (1997), Bower & Semple (1993), DLWC (1996), Goldney & Bowie (1990), Sivertsen & Metcalfe (1995).

RL ~205m	RL ~206-220m	RL ~210-225m	RL ~220-230m	RL ~230-245m

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FIGURE ES-10
Rehabilitated Species Alliances

NORTH

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Outcomes from Studies
Results of modelling noise emission levels for construction and mining operations (years -1, 3 and 8) at residences surrounding the Project area show that noise contributions during day and night time meet noise level design goals set by the EPA even under adverse conditions. Blast emission criteria are also shown to be met at all times.

In terms of traffic movements, noise levels set by the EPA are met at all residences during day time and night time except for five residences situated 30 m from the road near West Wyalong where a small exceedance of the night time design goal is predicted.

Noise and blast levels at known wetland bird breeding areas are predicted to be many times lower than those levels considered or known to cause nuisance or disturbance to birds.

Mitigation Measures
Noise and ground vibration monitoring would be undertaken at nearby residences and key bird breeding areas.

Should the Project proceed, the Bland Shire Council have advised that they would relocate the 60 km/h zone further north along Ungarie Road where it exits West Wyalong to reduce traffic noise levels.

4.7 Aboriginal Heritage

Potential Impacts
Impacts from the Project include the removal or destruction of artefact sites within the active construction area or the unearthing of previously unknown artefact sites during construction.

Mitigation Measures
Advice from archaeological consultants in consultation with local and regional Aboriginal land councils recommends that management of sites to be disturbed by the Project be directed towards enhancing local knowledge and appreciation of the cultural heritage of Lake Cowal.

Sites not affected by the Project area would be fenced and signposted while background artefacts on areas to be disturbed would be collected and stored. The scarred tree within the open pit area would be removed and displayed at the West Wyalong Local Aboriginal Land Council offices.

The most important identified site on the Project area (termed the "men's site") would be excavated to determine the chronology and function of the site.

A representative from the Land Council would be employed to oversee construction activities.

4.8 Social and Economic Aspects

Potential impacts
The movement of a large construction workforce into the town of West Wyalong and surrounding townships, and a more permanent workforce occupying the area for approximately 13 years may bring stresses to existing facilities. A new level of economic activity would also be established which may pose problems during the phase down of the mine workforce.

Outcomes from Studies
A diverse range of services and facilities are locally available within West Wyalong along with a degree of spare capacity due to the declining population. The demand generated by the incoming population is not expected to unduly affect the levels of services and facilities at West Wyalong.

Overall the impacts of the Project are considered to be positive for the local community.

Mitigation Measures
To cater for the increased demand for houses, North is expected to either acquire or build approximately 30 houses for staff. Hotel accommodation and caravan park accommodation is considered adequate for the construction workforce.

As part of the consultation process with the community, measures to alleviate adverse effects of a reduction of workforce numbers at year 8 (when mining is completed) and year 13 (when the operation is expected to end) would be developed into a management plan prior to year 8.

4.9 Traffic

Regional roads in the area of the Project operate significantly under capacity and both construction and operational traffic can be accommodated. The upgrade of key intersections would occur in conjunction with road improvement works to be carried out over the last 12 km of road to the Project area.

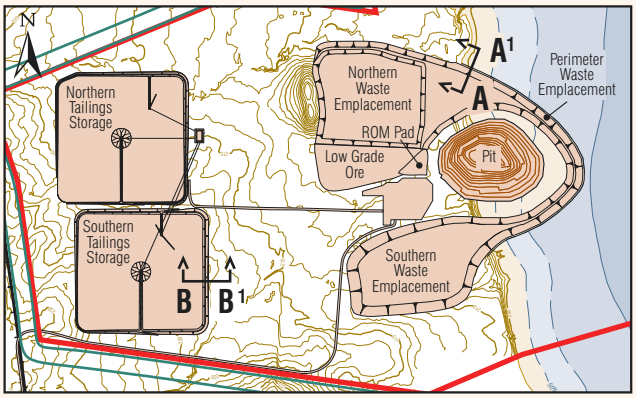
5.0 REHABILITATION

The rehabilitation philosophy for the Project is to create stable rehabilitated landforms which increase areas of endemic vegetation in the Project area and the conservation status of lake-land habitats in general. Typical species alliances proposed are shown in Figure ES-10.

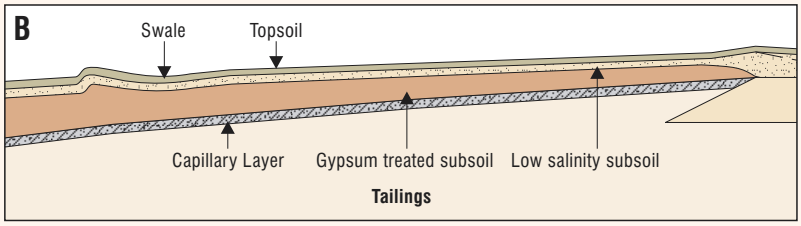
Rehabilitation would be progressive and in accordance with approved plans which would be updated annually.

New Lake Foreshore
This would be rehabilitated as a series of up to four zones (a flood zone around the fringe of the Lake and three Lake edge zones, *viz.* littoral zone, rush zone and depending, on Lake levels at the time, a water zone) with species to match each zone. This area would be one of the first to be rehabilitated.

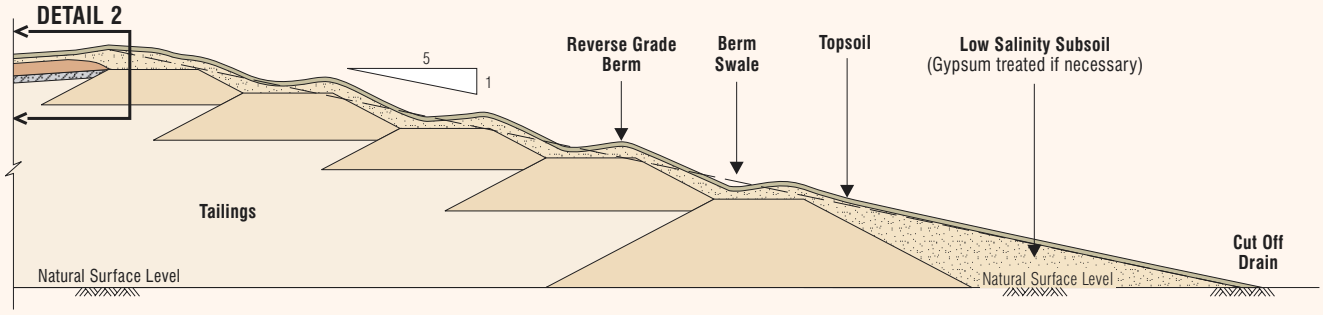
Mine Waste Emplacements
Outer slopes would be covered with a layered system of soils and subsoils retrieved from stockpiles or direct from mine operations. Reverse grade berms together with the considerable depth of the cover proposed would have the effect of absorbing and storing rainfall in all but extreme events (Figure ES-11).



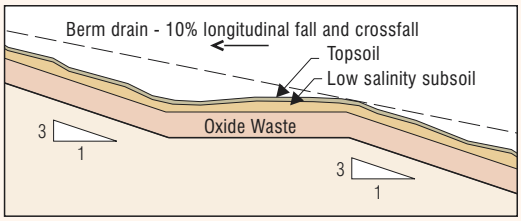
PLAN



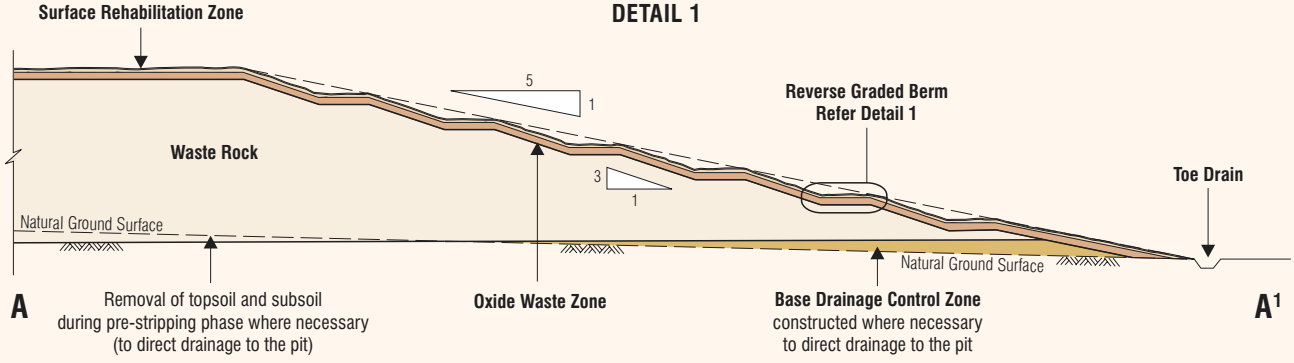
DETAIL 2



TAILINGS STORAGE REHABILITATION CONCEPTS



DETAIL 1



WASTE ROCK EMPLACEMENT REHABILITATION CONCEPTS

Not to Scale

FIGURE ES-11
Rehabilitated Landform Concepts

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Drainage on the top surfaces of the emplacements would be similarly managed by a series of small shallow drainage features (swales) which in combination with a deep cover and high absorption capacity would support a diverse woodland vegetation community.

Final Void

The objective with the final void is to leave its surrounds safe for humans, stock and wildlife and where feasible create habitat opportunities for waterbirds at the approximate level at which void water would reach its equilibrium.

The volume of the void would be around 80,000 ML. Groundwater inflows, rainfall and site runoff are expected to gradually increase the level of water in the void over a period of 100 years, reaching equilibrium at about 22 m to 24 m below the level of Lake Cowal.

An evaluation of the likely geochemical characteristics of the water show that the long term scenario would be for the deep water to trend towards hypersalinity. Near the surface, a mixing layer would establish with a mid year (June – August) seasonal increase in salinity from that approximating sea water to a level about twice that of sea water. During summer months the concentration of salinity in this layer would return to about sea water levels.

Metal solubility in the void is expected to remain low and void water quality is not expected to pose a threat to wildlife.

Given this scenario it is likely that salt tolerant species of phytoplankton would colonise the void to form a simple ecosystem.

Tailings Storages

The outer embankments of the tailings storages would be left grassed until the cessation of use (to minimise bird habitat potential) at which stage they would be re-vegetated using endemic shrub and woodland species with the embankments developed in the same reverse grade as proposed for the waste emplacements (Figure ES-11). Surfaces would receive a deep cover to allow rainfall to be absorbed and stored by the covers allowing a woodland vegetation with a relatively high demand for water to be established.

6.0 MONITORING

Figure ES-9 summarises a detailed environmental monitoring programme proposed for the Project.

Environmental management of the site would be overseen by the statutory Mining, Rehabilitation and Environmental Management Process, the first step of which is to prepare a Mining Operations Plan for Government review. This would include all mining and rehabilitation operations and relevant environmental controls for compliance with mining lease conditions.

Other plans which would be required to be completed before construction commences are:

- Construction Environmental Management Plan
- Integrated Erosion, Sediment and Salinity Control Plan
- Soil and Stripping Management Plan
- Hazardous Waste and Chemical Management Plan
- Bushfire Management Plan
- Land Management Plan
- Site Water Management Plan.

During construction and operations, annual Environmental Management Reports would be prepared for Government and the community detailing monitoring results. Annual rehabilitation plans would also be prepared as with a final rehabilitation plan.

Post-operations, ongoing annual reviews of environmental performance would occur as with monitoring of landform stability and rehabilitation performance. This would continue to relinquishment of the lease.

Main Report



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Section 1

Section 1
Introduction

1.0 INTRODUCTION

1.1 Project Overview

1.1.1 Project Description and Background to this EIS

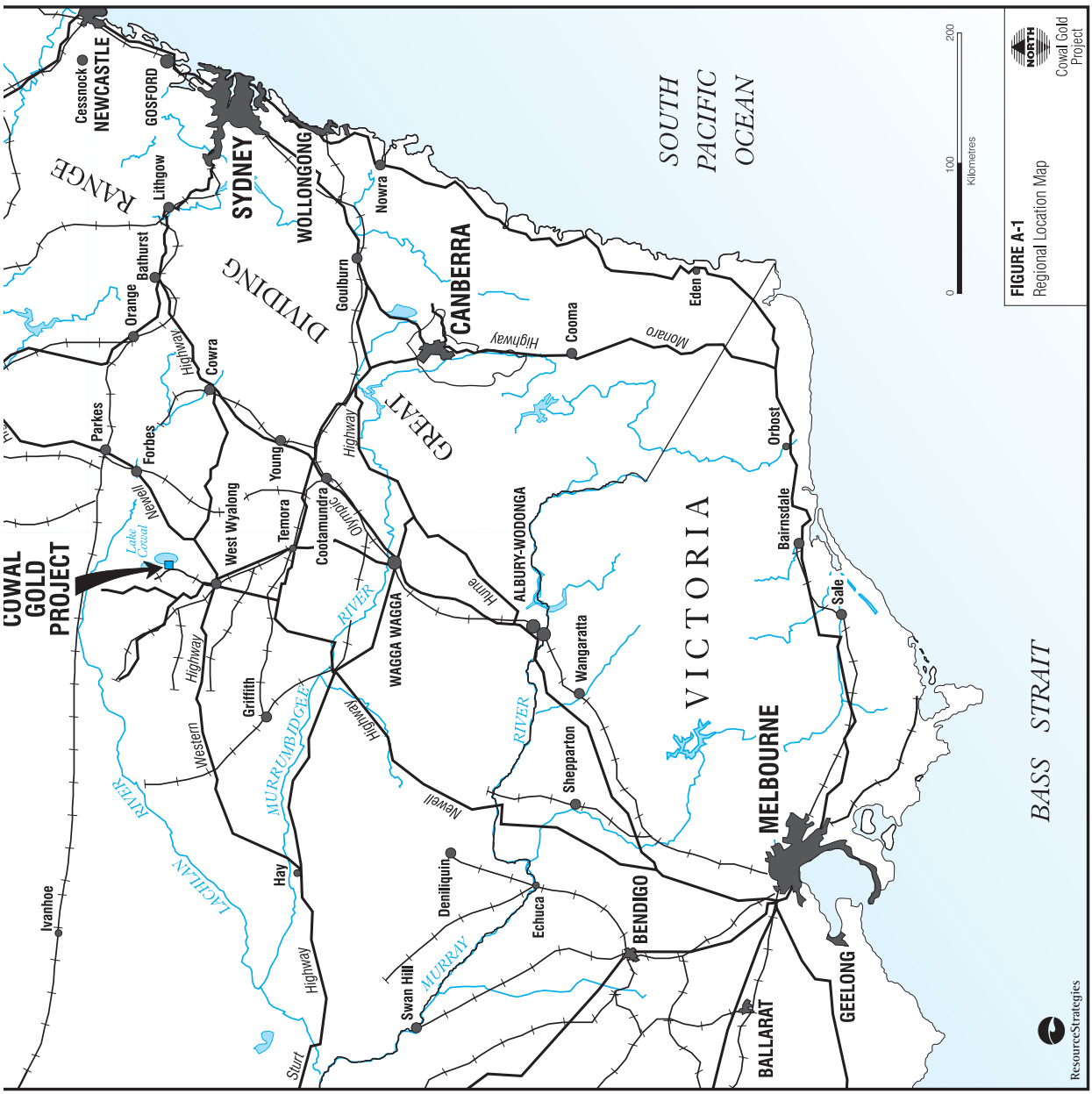
This Environmental Impact Statement (EIS) describes the construction, operation and rehabilitation of the proposed Cowal Gold Project. In summary, the Project involves:

- the development of an open pit gold mine adjacent to Lake Cowal, 38 km north-east of West Wyalong, New South Wales (Figure 1-1);
- the reformation of a section of Lake foreshore to protect the Lake from the mine and enhance the current state of lake:land ecotonal habitats;
- processing of ore at an average rate of about 6 million tonnes per annum;
- the disposal of waste rock within secure emplacement areas which have been located and designed to provide for new flora and fauna habitat following rehabilitation;
- the reduction of cyanide levels in tailings water to levels below those considered potentially harmful to fauna;
- the placement of tailings from the processing of ore in two storages, located approximately 3.5 km from the Lake's western edge. The final closure and rehabilitation of these storages to provide improved flora opportunities and fauna habitat;
- the transmission of electric power to the Project via an overland transmission line from Temora (to the south), located to avoid known water bird feeding and flight path areas and areas of high visual amenity;
- the provision of process water from a borefield to be located north-east across the Lake, in the Bland Creek palaeochannel;
- the relocation of a travelling stock reserve which presently crosses through the Project area;
- the public road upgrade for the proposed mine access road.

A summary of key Project facts is presented in Table 1-1.

Table 1-1 Cowal Gold Project Snapshot

Description	Open pit gold mine and processing plant employing approximately 200 people.
Proponent	North Gold (WA) Ltd A.C.N 005 233 689, a wholly owned subsidiary of North Limited, 476 St Kilda Road, Melbourne, Australia, 3004.
Tenement status	Exploration titles held by North Limited, who will apply for a Mining Lease covering an area of approximately 2,650 hectares.
Mining	Open pit mine producing a total of approximately 3.2 million ounces of contained gold from some 76 million tonnes of ore. Gold is to be extracted from the ore using a conventional carbon-in-leach cyanide leaching circuit.
Life of mine	The mine would have a 13 year operational life composed of a 8 year mining and mineral processing phase followed by a 5 year mineral processing phase.
Open pit	Final pit would occupy a surface area of approximately 1,000 m long, 850 m wide and 325 m deep.
Waste rock emplacement	A total of approximately 128 million tonnes of mined waste rock would be produced. This waste is to be placed to the north, south and east of the perimeter of the pit. The northern waste emplacement would be constructed to a RL of 243 m and the footprint would cover an area of approximately 150 ha. The southern waste emplacement would be constructed to a RL of 223 m and cover an area of approximately 115 ha. The perimeter waste rock emplacement would reach a RL of 223 m and cover an area of approximately 50 ha. In total the waste rock emplacements cover an area of 315 ha.
Tailings storage	Approximately 76 million tonnes of tailings would be produced over the life of the mine. Tailings are to be stored in two tailings storage areas located approximately 3.5 km west of the Lake shoreline. The tailings storages would cover an area of approximately 350 ha (northern storage ≈180 ha, southern storage ≈170 ha).
Process plant and infrastructure	The process plant and associated infrastructure are to cover an area of approximately 25 ha.
Run-of-mine pad	Situated immediately north of the process plant area, the run-of-mine ore stockpile pad covers an area of approximately 5 ha.
Low grade ore stockpile	The low grade ore stockpile adjoins the western side of the ROM pad, extending over an area of approximately 35 ha.
Topsoil and subsoil stockpiles	As a component of the rehabilitation process topsoil and subsoil would be stripped and stockpiled. The topsoil and subsoil stockpiles would cover an area of approximately 90 ha. Topsoil and subsoil re-application would occur progressively as final landforms become available.
Power supply	Electricity to the site would be via a 132kV transmission line from Temora, approximately 90 km south of the Project area.
Water supply	Water required for ore processing and related activities would be predominantly sourced from recycled process and site catchment water and pit dewatering. Make-up water requirements over the life of the mine, would be sourced by pipeline from the Bland Creek borefield.
Site access road	The site access road would follow existing roads from West Wyalong to the Project area. Two road re-alignments are proposed with existing unsealed sections proposed to be sealed.
Hours of operation	Mine operations are proposed for seven days a week with two, 12 hour shifts per day.


COWAL GOLD PROJECT
Cessnock
NEWCASTLE
GOSFORD
SYDNEY
WOLLONGONG
Nowra
Lithgow
Bathurst
Orange
Parkes
Forbes
Cowra
Young
Goulburn
CANBERRA
Cooma
Eden
Orbost
Bairnsdale
Sale
Temora
West Wyalong
Cootamundra
WAGGA WAGGA
ALBURY-WODONGA
Wangaratta
Griffith
Hay
Ivanhoe
Deniliquin
Echuca
Swan Hill
Shepparton
BENDIGO
MELBOURNE
BALLARAT
GEELONG
RANGE
DIVIDING
GREAT
VICTORIA
SOUTH PACIFIC OCEAN
BASS STRAIT
Lake Cowal
MURRUMBIDGEE RIVER
MURRAY RIVER
LACHLAN RIVER
Newell Highway
Western Highway
Olympic Highway
Hume Highway
Monaro Highway
Sturt Highway
0
100
200
Kilometres
NORTH
FIGURE A-1
Regional Location Map
Cowal Gold Project
ResourceStrategies
NOC-97-03_FF-023A.CDR

1.1.2 Brief History of the Cowal Gold Project

North Limited commenced exploration along the western side of Lake Cowal in 1981. From 1988 to 1994, exploration effort was concentrated on the Endeavour 42 (E42) orebody to increase the size and confidence of the resource by infill and deep drilling. Over 550 drill holes have been placed in the deposit to enable definition of the mineralisation and the resource. It is the development of E42 which is the subject of this EIS.

In August 1995, North submitted a Development Application (DA) and an Environmental Impact Statement (EIS) for a proposal to mine E42. The Application was refused consent on environmental grounds, causing North to re-assess the environmental management and compatibility of the Project with Lake Cowal from "first principles".

In developing the Project from first principles a range of development scenarios were examined (summarised in Section 1.3) and a study into the Project's compatibility with critical conservation values of Lake Cowal over the long term was completed (reported in Appendix N). North also re-examined consultation objectives for the Project which are detailed in Section 1.2.

Major outcomes from this process were:

- a new process being added to the mill resulting in a significant reduction in the use of cyanide;
- introduction of new cyanide destruction technology and increased recycling of cyanide within the mill;
- movement of the tailings storage 3.5 km from the edge of Lake Cowal;
- reduction in the number of tailing storage cells from four to two;
- a new electricity transmission line corridor from Temora to the south of the Project (to avoid Lake Cowal-Nerang Cowal habitats);
- an enhanced rehabilitation concept; and
- a *Statement of Intent* which documents the above and other commitments and details how North would conduct its activities during the assessment of the new Project DA.

1.1.3 Structure of the EIS

Section 1 of this EIS provides background on consultation undertaken in preparing the EIS, alternative development scenarios, legislative requirements and Ecologically Sustainable Development considerations.

Section 2 of the EIS provides a description of the proposed development while Section 3 provides a description of the existing environment. Section 4 details impacts and mitigation measures for each environmental assessment area. Section 5 describes the rehabilitation concept for the project during mining and once mining is complete. Section 6 summarises proposed environmental management and monitoring provisions. Appendices A to O provide backup documentation for the EIS including a number of independent specialist reports.

The EIS provides an assessment of three separate proposals all of which have a different approval process under the *Environmental Planning and Assessment Act* (EP&A Act):

- A Development Application (DA) under Part 4 of the EP&A Act by North Gold (WA) Limited (North) as the proponent of the Cowal Gold Project. The surface infrastructure items covered by North Limited's DA (Figure 1-3) includes all activity within the proposed Mining Lease Application (MLA) area, a relocated Travelling Stock Reserve (TSR) and road within the new TSR, borefield and water pipeline.
- A proposal under Part 5 of the EP&A Act by Great Southern Energy (a corporatised NSW electricity authority) as the proponent of the proposed electricity transmission line from Temora to the Project area (Figures 1-2 and 1-3). The complete EIS for the electricity transmission line (including Director-General's Requirements, baseline and impact mitigation studies) is provided in this document as Appendix D.
- A proposal under Part 5 of the EP&A Act by North to upgrade the public road (within the existing public roads and road reserves) which provides access to the proposed Mining Lease Application (MLA) area. The environmental impacts of the road upgrade are detailed in Appendix O.

The three proposals are being assessed together so that all potential impacts associated with the Project can be fully examined.

Detailed descriptions of the three proposals can be found in Section 2 of this EIS for the Cowal Gold Project and road upgrade, and Section 2 of Appendix D for the Electricity Transmission Line.

1.1.4 Profile of Proponents

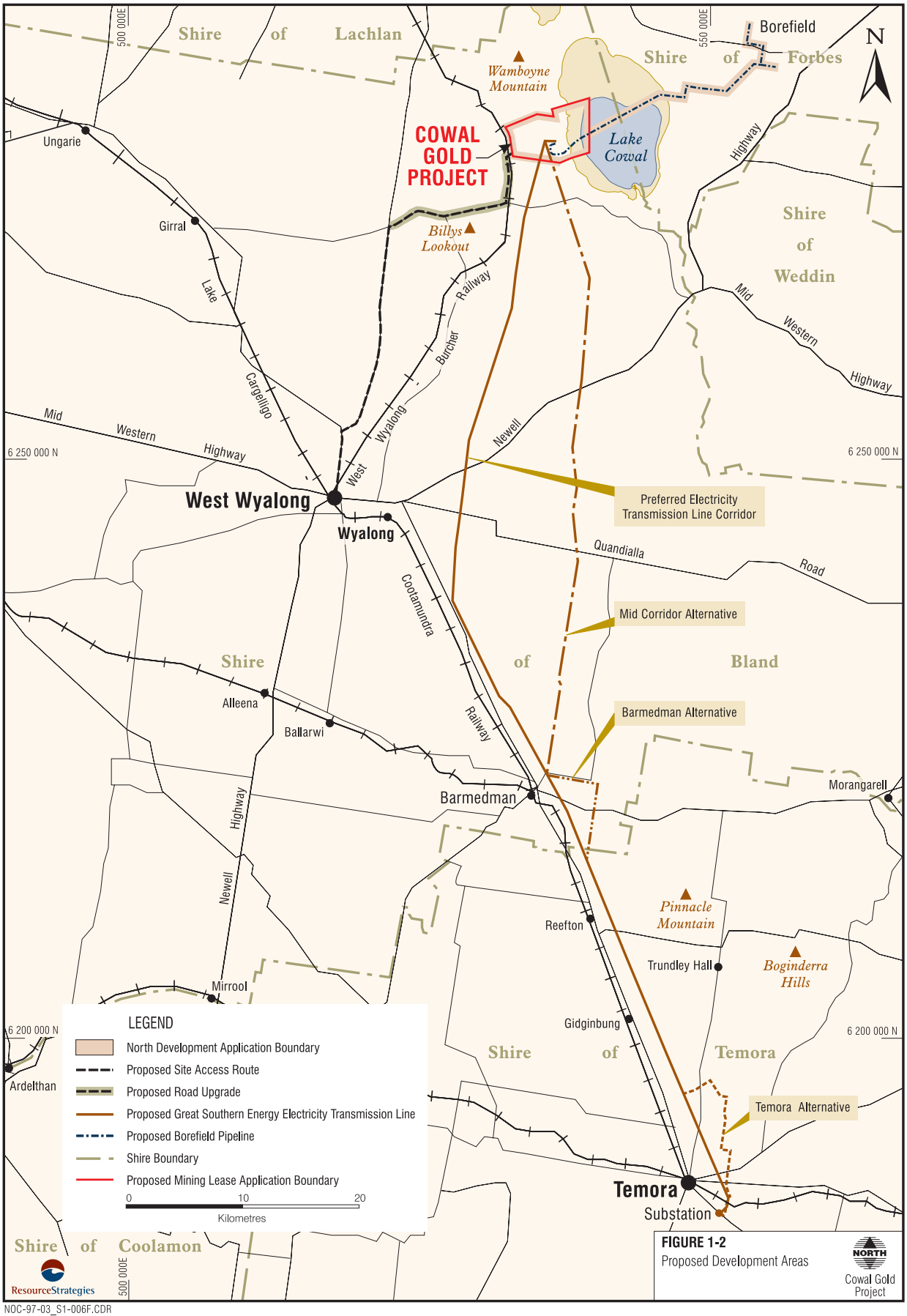
A profile of Great Southern Energy can be found in Appendix D.

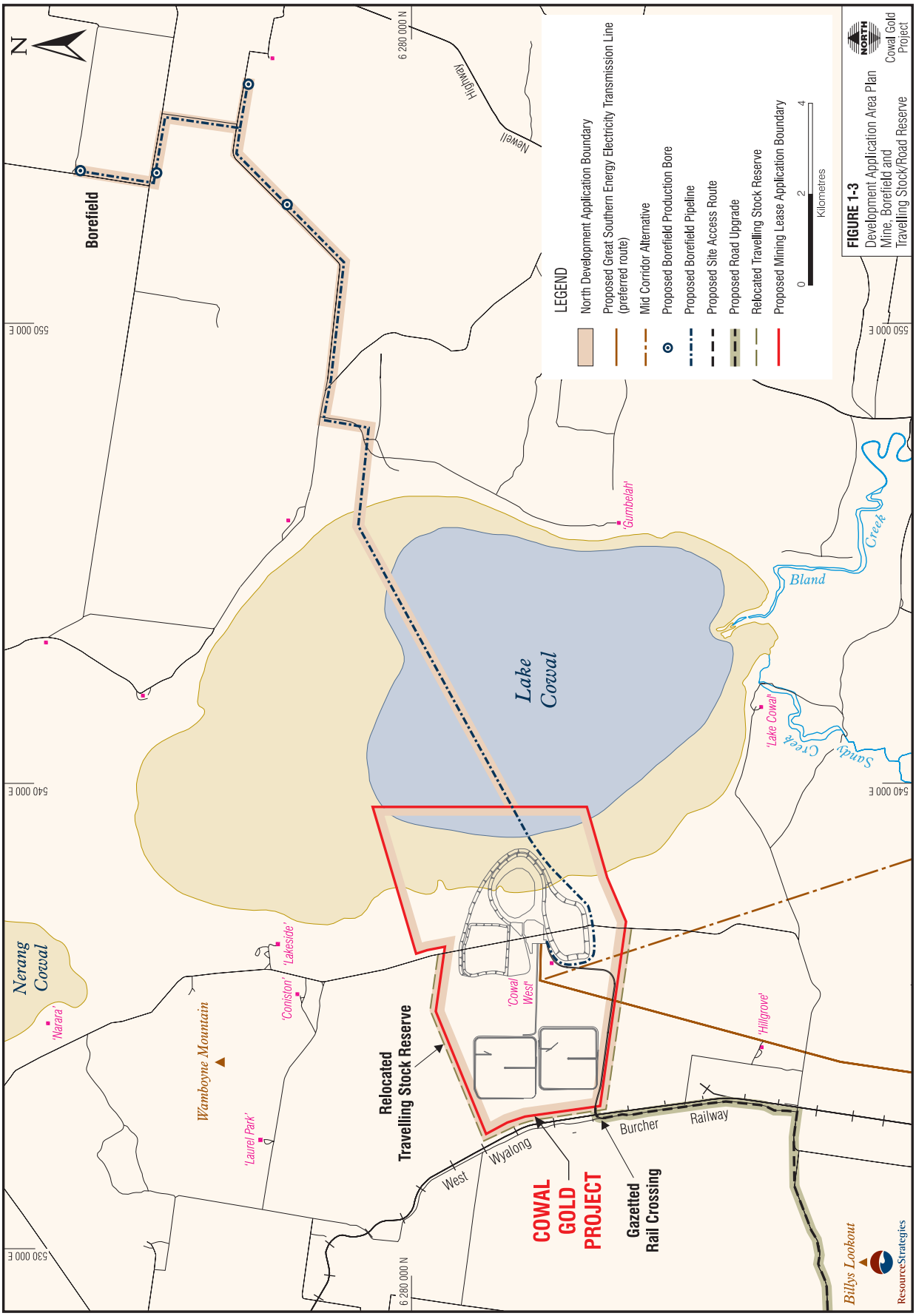
The proponent for the Cowal Gold Project is North Gold (WA) Ltd (North), a wholly-owned subsidiary of the Australian-listed resource company, North Limited. North Limited are a major international diversified resources company headquartered at:

476 St Kilda Road
MELBOURNE VICTORIA 3004

North Limited's business interests include minerals (exploration, development and mine operation), equipment manufacturing and forestry. Developed and prospective mineral resource projects are located throughout Australia, USA, Canada, South America, Sweden, Africa and Indonesia.

North Limited has annual sales of more than $1.4 billion (1997) and employs more than 6,500 people. Group net assets are approximately $4 billion, and the operating profit in 1996/97 after tax was $135 million. At June 1997, the company had 53,699 shareholders. Income distribution created in 1996/97 is shown in Table 1-2.


Shire of Lachlan
Shire of Forbes
Borefield
Wamboyne Mountain
COWAL GOLD PROJECT
Lake Cowal
Ungarie
Girral
Billys Lookout
Shire of Weddin
Lake Cargelligo
Railway
Burcher
Wyalong West
Mid Western Highway
Newell Highway
West Wyalong
Wyalong
Preferred Electricity Transmission Line Corridor
Quandialla Road
Mid Corridor Alternative
Cootamundra Railway
Shire of Bland
Alleena
Ballarwi
Barmedman Alternative
Barmedman
Morangarell
Pinnacle Mountain
Reefton
Trundley Hall
Boginderra Hills
Mirrool
Gidginbung
Shire of Temora
Temora Alternative
Temora Substation
Ardelthan
Shire of Coolamon
6 250 000 N
6 200 000 N
500 000E
550 000E
N
LEGEND
North Development Application Boundary
Proposed Site Access Route
Proposed Road Upgrade
Proposed Great Southern Energy Electricity Transmission Line
Proposed Borefield Pipeline
Shire Boundary
Proposed Mining Lease Application Boundary
0 10 20
Kilometres
ResourceStrategies
NOC-97-03_S1-006F.CDR
FIGURE 1-2
Proposed Development Areas
NORTH
Cowal Gold Project


N
LEGEND
North Development Application Boundary
Proposed Great Southern Energy Electricity Transmission Line (preferred route)
Mid Corridor Alternative
Proposed Borefield Production Bore
Proposed Borefield Pipeline
Proposed Site Access Route
Proposed Road Upgrade
Relocated Travelling Stock Reserve
Proposed Mining Lease Application Boundary
0
2
4
Kilometres
FIGURE 1-3
Development Application Area Plan
Mine, Borefield and
Travelling Stock/Road Reserve
Cowal Gold Project
Borefield
Lake Cowal
Bland Creek
Sandy Creek
'Gumbelah'
'Lake Cowal'
'Hillgrove'
'Cowal West'
'Coniston'
'Lakeside'
'Narara'
'Laurel Park'
Wamboyne Mountain
Nerang Cowal
Relocated Travelling Stock Reserve
COWAL GOLD PROJECT
Gazetted Rail Crossing
Burcher
Railway
Wyalong
West
Billys Lookout
Newell Highway
6 280 000 N
530 000 E
540 000 E
550 000 E
ResourceStrategies
NOC-97-03_S1-005K.CDR

The Cowal Gold Project office is situated at:

Showground Road
WEST WYALONG NSW 2671

Telephone (02) 6972 4500
Facsimile (02) 6972 2474

1.1.5 Land Description and Tenure

Land which encompasses the electricity transmission line corridor is described in full in Appendix D.

The land within the proposed MLA area for the Cowal Gold Project is held in a combination of freehold, perpetual leasehold and crown tenure as shown on Figure 1-4.

North holds exploration titles EL2865 and EL4510 which include the proposed MLA area (Figure 1-5).

The main private property to be physically affected by the Project facilities (within the MLA) is that held by the Carnegie family ("Cowal West"). Land held by W.J. & A. Buttenshaw would also be physically affected by the Project. North have options to purchase these and certain other properties in the vicinity of the Project (Figure 1-4).

Properties In the vicinity of the Project[1] are "Lake Cowal" (W.R. Buttenshaw, 6.5 km south), "Lakeside" (T. Bolte, 5.5 km north) and "Gumbelah" (L. & B. Dent, 8 km east), and "Hillgrove" (K. Boneham, 5.5 km south-west), "Coniston" (A. Buttenshaw, 5.5 km north) and "Laurel Park" (W.J. Buttenshaw, 6 km north-west).

The water pipeline and associated infrastructure which runs from the borefield to the MLA boundary (Figure 1-3), crosses three privately held properties, that of I. Low, B. Mattiske and M. Buttenshaw and M.B. Currie. Outside of these properties the pipeline follows existing road reserves.

[1] Approximate distance measured from the centre of the proposed open pit.

Proposed bores within the borefield would also be located within existing road reserves or on Crown land. The electricity supply to the borefield would follow existing road reserves. Access to these infrastructure components will, therefore, be via these existing road reserves.

The Project access road follows existing public roads and an existing road reserve (Figure 1-2).

The Crown land on the proposed MLA encompasses a Travelling Stock Reserve (TSR), a Game Reserve and three unformed Crown roads (Figure 1-4). It is proposed to relocate the TSR around the proposed MLA and provide a gravel road within the TSR. The Game Reserve would also be relocated to an area north of the proposed MLA pursuant to a "Land Swap" agreement, to be made by North and the Department of Land and Water Conservation (DLWC). Under this agreement, the land currently included in the Game Reserve will be transferred to North in return for North providing an equivalent parcel of land away from the Project. The unformed Crown roads would be closed.

The Project is located on agricultural and grazing land adjacent to and within the high water mark of Lake Cowal (Plates 1-1, 1-2, 1-3). Lake Cowal is an ephemeral lake fed by its major tributary, Bland Creek, and by large but infrequent south-westerly flood flows from the Lachlan River near Jemalong Weir (Figure 1-1). Records since the late 1940s indicate that the Lake is substantially full approximately 7 years out of 10. Throughout its drying cycle the Lake bed supports livestock grazing and, in some areas, cropping.

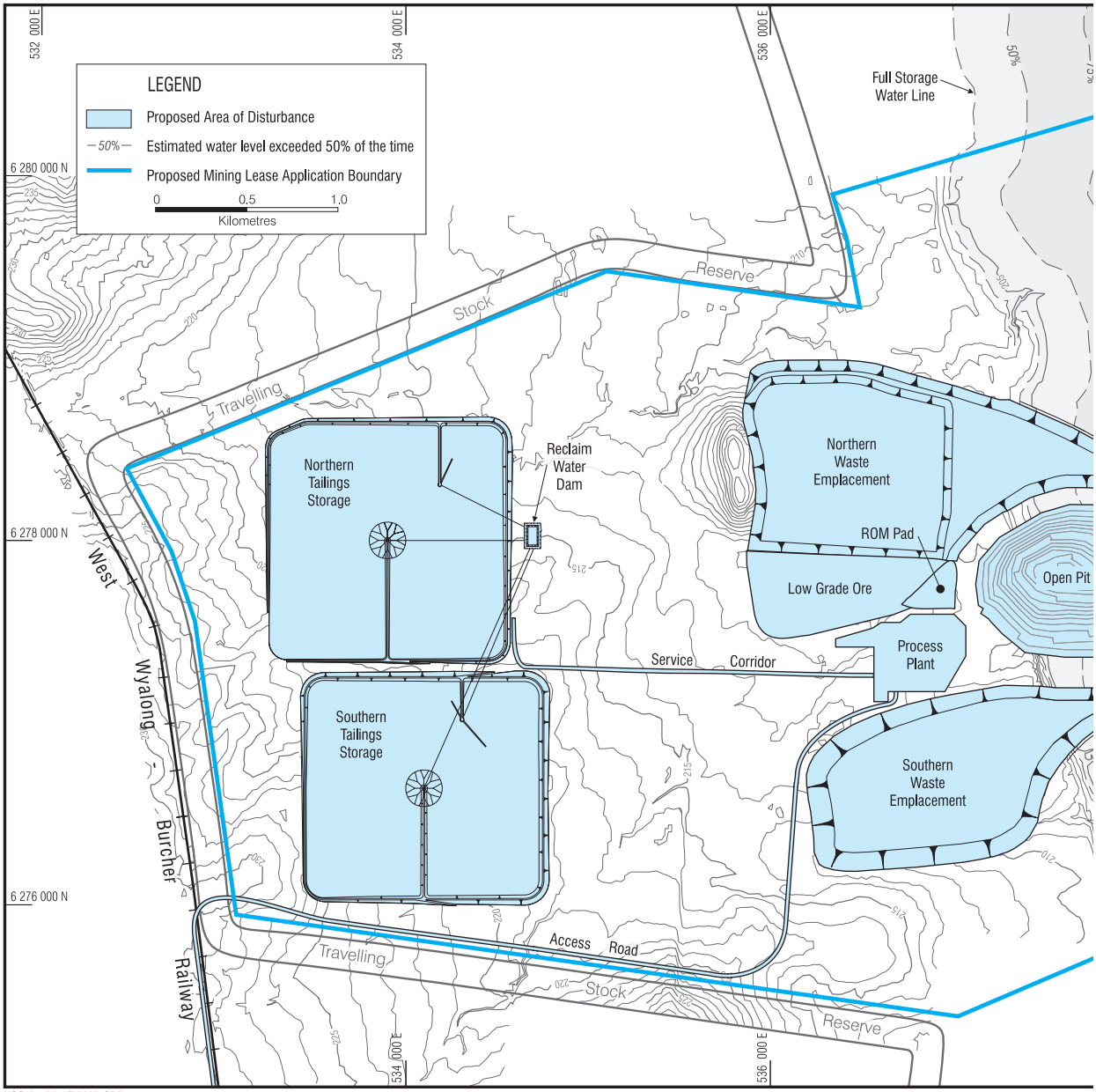
The Lake supports a range of values and uses including:

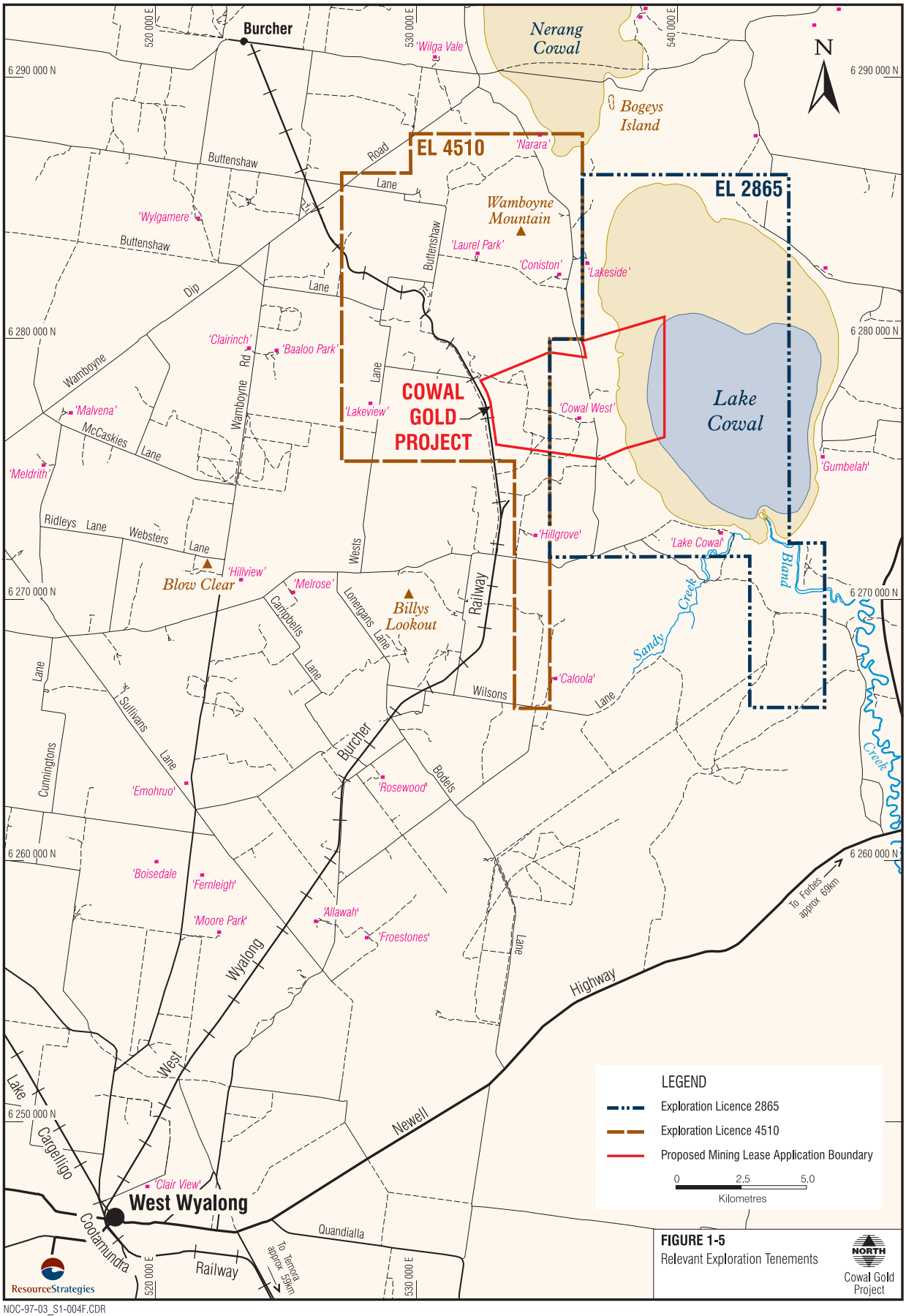
- waterbird breeding and feeding areas;
- recreational and commercial fishing;
- recreation and amenity; and
- stock water, cropping and grazing.

Table 1-2 North Limited 1996/97: Income Distribution

Value Added	1996/97 A$M
Wealth created (excluding interest received)	
Sales and other revenue	1,509
Less cost of materials, investments and services	805
Total wealth created	704
Distribution of wealth created	
To employees:	
Wages and salaries, pension and provident funds, long service leave and directors' fees after deducting personal income tax	162
To government:	
Company income tax, payroll tax and other taxes	
Personal income tax in respect of employees	
Royalties from forestry and mining	259
To providers of equity and loan capital:	
Interest paid less interest received	
Dividends to shareholders	
Portion relating to outside shareholders of subsidiary companies	116
Reinvested in the business:	
Depreciation	
Retained profit	167
Total wealth distributed	704

Source: North (1997 Annual Report)


LEGEND
Proposed Area of Disturbance
50%
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
532 000 E
534 000 E
536 000 E
6 280 000 N
6 278 000 N
6 276 000 N
Full Storage Water Line
Reserve
Stock
Travelling
Northern Tailings Storage
Reclaim Water Dam
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Open Pit
Process Plant
Service
Corridor
Southern Tailings Storage
Southern Waste Emplacement
West
Wyalong
Burcher
Railway
Access Road
Travelling
Stock
Reserve
NOC-97-03_LT-002B.CDR

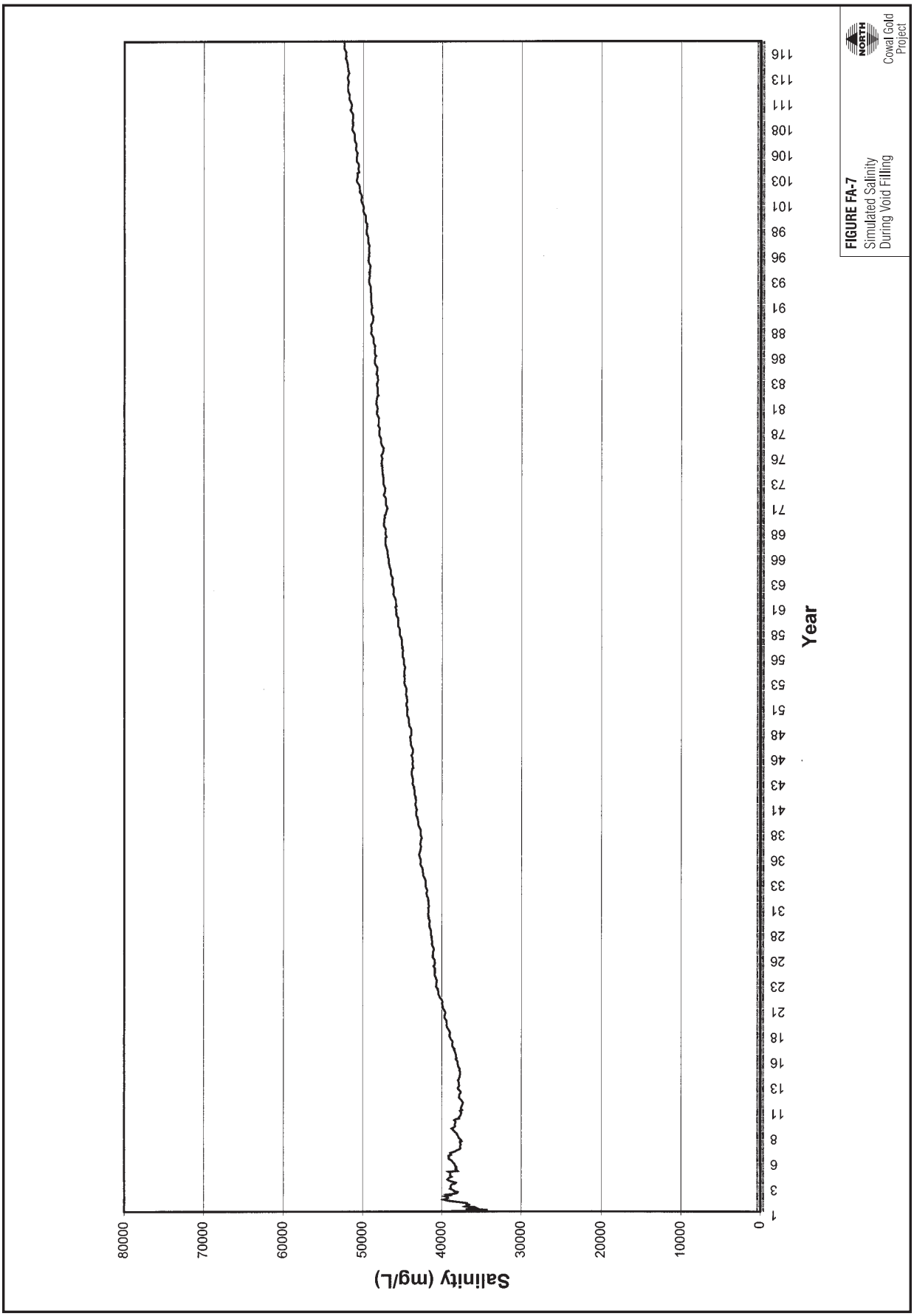


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NOC-97-03_S1-010C.CDR


Date of Photograph: September 1997
NORTH
PLATE 1-2
Oblique Regional View
of the Project and Environs
from the South-East
Cowal Gold
Project
ResourceStrategies
NOC-97-03_S1-012D.CDR


Salinity (mg/L)
80000
70000
60000
50000
40000
30000
20000
10000
0
Year
1
3
6
8
11
13
16
18
21
23
26
28
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NORTH
Cowal Gold Project
FIGURE FA-7
Simulated Salinity
During Void Filling
NOC-97-03_WM-032B.CDR

Lake Cowal is one of the largest natural inland lakes in NSW (approximately 13,800 ha when full [ANCA, 1996]), and at times it supports a great abundance of water birds. It has been described as "*one of the most significant water bird concentration areas in NSW*" by the Australian Heritage Commission (AHC, 1992), and it is primarily for this reason that the Lake was listed by the Commission on the Register of the National Estate on 30 June 1992.

The immediate and regional surrounds of the Lake have historically been substantially cleared of native vegetation, restricting the main bird breeding areas to preserved vegetation areas to the north of the Lake. Elsewhere, trees are sparsely scattered throughout paddocks, with occasional clumps on drainage lines and gilgai soils. Patches of remnant open woodland and open forest are found on the rocky ridges and hills (Plates 1-1, 1-2, 1-3).

1.2 Consultation

1.2.1 Objectives

North has initiated a consultation programme tailored to specific stakeholder groups.

The key stakeholder groups identified by North for on-going consultation are:

- Local landholders;
- Local Government and communities;
- Government agencies;
- Aboriginal associations;
- Temora Shire Council and landholders affected by the electricity transmission line; and
- State and Local environment groups.

The objectives of the consultation programme are:

- To inform all stakeholders as to the status of the Project;
- To receive comment from stakeholders with regard to the mining proposals in a timely manner such that Project design may consider the feedback;
- To endeavour to present sufficient information to stake-holders to permit informed assessment of the proposal; and
- To establish linkages for post-EIS community involvement.

To date the consultation programme has been built around the following key activities:

October 1996
Discussions commenced with DUAP on a new DA and assessment process.

January 1997 to June 1997
Assessment of the compatibility of a mine with Lake Cowal over the long term (Long Term Compatibility Study).

June 1997 to February 1998
Preparation of two new EIS's for the Cowal Gold Project and associated electricity transmission line.

1.2.2 Local Landholders

The landholders around Lake Cowal are represented by the Lake Cowal Landholders Association. This group meets formally about four times a year. North is usually invited to these meetings to respond to any landholder concerns and to provide an update of proceedings.

Of the landholders directly affected by the development, more frequent informal contact is made during visits to the Project area or before field investigations in the area are conducted by specialists.

Feedback on the draft of the EIS was sought from landholders around Lake Cowal. Over the same period government agencies reviewed the draft document.

1.2.3 Local Governments and Communities

Bland Shire and Local Community
The Bland Shire Council have maintained close interest in the Cowal Project. Meetings between the Company and the Shire Council occur on a regular basis.

A community consultative committee in place during the assessment of the previous DA was restructured and formalised for the preparation and assessment of this EIS and DA. Expressions of interest were requested by the Council from community representatives for a new Cowal Gold Mine Community Consultative Committee (advertised over four editions of the West Wyalong Advocate in August 1997).

The purpose of the Committee is to liaise with North on a range of community issues during the assessment process. It is proposed that this committee form the basis for the on-going liaison with the community during the life of the Project.

The Consultative Committee is co-ordinated by the Council and is made up of 17 representatives from local education, business, farming and social organisations.

Temora and Forbes Shire Councils and Landholders
Consultation with Forbes Council and affected landholders concerning the installation and operation of the borefield and pipeline has been undertaken.

Consultation with Temora Council and landholders affected by the electricity transmission line has been undertaken by Great Southern Energy and is addressed in their EIS attached as Appendix D and in Section 1.2.7.

1.2.4 Government Agencies

Consultation with government agencies has occurred on a frequent basis over the past 18 months.

North initiated discussions on a new DA with DUAP in October 1996. At that time the key concern of DUAP was whether a mine at Lake Cowal could be made compatible with the surrounding wetland environment. North expressed a desire to hear all of the concerns of government agencies and a meeting was subsequently held with key agencies in December 1996. This meeting confirmed that the issue of long term compatibility was the main concern of the government agencies.

A pre-assessment process was developed with DUAP to examine the issue of long term compatibility. A working party comprising senior representatives from key government agencies was subsequently formed and met for the first time in February 1997 to oversee North's proposed assessment of the long term compatibility issue. This Committee met in April, May and June 1997 to receive briefings on the study and to provide feedback to North and views on possible development options.

The preliminary findings of the long term compatibility study were presented at the May meeting of the working party along with a discussion paper on development options for the mine. At the final meeting of the working party in June 1997 there was general agreement that the Project could move into a new assessment phase. To facilitate this process North drafted and circulated to the working party for comment a *Statement of Intent*. The final version of this *Statement of Intent* appears towards the front of this EIS volume.

Director-General's Requirements for the preparation of an EIS were requested in July 1997 and a Planning Focus meeting was held at the Project site in August 1997. Represented at this meeting were:

- Department of Urban Affairs and Planning (DUAP);
- Department of Mineral Resources (DMR);
- National Parks and Wildlife Service (NPWS);
- Environment Protection Authority (EPA);
- Department of State and Regional Development (DSRD);
- NSW Agriculture (NSW Ag);
- Department of Land and Water Conservation (DLWC);
- Roads and Traffic Authority (RTA);
- NSW Fisheries;
- Forbes Rural Lands Protection Board;
- Condobolin Rural Lands Protection Board;
- West Wyalong Local Aboriginal Land Council;
- NSW State Aboriginal Land Council;
- Bland Shire Council;
- Forbes Shire Council;
- Lake Cowal Landholders Association;
- North.

Representatives from Environment Australia, Australian Heritage Commission, NSW Premier's Department, Landcare Australia, Jemalong Irrigation Ltd, Murray-Darling Basin Commission, Department of Transport and the Murray-Darling Basin Aboriginal Committee were invited but could not attend. Director-General's Requirements were subsequently issued in September 1997 (Attachment 1).

Since August 1997, DUAP have been kept informed of EIS progress and emerging issues (meetings were held in September, November and December 1997 and January 1998). The NPWS have also been consulted prior to their issuance of requirements for the Species Impact Statement and, in particular, on the identification of threatened and vulnerable species likely to inhabit the area.

During November and December 1997 and January 1998, key Government Agencies were asked to provide feedback on key sections and appendices of the EIS.

1.2.5 Aboriginal Associations

All three land councils (the Local, Regional and State Aboriginal Land Councils) have been involved in consultation with North on the Cowal Project and EIS. Meetings have generally been co-ordinated so that all parties are present at the one time. Meetings have been held in West Wyalong and Sydney in February, May and September, 1997 and January 1998.

The aim of the meetings was to ensure that site surveys were appropriately conducted and to identify issues of concern with the Project. Contact has also been made with the Department of Aboriginal Affairs. Management of identified sites and monitoring measures have also been discussed.

Discussions with Aboriginal groups are on-going.

1.2.6 State and Local Environment Groups

Primarily, the outcome which North is pursuing with environmental groups is to examine what North can bring to the process of improving the conservation status of Lake Cowal.

Groups which were approached to participate in discussions were:

- The Total Environment Centre;
- Safe Australia;
- The National Parks Association of NSW;
- The Australian Conservation Foundation; and
- The Nature Conservation Council of NSW.

Discussions are on-going.

A number of other environmental groups expressed an interest in the Project. In August 1997 North wrote to nine groups to initiate direct consultation, to directly hear concerns about the Project and ensure the groups had as much information about the Project as they needed. These groups were:

- The Wilderness Society (Orange);
- Young Community Landcare Group;
- Royal Australasian Ornithologists Union, now Birds Australia (Melbourne);
- Australian Bird Study Organisation (Sydney);
- Bathurst Conservation Group;
- Central West Environmental Council;
- National Parks Association (Lachlan Valley Branch);
- Lachlan Valley Scarred Tree Project;
- NSW Field Ornithologists Club.

A second letter was sent to the nine groups informing them of progress with the EIS and encouraging consultation.

1.2.7 Electricity Transmission Line

Consultation for the electricity transmission line has focused on landholders affected by the four potential corridors from Temora to the Cowal Gold Project. About 150 landholders were consulted by Great Southern Energy during October 1997. All comments from the landholders and other parties were recorded by Great Southern Energy. During this consultation process a free-call information line was established to receive comments or ask for additional information.

A four page pamphlet was produced outlining the four potential corridors to interested parties. The pamphlet detailed:

- electricity needs of the Cowal Project;
- environmental considerations in identifying the four corridors;
- the steps to be completed for the assessment and approval of the line;
- advice on what to do if a line crosses a property, what the line would look like; and
- options for participating in the assessment process.

A 46 page booklet containing the four corridors plotted on 1:50,000 topographical maps and aerial photographs was also prepared to give an accurate as possible indication of the location of the line and the type of land covered.

The consultation (and broad environmental assessment) process resulted in the identification of a preferred route. Several minor changes were made to the preferred route as a result of further consultation with landholders, in particular around Temora.

In October 1997 Government agencies received a copy of the corridor maps for their comment. The agencies contacted were:

- Department of Urban Affairs and Planning (Sydney and Queanbeyan);
- Bland Shire Council;
- Temora Shire Council;
- Lake Cowal Landowners Association;
- Department of Mineral Resources;
- Department of Land and Water Conservation;
- Department of State and Regional Development;
- Department of Transport;
- Environment Protection Authority;
- NSW State Aboriginal Land Council;
- National Parks and Wildlife Service;
- NSW Agriculture;
- Condobolin Rural Lands Protection Board;
- Young Rural Lands Protection Board;
- Wagga Wagga Rural Lands Protection Board.

Further information on consultation for the electricity transmission line can be found in Appendix D.

1.3 Alternatives Considered

1.3.1 Project Scale

By world standards, the Cowal Gold Project is a medium-sized mine and a low-medium grade orebody. In general terms, the scale of a mining Project (ie. the amount of rock mined and milled each year and the life of the Project) is dictated by the grade of the ore, the costs of treatment, the size of the orebody, and the calculated pay-back period for return on investment.

North have analysed the Project at a range of scales from small (eg. 1 million tonnes of ore milled per annum) to large scale (eg. 10 million tonnes per annum). When the defining criteria outlined above were included in these analyses, an optimum-sized Project emerged. This reveals an orebody of approximately 76 million tonnes of ore. Due to differing mine production schedules from year to year, this requires a mill capable of treating up to 7 million tonnes of ore per annum. From an environmental perspective, there are no advantages to operating a significantly smaller or larger Project than that proposed as only the life of the Project changes and not the overall impacts of the Project.

1.3.2 Mining Methods

Gold-bearing orebodies (as opposed to alluvial deposits) can be mined in three ways: by open pit methods (whereby mining excavates a pit from the surface downwards) or by underground methods (whereby the orebody is accessed via a small surface opening leading to subsurface excavations which follow the orebody), or by a combination of open pit leading to an underground facility.

By virtue of their form and occurrence, underground mining methods are best suited to deeper, narrower, more confined orebodies (eg. where gold is contained in veins or "ore shoots"). Open pit mining methods are suited to orebodies which are located closer to the earth's surface and wherein minerals are more disseminated throughout the rock mass (requiring a bulk mining approach to recover the distributed minerals).

The distribution of the gold mineralisation at the Cowal Gold Project does not lend itself to underground mining as gold ore initially occurs near surface and is not contained in discrete veins of significant width. Open-pit mining is conducted by either front-end loaders/excavators and trucks, or by draglines and trucks. The latter method has been developed for very large scale mines where large quantities of comparatively softer materials (eg. coal) are excavated.

No economic quantities of gold occur west of the Lake's full storage level (ie. the open pit cannot be moved to avoid intrusion into the Lake).

A summary of optional methods is presented in Table 1-3 below.

Open pit mining using front-end loaders/excavators and trucks is therefore the most applicable mining method for the Cowal deposit.

1.3.3 Processing and Tailings Storage

The processing and extraction of gold from the ore results in a finely ground unmineralised residue known as tailings, which is normally disposed of in specifically engineered and constructed storages (tailings dams or storage facilities). Deposited tailings settles from the slurry and dries to a solid mass. When completed, the dams are then covered and revegetated.

Alternatively, a proportion of tailings are sometimes dewatered and returned to the mining area (eg. as backfill in some underground mines or, more rarely, completed open pits).

The absence of underground potential and the mining of the Cowal orebody as a single pit necessitates the construction of surface tailings storage facilities.

Alternatives for mineral processing and the location of tailings storages have been assessed and are presented in Table 1-4.

These options are also addressed in the multi-criteria analysis report presented as Attachment 1 to Appendix K.

As discussed above, the only viable technology for the Project involves the use of cyanide in a strictly controlled "closed" process. Two options are generally used depending on the characteristics and mineralogy of the rock, *viz*: leaching the heaped ore on a prepared pad with cyanide solution (heap leaching), or fine grinding the ore and leaching it with cyanide solution in large steel tanks (carbon in leach or carbon in pulp technology). Because the Cowal ore is not physically and metallurgically amenable to economic heap leaching, the latter method has been adopted.

Based on a thorough review of the mill and tailings storage options, the preferred development scenario includes:

- the introduction of a flotation circuit into the mill to significantly reduce cyanide use and cyanide levels expected at the tailings storage for the processing of primary ore (representing 80 percent of the ore being mined at the Project);
- the introduction of Caro's Acid and a recovery circuit to destroy and recover cyanide;
- movement of the tailings storage 3.5 km from the Lake but within the catchment of the mine pit for any potential events which may result in seepage or spillage from the tailings storage;
- reduction in the number of tailings storage cells from four to two; and
- location of the mill close to the mined ore.

1.3.4 Waste Rock Disposal

Mined material which does not contain economic mineralisation is termed waste rock. This is normally disposed of in constructed emplacements which are revegetated throughout the mine's life.

Development options for waste rock disposal are presented in Table 1-5.

It is proposed that waste emplacements be constructed from the outside in to allow the outer embankments to be profiled, prepared and rehabilitated to maximise the synergy with surrounding landforms and terrestrial ecology as early as possible. The emplacements would be designed to merge with the surrounding landforms at slopes which achieve long term stability.

Potential exists to re-establish a greater and more diverse amount of habitat as a result of the proposed waste emplacement rehabilitation design.

Successful waste rock rehabilitation in the central NSW mining province is demonstrated at the Temora, Northparkes, London-Victoria and Browns Creek mines.

Table 1-3 Optional Mining Methods

Mining Method	Advantages	Disadvantages
Underground mine	• Impact on lake bed avoided.	• Gold occurs within 5 metres of the surface. • The gold ore is low grade and finely disseminated, ie. it is not vein concentrated nor high grade (which are typical requirements for underground development). • Mining costs alone are considerably higher ($20 v $5/tonne ore) which, coupled with the low grade, makes mining costs greater than the value of the material mined.
Staged development	• Initial mine development away from lake bed.	• No economic quantities of gold exist west of the lake high water mark. • A starter pit adjacent to the lake edge would yield insignificant amounts of gold and be uneconomical as a stand alone pit.
Open cut mine	• Economically feasible. • Allows lake protection bund to be established and foreshore to be reinstated at the outset of mine development. • Creates a void able to contain all water falling on mine area. • The most accessible ore is mined first.	• Occupies under 2% of lake bed at the high water mark.

Table 1-4 Processing and Tailings Storage Development Options

Development Option	Advantages	Disadvantages
Use of cyanide to extract gold	• Proven and well understood technology. • Cyanide naturally decays. • Proven cyanide destruction and recovery processes exist.	• Destruction or recovery technology needs to reliably keep cyanide levels safe • Above safe levels cyanide is harmful to wildlife.
Use of bacteria to extract gold	• Reduces the use of cyanide use by pre-concentrating gold through use of bacteria.	• Tests indicate technique is unreliable due to air temperature control requirements.
Use of ammonia thio-sulfate to extract gold	• Avoids the use of cyanide.	• Likely to cause environmental concerns when material reaches tailings storage. • Poor gold recoveries have resulted from test work. • Chemical reactions not understood despite test work.
Use of gravity separation for gold	• Avoids the use of cyanide.	• Uneconomic gold recovery.
Introduction of a "flotation" circuit into the mill	• Reduces the amount of primary ore needing to be cyanide treated by 92% (primary ore itself represents 80% of the ore to be processed at the Project). • Cyanide use reduced from 22 tonnes per day to 8 tonnes per day. • Flotation process needs reclaim water to be less than 5 ppm of cyanide. • Tailings from the flotation process (which contain no cyanide and are 95% of mill feed) are combined with tailings from the cyanide circuit after destruction resulting in low levels of residual cyanide. • Reduced cyanide use reduces operating costs. • Less transport of cyanide to the site.	• Cyanide levels must still be managed. • Considerable addition to the cost of the mill.
No "flotation" circuit	• Reduced cost of building the mill.	• Controlling cyanide levels a critical operating cost for the mill. • Environmental concerns about cyanide levels at tailings storage remain.
Recycling of cyanide	• Recovers 25% of cyanide during the processing of oxide ore before going to tailings storage. • Reduced cyanide use reduces operating costs.	• Additional cost to build the mill. • Reliable cyanide destruction or recovery process still required to make levels in tailings storage safe for wildlife.
Use of "Caro's Acid" to destroy cyanide	• Proven technology. • Levels of 20 ppm consistently achievable. • Process can destroy cyanide to very low levels.	• An additional (but not critical) operating cost. • Destruction below 20 ppm increases costs to the Project.
Use of "Vitrokele" process to recover cyanide	• Recovers cyanide for use in mill.	• Unproven technology.
Moving mill further from the lake	• Perception of risks associated with a mill near the lake avoided.	• Mill becomes more elevated. • Reduced noise and light buffer from waste emplacement. • Additional land required for conveyors. Additional noise, light, dust and visual impacts likely. • At greater than 3 km, mill outside the fail-safe catchment of the mine pit. • Dissection of farmlands. • Increased capital and operating costs associated with large conveyors or truck movements.
Mill located near mine	• Mill infrastructure contained within minimal area. • No transfer across land of large quantities of ore. • Fail safe of mine pit to contain any runoff or accident at mill.	• Mill remains essentially where previously proposed.
Mill located at considerable distance from mine	• Mill would be outside catchment of Lake Cowal.	• Additional farmland required with land dissected by conveyor and roads. • Fail safe of mine pit to contain any runoff or accident at mill absent. • Considerable noise and dust issues to overcome from either truck movements or conveyors. • Additional cost likely to make Project not viable.
No mill – ore trans-ported to Northparkes or other mine	• No use of cyanide at the Cowal site.	• Considerable volume of truck movements or truck/train/truck movements. • Additional environmental strain on other mines. • Option would make Project uneconomic. • Requirement for necessary transport infrastructure at the current proposed mill site. • Imposes further strain and safety consequences on the regional road system. • Tailings storages and process reagent use still required.

Table 1-4 Processing and Tailings Storage Development Options Continued

Development Option	Advantages	Disadvantages
Moving tailings storage 3.5 km from lake	• Reduces likelihood of tailings storage being used by some wetland species. • Seepage, if any, from the tailings storage would take longer to reach lake. • If moved within 3.5 km of lake, runoff from outer embankments still able to be contained within confines of mine. • Spillage contingency provided - any losses contained within mine catchment and pit.	• Tailings storage still likely to be used by birds, especially in dry conditions. • Additional costs of pumping tailings slurry.
Tailings storage not moved	• Catchment area of mine remains minimal.	• Proximity to Lake Cowal.
Tailings storage located considerable (>3.5 km) distance from mine	• Tailings storage likely to be outside Lake Cowal catchment.	• Tailings storages outside the containment system afforded by the current proposal. • Would require a longer overland (or buried) tailings pipeline and service road and pump stations. • Additional farmland required. • No fail safe back-up by mine pit for any seepage, containment of runoff from outer embankments or catastrophic failure. • Slurry pipeline to dissect farmland. • Any failure of longer slurry line likely to produce larger spillage – less easily contained.
Number of tailings cells reduced from four	• Two cells reduces the total water storage (and attractiveness to birds).	• Deposition of tailings and drying cycle requires closer management and control.
Reduced height of tailings storage	• If the tailings storage are moved to within 3.5 km of lake, reduced height would make the tailings storage more in keeping with the surrounding landforms.	• Reducing the height of the tailings storage would increase the storage area required.

Table 1-5 Waste Rock Disposal Options

Disposal Option	Advantages	Disadvantages
Status quo - majority of rock placed north of Project, some south and on lake protection bund	• Noise and light shelter provided to lake and residents. • Keeps land required to a minimum. • Height of landforms in line with surrounding country.	• Essentially as previously proposed. • Proximity to Lake Cowal.
Emplacement footprint made smaller	• Less land required for emplacements. • Reduced haulage costs.	• Landform rises above surrounding landforms.
Emplacement footprint made larger	• Lower structure.	• More land required for emplacements. • Increased haulage costs.
Locate emplacements away from the lake	• No major emplacement near lake.	• Protection of external environment from mine noise, dust and light largely absent. • Haulage costs likely to make Project not viable. • Additional land required away from lake, spreading mine impact.
Removal of lake protection bund and perimeter waste emplacement post-mining	• Final void filled sooner than currently anticipated. • Reduces post-mining Lake intrusion.	• Lake water quality compromised by highly saline void water. • Void still isolated when Lake levels are low. • Increased project costs due to double handling of material.
In-pit disposal of waste rock	• No land required for emplacements. • No major emplacement near Lake.	• Would render the Project totally uneconomic. • Bulking (swell) factor created by blasting and moving rock would mean only 75% of the total waste rock volume would fit back in the pit.

1.3.5 Water Supply

The milling of gold ores such as Cowal requires water to convey the finely crushed rock throughout the extraction process, to act as a medium for the chemicals used to liberate the gold from its host mineralisation, and to convey the residue from milling (ie. tailings) to the tailings storage facilities.

Water is also required for activities such as dust suppression on roads and crushing facilities, equipment washdown areas, and workforce showers and washrooms.

Sometimes, the safe and stable mining of an orebody requires advance dewatering of the rock (sufficient in some cases to provide a significant proportion of Project water demand). Advance dewatering of saline water associated

with the Cowal orebody would be required, but it would not generate sufficient water for all processing needs for the life of the Project. The immediate area's groundwater resource is inadequate to make up the shortfall, and the surrounding landform, drainages and water use characteristics and laws do not permit the extraction of surface waters for the Project. Consequently, the Project has identified a groundwater source some 20 km to the north-northeast of the orebody, in the Bland Creek palaeochannel (Plate 1-1).

The Project's water supply would comprise:

- secure storage and use of pit dewatering waters (ie. there would be no discharge of saline waters pumped ahead of mining);
- maximum recycling of water used in ore processing and tailings disposal;
- total reuse of stormwater held in runoff dams located in the Project's disturbance area (the internal catchment containment system);
- a groundwater supply scheme for raw water make-up consisting of up to four unobtrusive bores located on road reserves to the east of the Project area, a holding tank, and a buried pipeline laid across the bed of Lake Cowal to the mill site.

Alternative pipeline routes have been assessed, and include a route around the Lake (as opposed to across it). A summary of development options for Project water supply is presented in Table 1-6.

On balance, it is concluded that a pipeline buried or laid across the Lake placed under the terms of an appropriate Environmental Management Plan can be justified and would result in less disturbance to creeks and landholders than the longer routes.

1.3.6 Power Supply

A feasibility study for Project power supply options based on economic, environmental and technical factors has been undertaken by North.

As a consequence of the options study, on-site power generation utilising gas or diesel could not be justified on economic grounds and the selected power supply option is an electricity transmission line from Temora (Figure 1-2). Appendix D presents the EIS for the electricity transmission line proposed by Great Southern Energy (GSE) and provides further information on power generation and electricity transmission line route options.

1.4 Legislative Requirements

Summarised below are the key legislative requirements for the Cowal Gold Project. Legislative requirements for the electricity transmission line are outlined in Appendix D.

1.4.1 Cowal Gold Project – Statutory Requirements, Local/Regional Environmental Plans and State Environmental Planning Policies

The NSW and Commonwealth legislation that could potentially be relevant to the development and operation of the Project has been detailed by North's legal advisors and is outlined in Table 1-7.

Environmental Assessment Approval Process

The proposed MLA area is located within the local government area of Bland Shire Council. The electricity transmission line traverses portions of both the Bland and Temora Shires. The borefield itself is located in Forbes Shire with the pipeline traversing the Forbes and Bland Shires. The public road upgrade works would take place entirely within Bland Shire. The Development Application for the Project has been lodged with the Minister for Urban Affairs and Planning under Part 4 of the EP&A Act, and SEPP 34.

The Development Application seeks consent for the construction and operation of the mine and related mineral processing facilities, relocated travelling stock reserve and road, borefield and pipeline (Part 4 Assessment under the EP&A Act).

The environmental assessment approval process for the construction and operation of the electricity transmission line from Temora to the Project site under Part 5 of the EP&A Act is detailed separately in Appendix D.

The approval of the road upgrade works would be considered separately by Bland Shire Council under Part 5 of the EP&A Act. The environmental impacts of these works are detailed in Appendix O.

Under SEPP 34 the consent authority for North's Development Application for the Project is the Minister for Urban Affairs and Planning. The nominated determining authority for the electricity transmission line is Great Southern Energy although approval is also required from the Minister for Urban Affairs and Planning under Division 4 of Part 5 of the EP&A Act.

Table 1-6 Water Supply Development Options

Development Option	Advantages	Disadvantages
Water supplied from Palaeochannel via main across the lake	• Minimal impact on landowners.	• Pipeline would need to be buried.
Water supplied from Palaeochannel via alternative route	• Avoids lake.	• Indirect route. Increased cost and burden on landowners.
Saline water used from east of lake	• Reduction in saline water in region. • Saline water able to be used by mill.	• Temporary and only partial solution to a broad concern. • Need to have water transferred to North pipeline.

It is possible that the Minister for Urban Affairs and Planning will direct that a Commission of Inquiry be held under Section 119 of the EP&A Act before the Minister determines the proposals lodged for the Project.

Local Environmental Plans

A. Mine and Borefield Water Pipeline

Bland Shire Council

The *Environmental Planning and Assessment Act, 1979* (EP&A Act) provides for planning instruments based on the zoning of land according to its suitability for given uses. The most common planning instrument is the local environmental plan (LEP) prepared by Councils for part or all of a local government area. The portion of the Project to be undertaken in Bland Shire includes the mine, site facilities, the mine access road and sections of the water pipeline.

The environmental planning instrument applicable to the Project area within Bland Shire is the Bland LEP (1993).

Table 1-7 Relevant Project Permits – Cowal Gold Project

Issue	Statute	Government Agency	Approval/Commentary
Mine Development	*Environmental Planning and Assessment Act 1979*	Minister for Urban Affairs and Planning	Development consent under the *Environmental Planning and Assessment Act* will be required for both the mine itself and associated infrastructure (electricity transmission line, water pipeline, access road). Under SEPP 34, the Minister for Urban Affairs and Planning is the consent authority. In addition: • **SEPP 33** – a person who proposes to make a Development Application to carry out development for the purposes of a potentially hazardous industry must prepare a preliminary hazardous analysis (in accordance with DUAP circulars); and • **Section 77(3) of the *Environmental Planning and Assessment Act*** – if a Development Application is in respect of a critical habitat or is likely to significantly affect threatened species, populations or ecological communities, or their habitats, the application must be accompanied by a species impact statement prepared in accordance with Division 2 of Part 6 of the *Threatened Species Conservation Act 1995*.
Mining	*Mining Act 1992*	Minister for Mineral Resources	Pursuant to the provisions of the *Mining Act 1992*, North will apply for the grant of a mining lease over the Project area. A mining lease authorises the mining of the minerals specified in the lease. It also allows the holder to carry out any primary treatment operations necessary to separate minerals from the ore. The Minister for Mineral Resources must not grant a mining lease over the Project area unless an appropriate development consent is in force with respect to the land. The mining lease may contain conditions relating to the operation of the mine and the prevention of harm to the environment.
Native Title	*Native Title Act 1993* (Cth)	Department of Mineral Resources	Prior to the grant of any mining lease under the *Mining Act 1992*, the grant must be assessed pursuant to the future act provisions of the *Native Title Act 1993* (an alternative to this procedure is for North to initiate the native title assessment process itself, by lodging an application for a non-claimant determination).
Aboriginal Heritage	*National Parks and Wildlife Act 1974* *Aboriginal Land Rights Act 1983 (NSW)*	Department of Land and Water Conservation	A claim under the *Aboriginal Land Rights Act 1983* (NSW) has been lodged over an area including the proposed Project area. In the event that the Department of Land and Water Conservation accepts the claim, Section 45 of the Act will apply. This section provides that no person shall carry on mining operations on the land the subject of the successful claim without the consent of the Aboriginal Land Council in which the land will vest. This restriction does not apply where the mining operations are being conducted to extract gold, silver, coal or petroleum. The *National Parks and Wildlife Act 1974* (NPW Act) also makes provision for the protection of "Aboriginal areas" and "archaeological areas". Such protection will only apply to a given area if that area is the subject of a declaration by the Governor (for an Aboriginal area) or the Minister (for an archaeological area). Section 90 of the NPW Act also requires consent from the Director-General of the NPWS to destroy, damage or deface an Aboriginal relic.
Mine Operations – Environmental	*Clean Air Act 1961, Clean Waters Act 1970, Noise Control Act 1975, Pollution Control Act 1970*	Environmental Protection Authority	The proposed mine will be "scheduled premises" for the purposes of the *Clean Air Act 1961* and accordingly, will be required to be licensed under the *Pollution Control Act 1970*. Under the *Clean Waters Act 1970*, any discharge of waters must also be authorised by a pollution control licence. The proposed mine will be scheduled premises for the purposes of the *Noise Control Act 1975*, however scheduled premises are required to be licensed ons not located within a proclaimed area and therefore does not require a pollution control licence as a result of the provisions of the *Noise Control Act*.

Table 1-7 Relevant Project Permits – Cowal Gold Project Continued

Issue	Statute	Government Agency	Approval/Commentary
Mine Operations – Environmental Continued			The *Clean Air Act*, the *Clean Waters Act* and the *Noise Control Act* also require pollution control approvals to be obtained under the *Pollution Control Act* for: • the construction of the mine; • the installation, replacement or alteration of plant, changes in methods of operation or any alteration of plant, changes in methods of operation or any alteration of the physical features of scheduled premises which are likely to cause or increase the emission of air impurities; • the installation, construction of certain apparatus, equipment or works relating to the discharge and treatment of any pollutants prior to their discharge of waters; • the installation, replacement or alteration of plant, changes in methods of operation or any alteration of plant, changes in methods of operation or any alteration of the physical features of scheduled premises which are likely to cause or increase the emission of noise.
Mine Operations	*Mines Inspection Act 1901*, *Mines Inspection General Rule 1994*	Department of Mineral Resources	The *Mines Inspection Act 1901* makes provision for the management and inspection of mines. This statute requires a mine manager holding a certificate of competency to be appointed to exercise daily personal supervision of and be responsible for the control, management and direction of the mine. Certificates of competency are also required for engine-drivers. In addition, the *Mines Inspection General Rule 1994* imposes a number of specific requirements: • A person must not manufacture explosives at a mine unless written notice of the proposed manufacture has been given to an inspection (rule 25(1)). If the explosive is to be manufactured on the surface of the mine a licence must be obtained under the *Dangerous Goods Act* (rule 25(2)). • If explosives at a mine are stored in a surface magazine, the magazine must be licensed under the *Dangerous Goods Act* (rule 26(1)). • A person must not be appointed as a shotfirer at a mine unless the person is the holder of a shotfirer's certificate issued by the Minister, or a shotfirer's permit issued by an inspector (rule 27). • The manager of a mine must give adequate notice to an inspector of any proposal to construct a major building or structure at the mine so as to allow the inspector time to examine the plans and specifications for the building or structure before construction commences (rule 44). • Licence is required for the construction and operation of the tailings storages from the Dam Safety Committee (although not a statutory requirement, it is required pursuant to Dam Safety Commitee guidelines).
Mine Safety	*Dangerous Goods Act 1975*	Environment Protection Authority Work Cover	The *Dangerous Goods Act 1975* requires that licences be held for the storage, transport, and use of dangerous goods and for the manufacture and storage of explosives, as prescribed by the *Dangerous Goods Regulations 1978*.
Water Resources and Management	*Water Act 1912*	Water Administration Ministerial Corporation (Department of Land and Water Conservation)	Licences will be required from the Water Administration Ministerial Corporation for the following activities: • under Part 2 of the *Water Act*, for the construction and use of that part of the water supply pipeline which will be buried in Lake Cowal; • under Part 5 of the *Water Act*, for the borefield; and • under Part 2 of the *Water Act*, for the construction of the cofferdam and the pit protection bund.
	Rivers and Foreshores Improvement Act 1948	Water Administration Ministerial Corporation (Department of Land and Water Conservation)	A permit is required under Part 3A of the *Rivers and Foreshores Improvement Act 1948*, for the installation of the water supply pipeline across the bed of Lake Cowal. However, Part 3A does not apply in respect of the exercise of any rights lawfully exercisable "under any lease, licence, permit or other right in force under any Act relating to mining", that is, within a mining lease area.
	Pipelines Act 1967	Minister for Energy	Although pipelines are required to be licensed under the *Pipelines Act 1967*, the current practice of the Minister for Energy is to grant such licences only in the case of pipelines for the transportation of hydrocarbon derivatives.
Flora and Fauna	*Threatened Species Conservation Act 1995*	National Parks and Wildlife Service	The *Threatened Species Conservation Act 1995* governs the content of the species impact statement which must accompany a Development Application made in respect of development which is likely to significantly affect threatened species, populations or ecological communities.

Table 1-7 Relevant Project Permits – Cowal Gold Project Continued

Issue	Statute	Government Agency	Approval/Commentary
Flora and Fauna Continued	*Fisheries Management Act 1994*	Minister for Fisheries	Under the *Fisheries Management Act*, a person is prohibited from carrying out dredging or reclamation work in any waters except under the authority of a permit issued by the Minister (Division 3 of Part 7).
	National Trust of Australia (New South Wales) Act 1990	National Trust of Australia	In 1987, Lake Cowal was classified as a "Landscape Conservation Area", by the National Trust. However the National Trust may exercise its powers under the *National Trust of Australia (New South Wales) Act 1990* only if the land is vested in the Trust.
	Australian Heritage Commission Act 1975 (Cth)	Australian Heritage Commission	Lake Cowal was listed on the Register of the National Estate in 1992, pursuant to the *Australian Heritage Commission Act 1975*. The reason for the listing was stated to be that the Lake is "one of the most significant waterbird concentration areas in New South Wales". The listing constrains the Commonwealth Government from actions that might adversely affect the listed area, but does not place any legal constraints on the actions of owners of private property or on State or Local Governments.
Heritage	*Heritage Act 1977*	Heritage Council	A person must not disturb or excavate any land for the purpose of exposing or moving a relic without an excavation permit granted by the Heritage Council. "Relic" is defined to mean any deposit, object or material evidence which relates to the settlement of NSW, not being aboriginal settlement, and which is 50 or more years old. Approval is also required from the Heritage Council if the construction of the mine and/or related infrastructure will result in the damage, destruction or disturbance of a building, work relic or place to which a conservation order applies. If a conservation order exists, Heritage Council approval must be obtained prior to the grant of development consent.
Transport Requirements	*Roads Act 1993*	Bland Shire Council	Access to the site will be from the Newell Highway at West Wyalong along established roads to the West Wyalong-Burcher railway. From the Lake Cowal Station silo, a new road will follow the existing reserve along the west of the railway and then north and east to the site, following an existing road reserve. Council approval for the public road upgrade will be required pursuant to Section 138 of the *Roads Act*, 1993.
	Environmental Planning and Assessment Act, 1979		Bland Shire Council cannot approve the public road upgrade until it has complied with the procedure contained in Part 5 of the *Environmental Planning and Assessment Act*, 1979.
Building Requirements	*Local Government Act 1993*	Bland Shire Council	The erection of buildings at the mine site will require building approval from Bland Council. "Building" is defined broadly under the *Local Government Act 1993* to include any structure.
Sewage Treatment and Refuse Disposal	*Local Government Act 1993*	Bland Shire Council Environment Protection Authority	North proposes to provide a package sewage treatment plant for the site. Treated effluent will be pumped to tailings storage. Plans developed during the detailed design stage will be submitted for Council and/or EPA approval. Waste oils and solvents will be recycled. General refuse will be taken to the West Wyalong tip. Non-putrescible, non-recyclable material (including mining waste rock) will be buried in the main waste emplacement.
Relocation of Travelling Stock Reserve	*Crown Lands Act, 1989* *Environmental Planning and Assessment Act, 1979*	Department of Land and Water Conservation	In order to revoke the existing travelling stock reserve, the Minister is required to make a notification in the Government Gazette. The use of the land selected for the relocated travelling stock reserve is permissible without consent from Bland Shire Council if used for an "agricultural" purpose. This land will, however, be required to be reserved under Section 87 of the *Crown Lands Act, 1989* for the purpose of a travelling stock reserve.

The Bland LEP (1993) zones the land required for the Project as "1(a) – General Rural Zone". Under this LEP, development for mining purposes is permissible in this zone with development consent.

Lake Cowal is shown on Bland LEP map no. 2 as a "wetland" and "conservation area". The map also designates:

- an area adjacent to the Lake as "nature reserve" (corresponds to the game reserve on Figure 1.3, which is Game Reserve No. 509); and
- some small portions of land to the north of the proposed mine site as "environmentally sensitive land". This designation attracts the operation of the clause 24, which relevantly states:

"*24(1) In this clause, "clearing" means the destruction or removal of trees and other vegetation, but does not include the clearing of re-growth from land previously cleared for agricultural use, or the cutting down of individual trees for farm*

purposes, such as fencing or firewood, which may be carried out without the consent of the Council.

(2) A person shall not clear land within a conservation area or clear environmentally sensitive land without the consent of the Council.

(3) A person shall not, except with the consent of the Council:
(a) erect a building within a conservation area; or
(b) clear, drain or fill a wetland or construct a levee on a wetland within a conservation area.

(4) In determining an application for consent required by subclause (2) or (3), the Council shall make an assessment of:
(a) the risk of soil erosion or other land degradation;
(b) the loss of important vegetation systems and natural wildlife habitats; and
(c) the extent to which the carrying out of the proposed development in accordance with the consent would affect the historic, scientific, cultural, social, archaeological, natural or aesthetic significance of the conservation area,

and may attach conditions to minimise any adverse effects."

Clause 10(1)(d) of the Bland LEP is also relevant. This clause provides:

"*10(1) The Council shall not consent to an application to carry out development on land within Zone No. 1(a) ... unless it has taken into consideration, if relevant, the effect of the carrying out of that development on ...*

(d) the protection of areas of significance for nature conservation or of high scenic or recreational value, and places and buildings of archaeological or heritage significance including Aboriginal relics and places;".

The table to clause 9 of the LEP lists objectives of the 1(a) General Rural Zone to include the protecting, enhancing and conserving of "water resources for use in the public interest", "areas of significance for nature conservation" and "places of heritage significance, including Aboriginal relics and places". The combined operation of the objectives clause for the 1(a) zone and clause 9(3) of the LEP is negated by SEPP 45 ("Permissibility of Mining"). Clause 5(2) of SEPP 45 states:

"(*2) ... if mining is permissible on land with development consent in accordance with an environmental planning instrument if the consent authority is satisfied as to certain matters specified in the instrument, mining is permissible on that land with development consent without the consent authority having to be satisfied as to those specified matters.*"

Forbes Shire Council

The environmental planning instrument applicable to the Project area within Forbes Shire (proposed borefield and water pipeline) is the Forbes LEP (1986).

The Forbes LEP (1986) zones the land required for the borefield and water pipeline as "1(a) – General Rural". The LEP permits the construction and use of this infrastructure with development consent.

The Forbes LEP includes a clause 9 which is identical to clause 9 of the Bland LEP (1993) which is discussed above.

B. Electricity Transmission Line

The route of the proposed Temora to Cowal electricity transmission line traverses land located in Bland and Temora Shires. The approval process for this aspect of the Project is described in Appendix D.

C. Road Upgrade

The upgrading works required to be carried out on the public road to be used as the access road to the MLA would be entirely located within Bland Shire. North is the proponent of these works.

The upgrade works are proposed within existing road reserves, vested in Bland Council.

The Bland LEP adopts clause 35(a) of the Environmental Planning and Assessment Model Provisions for the works within the bounds of Council's road reserves. This clause provides:

"*Nothing in the local environmental plan shall be construed as restricting or prohibiting or enabling the consent authority to restrict or prohibit:*

(a) the carrying out of development of any description specified in Schedule 1."

Clause 8 of Schedule 1 lists the following types of development:

"*The carrying out of any development required in connection with the construction, reconstruction, improvement, maintenance or repair of any road, except the widening, realignment or relocation of such road.*"

The upgrade works proposed within road reserves do not comprise "widening, realignment or relocation" of a road, as the word "road", as used in this clause, refers to the entire road reserve, and not simply the asphalt surface. This interpretation is consistent with the use of "road" in the Roads Act, 1993.

Accordingly, as no widening of a road reserve is contemplated in conjunction with the upgrade works, the works would be exempt from the requirement under the Bland LEP to obtain development consent. Despite this, the environmental impacts of the works are required to be assessed under Part 5 of the EP&A Act, as such works constitute an "activity" (as defined in section 110). In the present case, Council is the determining authority, as Council approval is required for the road upgrade works,

pursuant to section 138 of the Roads Act. As a consequence, in deciding whether or not to grant the approval, section 112 requires Council to consider the environmental impacts of the road upgrade works.

The environmental impacts of all of the road upgrade works are considered in Appendix O. The conclusion in that document is that these works would not significantly affect the environment.

Regional Environmental Plans
Regional environmental plans relevant to the Project area include the Jemalong Land and Water Management Plan, Lake Cowal Management Plan and the Mid Lachlan Pilot Project for Regional Vegetation Management Plans. All plans are currently in preparation, with finalisation expected by June 1998.

The integration of Project environmental management plans with regional environmental management plans is recognised as important.

Where appropriate, management recommendations resulting from the completed plans would be incorporated within mine operating requirements. Brief descriptions of the plans are presented below.

Jemalong Land and Water Management Plan
This plan has been formulated to facilitate management strategies to address the major concern of salinisation done to rising groundwater. Formulation of the plan has been underway since 1991.

Lake Cowal Management Plan
A component of the Jemalong Plains Land and Water Management Plan, this plan's primary objectives are soil structure and vegetation cover conservation and/or enhancement. Management considerations, therefore, include feral pest control (eg. carp), agricultural practices and revegetation strategies.

Mid Lachlan Pilot Project for Regional Vegetation Management Plans
This is a pilot for Regional Vegetation Management Plans being prepared in support of the Native Vegetation Conservation Act 1997. Pilot project objectives include the identification of priorities for the restoration of native vegetation habitat as well as identifying native vegetation areas which would/would not require consent to clear.

State Environmental Planning Policies (SEPP)
SEPP 11 – Traffic Generating Developments. SEPP 11 requires the consent authority to refer a copy of the Development Application for the Project to the Roads and Traffic Authority (RTA).

SEPP 33 – Hazardous and Offensive Development.
SEPP 33 requires the consent authority, in considering a Development Application for a potentially hazardous or a potentially offensive industry, to take into account current guidelines or circulars published by the Department of Urban Affairs and Planning, consultations with public authorities, any preliminary hazard analysis, any feasible alternatives to the carrying out of the development and the reasons for choosing the development the subject of the application and any likely future use of the land surrounding the development. For potentially hazardous development, SEPP 33 requires a preliminary hazard analysis to be prepared and submitted with the Development Application.

SEPP 34 – Major Employment Generating Industrial Development. The effect of the SEPP 34 is to make the Minister for Urban Affairs and Planning the consent authority for the Project.

SEPP 44 – Koala Habitat Protection
This policy aims to "*encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas, to ensure permanent free-living populations over their present range and to reverse the current trend of population decline*."

The proposed Cowal Gold Project mining area is located within the Bland Shire Local Government Area (LGA) which is not listed in Schedule 1 of SEPP 44 and is therefore exempt from the policy. The proposed water supply borefield and pipeline (greater majority thereof) is located approximately 20 km north-northeast of the Project area in the Forbes Shire LGA, which is listed in Schedule 1 of SEPP 44. Accordingly, this determination would focus on the proposed borefield development in the Forbes LGA.

The proposed borefield and water supply pipeline easement covers an area of approximately 10 ha.

Based on a flora report of the proposed borefield and pipeline route (Anne Clements & Associates, 1996) and examination of aerial photography (1:50,000, 1997), the upper or lower strata of the tree component, although sparse, is characterised by River Red Gum (*Eucalyptus camaldulensis*) and Poplar or Bimble Box (*E. populnea*). Both these species are listed in Schedule 2 of SEPP 44 and based on that, the area is potential Koala habitat.

In accordance with SEPP 44 core Koala habitat is defined as "*an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (that is, females with young) and recent sightings of and historical records of a population*".

Examination of NPWS records (Ayers *et al.,* 1996), CSIRO database records and the results of various fauna surveys conducted in the Lake Cowal region (eg. Gunninah Consultants, 1996; Vestjens, 1977) indicates a relative paucity of recent Koala records in the region. This combined with the absence of substantive quantities of preferred Koala feed trees, the occurrence of large tracts of cleared land and the presence of dogs, suggests that the area does not contain core Koala habitat.

SEPP 45 – Permissibility of Mining. The effect of the application of SEPP 45 to the Project is discussed under the heading "Local Environmental Plans" above.

1.4.2 Director-General's Requirements for the EIS

The Director-General of the Department of Urban Affairs and Planning has issued EIS Director-General's Requirements for both the North proposal (Cowal Gold Project) (Attachment 1) and the electricity transmission line proposed by Great Southern Energy (Appendix D). The Director-General's requirements for the North proposal were compiled subsequent to the stakeholder Planning Focus Meeting held on site in August 1997. Additionally, the Minister for Urban Affairs and Planning has determined that SEPP 34 (*Major Employment Generating Industrial Development*) applies to the Project. The EIS has been prepared in accordance with the above Director-General's requirements.

1.5 Ecologically Sustainable Development

1.5.1 Concepts

ESD is defined in the National Strategy for ESD (NSESD) (Commonwealth of Australia, 1992) as:

"*using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased.*" In layman's terms, ESD is development focused on satisfying the needs of Australians today, while conserving our ecosystems for future generations. To achieve this it is imperative that we develop ways of utilising environmental resources that form the basis of our economy in a way that maintains and, where possible, improves their range, variety and quality. It is also important that those resources be utilised to develop industry and generate employment.

Environmental Planning and Assessment Regulations made pursuant to the NSW *Environmental Planning and Assessment Act* (Schedule 2, Clause 5) detail matters which an EIS must consider with regard to ESD. These are:

(a) The precautionary principle – namely, that if there are threats of serious or irreversible environmental damage, then a lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;

(b) Inter-generational equity – namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;

(c) Conservation of biological diversity and ecological integrity; and

(d) Improved valuation and pricing of environmental resources.

The NSESD identifies two key features which distinguish an ecologically sustainable approach to development. These are:

- the need to consider, in an integrated way, the wider economic, social and environmental implications of our decisions and actions for Australia, the international community and the biosphere; and
- the need to take a long-term rather than short-term view when taking those decisions and actions.

By following an ecologically sustainable path of development, it is anticipated that there would be a reduction in the occurrence of serious environmental impacts arising from economic activity and hence fulfilment of the goals established in the NSESD.

1.5.2 ESD for the Cowal Gold Project

North's role in supporting the concept of ESD is primarily focused on ensuring that their decisions and actions regarding development of a mine are consistent with the principles of ESD. This is achieved through:

- enhanced decision-making based on full risk assessment;
- achieving a high standard of environmental and occupational health and safety performance;
- strengthening the geoscientific and biological information base;
- optimising the economic return to the community from mining; and
- improving consultative mechanisms.

In addition to this, North has defined the following four key objectives for the implementation of successful ESD practices:

- Adopt innovative environmental practices throughout the mining operation that consider aspects such as alternate landuse and biological diversity;
- Provide community benefits through mineral resource developments;
- Facilitate community consultation and information dissemination through an "open door" approach; and
- Maintain a high standard of occupational health and safety.

The principles of ESD have been applied to all aspects of the Project and incorporated in Project planning. Throughout the EIS document, these principles have been incorporated in the overall development description and documented in relevant sections.

The application of the ESD principles to the development of the Project are addressed below.

1.5.3 Precautionary Principle

1. The application of the precautionary principle to the mining proposal is described as:
   - adoption by the company of external and internal codes of practice, guidelines, standards and principles for exploration, environmental management, rehabilitation and community relations activities;
   - comprehensive study, planning, evaluation, and development of Project proposals;
   - extensive consultation with government, landholders and community groups;

- objective and comprehensive environmental impact and risk assessment of Projects;
- comprehensive environmental management systems;
- research and development programmes; and
- industry environmental review, education and knowledge-sharing networks.

All of the above aspects have been incorporated into the Project through the EIS process. The EIS has focussed on identifying all risks to the Lake Cowal environment even over the very long term.

2. Substantial effort has been made to identify all potential effects (both short and long term) thus minimising the risk of externalities arising as a result of the Project. Fauna issues have been thoroughly addressed within the EIS and management of mine wastes would ensure that environmental risks are minimal or negligible. Hydrological and long term compatibility issues have been similarly addressed.
3. There is significant potential for ESD in terms of North's commitment to implement innovative technologies which would further enhance waste rehabilitation, and improve the environmental efficiency of the mining operation. In recognition of precautionary principles, only proven Best Management Practice techniques have been incorporated into Project design and rehabilitation practices.
4. It is also anticipated that the development of DUAP conditions of consent for the Project would provide further assurance that ESD principles are consistently met.
5. The rehabilitation strategy designed for the Project utilises proven and innovative technology and is based on comprehensive hydrological, botanical and fauna studies.
6. Both proven and innovative technology has also been employed in the water management system planned for implementation at the commencement of the Project and for retention at the close of operation.
7. A monitoring programme would accompany the rehabilitation strategy to ensure no unforeseen deleterious affects occur on land and water systems.

1.5.4 Social Equity (Inter- and Intra-Generational) Issues

The proposed Cowal Gold Project meets the principles of inter- and intra-generational equity by:

1. Implementing water and waste management strategies which would mitigate the risks of environmental degradation to negligible levels, thus not foreclosing on options for future generations with regard to the use of natural resources.
2. Implementing measures which would ensure that natural resource values including biodiversity and ecological integrity are not undermined.
3. Undertaking that the development area would not be relinquished prior to the successful implementation of the rehabilitation plan; the details of which would be outlined in a Final Rehabilitation Report submitted for Department of Mineral Resources' approval. The nature of the disturbances are such that complete rehabilitation is possible, ie. there is no reliance on future technological innovation to complete rehabilitation of North lands.
4. Responding to concerns expressed by the community during public consultation.
5. Undertaking investigation and assessment of heritage values represented within the DA area; during which consultation with the West Wyalong Local Aboriginal Land Council was carried out.
6. Stimulating local and regional economies.
7. Providing valuable export earnings.
8. Rehabilitating approximately 940 ha of land during the mine life. In recognition of the four guiding principles of ESD, only proven technology in rehabilitation techniques have been adopted to enhance wildlife diversity (via endemic community revegetation plans, and foreshore reformation) and ecological integrity. Rehabilitated surfaces have the potential to be a valuable natural resource. The final void water resource may have the potential to provide an additional natural resource and habitat for some avifauna.
9. Reafforestation areas would represent significant environmental gains in terms of wildlife habitat values, securing land and soil structures, and an increase in net carbon sequestration capacity. The construction of suitable terrestrial and perhaps aquatic habitats in addition to those already available would provide further diversification.
10. The site would potentially offer valuable research examples of mine rehabilitation and habitat restoration/enhancement.

1.5.5 Biodiversity and Ecological Integrity Issues and Greenhouse Emissions

North Limited is a voluntary signatory to the Australian Government's Greenhouse Challenge programme aimed at reducing greenhouse gas emissions per unit of production.

By the end of 2001, Projects planned by North Ltd would save about 94,000 tonnes of CO_2 with tree-planting programmes expected to sequester an additional 32,600 million tonnes of CO_2. During the next four years North's total emissions would increase as a result of increased production, although emissions would be 17% below "no action" levels. Energy efficiency would significantly improve.

The proposed Lake Cowal development meets biodiversity, ecological integrity and greenhouse emissions by:

1. Rehabilitation efforts at the Cowal Project site (the gain of about 600 ha of woodland) would result in a net

increase in CO_2 absorption capacity (in the order of 237,000 tonnes[2]). The amount of CO_2 produced by the operation would represent approximately 0.018% of the 1996 national greenhouse gas emission rate (currently estimated at 600 million tonnes).

The net gain of vegetated lands at the site would act as a carbon sink and provide a valuable natural resource for future generations, thus contributing to intergenerational equity and ecological integrity. An example of the benefits of woodland revegetation on site is the gain in carbon sequestration capacity within the waste rock dumps. Presently a grassland community, the rehabilitation plan would see the establishment of tree cover on the site. Seed stock from local landscapes would be utilised for habitat enhancement for wildlife and to achieve a self-sustaining ecosystem which meets the long term goals of conservation of biodiversity and ecological integrity.

2. The mine site operational management plan has been designed such that the long term species diversity and abundance in the area is not compromised. Measures include:
   - an extensive rehabilitation and revegetation programme;
   - adoption of mine site and transmission line layout design to minimise clearance of areas of native regenerating vegetation;
   - implementation of water management systems designed to ensure the ecological integrity of the Cowal wetland system is not compromised; and
   - commitment to on-going monitoring to enable assessment of the impacts of the mine operation on endemic flora and fauna populations.

1.5.6 Improved Valuation and Pricing of Environmental Resources

1. North is aware of the Commonwealth and State Government Sustainable Development policy and/or legislation which seeks to apply values to natural resources as a means of integrating environmental costs into the impact assessment process.
2. Recognition of these concerns has been expressed by past Inquiries, however recognition also, of the difficulty in ascribing monetary values to many of the environmental issues considered.
3. It is considered that the large extent of scientific investigations that have taken place at Cowal and the amount of future scientific research committed to in the EIS has and would continue to enhance and increase the value of the site's natural resources. This includes an expanded and publicly available scientific database.
4. To assist decision-making in this area, North has completed a Multi-Criteria Analysis of different development scenarios and their impact on different environmental values (Appendix K, Attachment 1).

2 Calculation based on the Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks, National Greenhouse Inventory Committee, Department of the Environment, Sport and Territories, 1994.

1.6 Project Timing and Economic Considerations

The Cowal Gold Project is termed by North as an advanced Project, having undergone considerable exploration to the point where a financial feasibility study has been completed on possible development of the orebody. The Cowal feasibility study examined in detail the geology of the deposit, metallurgical characteristics of the ore, likely gold recovery, costs of reagents and other consumables, likely operating expenditure, cost of land and capital equipment, approval and environmental issues and expected revenue taking into account inflation, likely gold prices and US dollar exchange rates over the life of the mine.

The Cowal Project feasibility study was completed in 1995 resulting in approval from the North Board to proceed with the lodgement of the 1995 DA.

In 1997 North conducted a review of capital costs and general feasibility of the Project based on the new development scenario presented in this EIS. The study confirmed the expected capital costs for the Project and a decision was made to continue preparation of a new EIS and DA.

1.6.1 Project Timing

The timing of North completing its final Project studies would itself be conditional upon the receipt of development consent.

The time required to develop the Project is shown in Table 2-2.

1.6.2 Consequences of Not Proceeding

The following consequences are implied were the Project not to proceed:

- no intrusion to the Lake occurs;
- alterations to the Lake's hydrological inputs and ambient noise and air environments do not occur;
- risks to wildlife in the area arising from the Project would not occur;
- a peak of 300 construction phase and 200 operational phase direct job opportunities along with indirect opportunities would not be created;
- economic benefit to the regional economy as a result of direct and indirect income derived from the Project would not be realised;
- tax revenue (both State and Federal) would not be generated;
- local infrastructure improvement would not occur;
- no relief to the existing rural economy would occur; and
- an undeveloped resource would create uncertainty for rural land development within the area.

1.6.3 Implications for Regional Development

Projected workforce numbers and estimated direct expenditure (wages and salaries and goods and services purchased by the mine) indicate that the proposal would directly, significantly benefit the regional economy. Indirect (flow-on) impacts would increase this benefit (Socio-Economic Assessment, Appendix K).

1.7 Project Team for the EIS

The Cowal Gold Project EIS has been prepared by Resource Strategies Pty Ltd with specialist input from the following organisations and/or individuals:

- Associate Professor David Goldney (species assessment and long term compatibility);
- Australian Nuclear Science & Technology Organisation (hazard and risk assessment);
- Blake Dawson Waldron Solicitors (legislative processes);
- Centre for International Economics (socio-economic assessment);
- Charles Sturt University (flora survey and assessment);
- Coffey Partners International Pty Ltd (hydrogeological investigations);
- Commonwealth Scientific Industrial Research Organisation Ecology and Wildlife (ecological impact assessment and long term compatibility);
- Culture and Heritage (archaeological survey and assessment);
- Department of Conservation and Land Management (soils and land capability survey, mapping and assessment);
- Dr Colin Bower (flora assessment and long term compatibility); and
- Dr Ian Irvine, Pollution Research Pty Ltd (text editing).
- EDAW (Australia) Pty Ltd (visual assessment – Cowal Gold Project);
- Environmental Geochemistry International (geochemical investigations);
- Gilbert and Sutherland (hydrology);
- Greg Richards and Associates Pty Ltd (bat survey and assessment);
- Kalf and Associates (groundwater and solute transport modelling);
- Knight-Piesold (geotechnical investigations and tailings storage design);
- Mount King Ecological Surveys (flora and fauna survey and assessment);
- Mr Allen Kearns (species assessment and long term compatibility);
- Mr Sid Cowling (long term compatibility);
- Pavel Zib and Associates (air quality);
- Richard Heggie Associates (acoustics);
- Tract Consultants (visual assessment – electricity transmission line);
- Traffix Consultants (road and traffic); and
- Tropical Water Solutions (final void investigation).

Attachment 1

Attachment 1

Director-General's Requirements for the Cowal Gold Project EIS

New South Wales Government
Department of Urban Affairs and Planning

Mr C. Anderson
Managing Director
North Limited
GPO Box 1903R
MELBOURNE VIC 3001

Contact: R Lloyd

Our Reference: S97/01796 Pt3

Your Reference:

Dear Mr Anderson,

Cowal Gold Project

Thank you for your letter of 17 July, 1997 indicating that you are consulting with the Director-General with regard to the preparation of an environmental impact statement (EIS) for the above development.

It is noted that the proposal meets the criteria for State Environmental Planning Policy No. 34 - Major Employment Generating Industrial Development (SEPP 34) and that North Limited has made a SEPP 34 application (dated 26 August 1997) for the proposal to be determined by the Minister for Urban Affairs and Planning. The application is currently being processed by the Department.

The EIS shall be prepared in accordance with clause 51 of the Regulation (see Attachment No. 2) and shall bear a certificate required by clause 50 of the Regulation. It shall address all relevant issues raised by participants of the planning focus meeting held on 11 August, 1997 at West Wyalong.

As you are aware, the long term compatibility of the project with Lake Cowal and its surrounds is a particularly important issue and will need to be thoroughly addressed in the EIS. In this regard, the identification of the conservation values of Lake Cowal, the lake's hydrology, water quality and wetland and terrestrial habitats, and the visual character of the area, will be critical.

Pursuant to clause 52 of the Regulation, the Director-General requires that the following key environmental matters be specifically addressed in the EIS:

- ❑ The long term compatibility of the project, particularly in relation to Lake Cowal, including the final results of the reports commissioned by North Limited for the Long Term Compatibility Studies for Lake Cowal;

Governor Macquarie Tower
1 Farrer Place, Sydney 2000
Box 3927 GPO, Sydney 2001

Telephone: (02) 9391 2000
Facsimile: (02) 9391 2111

- ❑ The identification of mitigation measures proposed to be taken to compensate for losses in ephemeral wetland habitat.
- ❑ Consideration of options to extract gold from mined rock and safely store residues, and provide a cost benefit analysis of the options.
- ❑ A review of all options for managing the final void and selection of a preferred method, together with measures to ensure that the final void management system provides long term environmental safety and geotechnical stability of the void.
- ❑ Provision of a commitment by North Limited to maintain specified rehabilitation management and monitoring systems in place until the long term environmental safety and management of the site, and surrounding land owned by the North Limited (e.g. the existing game reserve), is assured to the satisfaction of all relevant Government agencies.
- ❑ The preparation of a final Statement of Intent by North Limited for the Cowal Gold Project (originally presented as a draft in the Planning Focus Document of July, 1997) including a reference to the State Wetlands Management Policy (1996).
- ❑ An assessment of the Aboriginal, cultural and heritage values, including burial sites.
- ❑ Details of an 8 Part Test Of Significance (see Attachment No. 3) and Section 5A of the Environmental Planning and Assessment Act and (if the outcome of the 8 Part Test indicates that the proposed development is likely to have a significant effect on threatened species, populations, or ecological communities, or their habitats) a Species Impact Statement prepared under the provisions of the Threatened Species Conservation Act.
- ❑ An assessment of the economic effects of the proposal and its feasible alternatives in accordance with the attached draft guideline entitled 'Economic Effects and Evaluation in Environmental Impact Assessment'.

Attachment No 1 is an outline of further requirements under clause 52 which must also be addressed in the preparation of the EIS.

Should you require any further information regarding this matter please do not hesitate to contact Richard Lloyd on telephone (02) 9391 2365.

Yours sincerely,

SHaddad

S Haddad
Assistant Director-General
As Delegate for the Director-General

9/9/1997

DEPARTMENT OF URBAN AFFAIRS AND PLANNING

Attachment No. 1

A Full Description of the Development (Schedule 2 – 4(a))

- A discussion of the:
  - extent of exploratory and site works undertaken to date including:
    - a review of the site geology; and
    - statement of mineral resources and reserves at the site.
  - stages of development and works associated with each stage.
  - licences, permits, and other approvals required prior to commencement of work.
  - water supply requirements and works associated with the supply, conveyance, storage, use, recycling, treatment and disposal of water.
  - works proposed to manage local rainfall and runoff in the disturbed and adjoining areas.
  - on-site process water management including tailings dam management and security.
  - estimated increased volume of stormwater runoff generated by the development from new buildings and hard surfaces.
  - chemical characteristics and volume of liquid wastes, and the methods for their treatment, e.g. cyanide, flocculants, etc.
  - flooding status of the site.
  - operation of the dewatering bore network and the likely volumes and quality of water.
  - electricity supply requirements.
  - on-site sewage treatment.
  - the increased number of vehicle movements generated by the proposed development including peak volumes, types of vehicles, and expected loads and weights.
  - dangerous goods transport and an evaluation of the proposal with regard to the storage of any dangerous goods on the site. The evaluation should use the Department's publication *Applying SEPP 33*, to verify if the quantity and locational thresholds are being exceeded. If the thresholds are exceeded, a preliminary hazard analysis (PHA), in accordance with Hazardous Industry Planning Advisory Paper No. 6 – *Guidelines for Hazard Analysis*, should be included with the EIS.
  - relevant environmental planning instruments applying to the proposal including State Environmental Planning Policies No. 44 – Koala Habitat Protection and No. 45 – Permissibility of Mining, and applicable local environmental plans.

A General Description of the Environment (Schedule 2 – 4(b))

- The regional and local hydrology of Lake Cowal and the mining site should be fully documented and discussed including connections between surface and groundwaters.

- The groundwater conditions at the site, including depth to watertable, quality, and level of use should be fully described.
- Adjacent uses which may have the potential to create environmental impacts in common with the proposal (e.g. bore water use) should be described.
- The existing acoustic climate should be described including background noise levels (L_{90}), noise sources and estimated levels (L_{10}) from the proposal using, where appropriate, noise modelling under a range of climatic conditions, including prevailing weather conditions.
- The local, regional, national, and international significance of Lake Cowal for bird and other animal use.
- Maps clearly identifying the location of the proposal and the position of:
  - surrounding roads, adjoining communities, or dwellings and any land use likely to be affected by the development;
  - utilities including transmission lines, pipelines, cables, or easements;
  - watercourses, water storage, drinking water catchments;
  - all lands acquired or proposed to be acquired;
  - surface contours/topography; and
  - sight lines from residences or public places such as roads.
- An analysis of the soil characteristics of the area to determine their erosion potential and stability.
- A description and list of the fauna and flora occurring on and around the site.
- A description of Aboriginal relics/artefacts on and around the site.
- Identification of any Crown lands and details of:
  - status of Crown land; and
  - proposals for occupation and use of Crown land.

The Likely Impact of the Development on the Environment (Schedule 2 – 4(c))

- Consideration of the economic and social impacts of the proposal during both the construction and post-construction phases including:
  - the primary economic costs and benefits of the proposal.
  - the impacts of the proposal on employment and economic output at a local and regional level.
  - the impacts of the proposal on the local and regional communities of Burcher, Marsden, Forbes and West Wyalong with consideration of impacts on services and infrastructure (i.e. water supply, effluent disposal, electricity supply and local road networks), housing including regard to housing stock and rental accommodation, schools, and hospitals.
  - fiscal impacts to the expenditure and revenue of local councils directly affected by the proposal, particularly Bland Council.
- The economic costs and benefits of the feasible alternatives.
- The effects of traffic on the Classified Road system.

- Determination of the safety and road maintenance impacts of increased turning movements at the junction of the road at Blow Clear giving access to the mine, and at the Newell Highway junction in West Wyalong.
- The impacts of the road upgrade from Blow clear to the site.
- The effects of the development on the travelling stock route which traverses the site.
- A description of the interaction of the existing game reserve uses and the proposed mining operation.
- A discussion of all activities on and off-site likely to affect the groundwater resources including production bores, dewatering bores, the mine pit, chemical and petroleum spills, and liquid waste disposal.
- A consideration of the likely long term impacts to wildlife from low dose exposures to cyanide to other chemicals, particularly in the proposed tailings dams.
- A discussion of the likely impacts associated with each proposed option for the powerline alignment between the proposed site and link point to the power grid, including the area between Lake Cowal and Nerang Cowal, and including reference to the potential for bird strikes.
- A discussion of the likely impacts associated with each proposed option for the water pipeline alignment between the proposed site and borefield, particularly in relation to Lake Cowal.
- A discussion on the stability of bunds and pit walls, including stability in the event of any seismic activity that may occur on the site.
- A consideration of the likely environmental impacts during construction and post-construction on:
  - ecological values of Lake Cowal as a bird habitat of national and international significance, with particular reference to the JAMBA and CAMBA Migratory Bird Agreements;
  - losses to terrestrial and aquatic plant and animal habitats from disturbances on the site;
  - any Aboriginal relics, including burial sites identified on the site;
  - the adjoining aquifers, users and surface waters from the dewatering;
  - air quality particularly dust emissions on adjacent residences and wildlife;
  - stormwater water quality which leaves the site;
  - noise from industrial processes, mining operations, blasting, and road transport of materials and products particularly on adjacent residences and wildlife (e.g. the nesting and breeding behaviour of avifauna);
  - process waste waters which may be discharged to treatment facilities including odours, toxicity, hazardous compounds, etc; and
  - visual amenity of the area, particularly around Lake Cowal.

A Description of Measures Proposed to Mitigate any Adverse Effects (Schedule 2 – 4(d))

- Measures proposed to be taken to:
  - prevent the accession of groundwater to Lake Cowal as a result of the mining operations.
  - manage the mined void following cessation of mining to safeguard the lake from the intrusion of saline groundwaters.
  - mitigate environmental impacts associated with the powerline and water supply pipeline, particularly around Lake Cowal.
  - protect against contamination of surface and groundwaters from spills of toxic and hazardous materials including oil and petroleum products.
  - prevent erosion of natural drainage lines including providing details of an integrated soil and water management plan.
  - landscape the site to complement the surrounding landscape, including details of plant species, sowing and planting schedule, and the identification of persons responsible for environmental management.
  - rehabilitate and stabilise areas during and after mining operations including the development of an overall rehabilitation plan and systems to ensure long term environmental safety, geotechnical stability and satisfactory and assured vegetation establishment.
  - handle solid and hazardous wastes including their consideration in a management plan.
  - separate surface water runoff originating from outside of the area of operations from any contaminated water in a manner which does not result in either contamination of the water or other environmental impacts, e.g. erosion.
  - treat all liquid wastes indicating where recycling of waste waters may be used.
  - maintain or rehabilitate existing and proposed exploratory bores to protect the integrity of surface and groundwaters.
  - achieve acceptable air quality including a description of methods to be used to control dust.
  - achieve acceptable noise levels from both mining and transport operations.
  - mitigate losses to animal habitats and plant communities;
  - mitigate any fiscal and social impacts.
  - deal with Aboriginal artefacts found on the site.
  - monitor likely impacts including:
    - permeability/leakage problems of the tailings dam;
    - impacts on bores in the area of the proposed supply bores;
    - impacts on groundwater reserves resulting from the bore supply;
    - changes in the surface water quality;
    - changes to flood flows resulting from the development.

- changes to the ecology of the lake system including sediments and invertebrates of the lake bed, impacts on fishery resources, water quality particularly salinity;
- changes in the nesting, breeding, and feeding behaviour of avifauna;
- the effects on water quality from waste rock stockpile.

Consultation

- Department of Urban Affairs and Planning;
- National Parks and Wildlife Service;
- Department of Land and Water Conservation;
- Department of Mineral Resources;
- Environment Protection Authority;
- Department of Aboriginal Affairs;
- NSW Agriculture;
- NSW Fisheries;
- Australian Heritage Commission;
- NSW Department of Health;
- Department of School Education;
- Roads and Traffic Authority;
- Rail Access Corporation;
- Forbes Council;
- Bland Council;
- Murray-Darling Basin Aboriginal Committee;
- West Wyalong Local Aboriginal Land Council;
- NSW Aboriginal Land Council;
- Murray-Darling Basin Commission;
- Environment Australia;
- Total Environment Centre;
- Condobolin Rural Lands Protection Board;
- Forbes Rural Land Protection Board;
- Jemalong Irrigation Ltd;
- Lake Cowal Landowners Association;
- Local Catchment Management Committee;
- Landcare Groups in the catchment; and
- any other agencies, local councils or community organisations that may be relevant to the proposal.

DEPARTMENT OF URBAN AFFAIRS AND PLANNING

Attachment No. 2

STATUTORY REQUIREMENTS FOR THE PREPARATION OF AN ENVIRONMENTAL IMPACT STATEMENT UNDER PART 4 OF THE ENVIRONMENTAL PLANNING AND ASSESSMENT ACT 1979

In accordance with the *Environmental Planning and Assessment Act 1979* (the Act), an environmental impact statement (EIS) must meet the following requirements.

Content of EIS

Pursuant to Schedule 2 and clause 51 of the *Environmental Planning and Assessment Regulation 1994* (the Regulation), an EIS must include:

1. A summary of the environmental impact statement.
2. A statement of the objectives of the development or activity.
3. An analysis of any feasible alternatives to the carrying out of the development or activity, having regard to its objectives, including:
   (a) the consequences of not carrying out the development or activity; and
   (b) the reasons justifying the carrying out of the development or activity.
4. An analysis of the development or activity, including:
   (a) a full description of the development or activity; and
   (b) a general description of the environment likely to be affected by the development or activity, together with a detailed description of those aspects of the environment that are likely to be significantly affected; and
   (c) the likely impact on the environment of the development or activity, having regard to:
      (i) the nature and extent of the development or activity; and
      (ii) the nature and extent of any building or work associated with the development or activity; and
      (iii) the way in which any such building or work is to be designed, constructed and operated; and
      (iv) any rehabilitation measures to be undertaken in connection with the development or activity; and
   (d) a full description of the measures proposed to mitigate any adverse effects of the development or activity on the environment.
5. The reasons justifying the carrying out of the development or activity in the manner proposed, having regard to biophysical, economic and social considerations and the principles of ecologically sustainable development.
6. A compilation, (in a single section of the environmental impact statement) of the measures referred to in item 4(d).
7. A list of any approvals that must be obtained under any other Act or law before the development or activity may lawfully be carried out.
8. For the purposes of Schedule 2, the principles of **ecologically sustainable development** are as follows:
   (a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
   (b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations.
   (c) Conservation of biological diversity and ecological integrity.
   (d) Improved valuation and pricing of environmental resources.

Note

The matters to be included in item (4)(c) might include such of the following as are relevant to the development or activity:

(a) the likelihood of soil contamination arising from the development or activity;

(b) the impact of the development or activity on flora and fauna;
(c) the likelihood of air, noise or water pollution arising from the development or activity;
(d) the impact of the development or activity on the health of people in the neighbourhood of the development or activity;
(e) any hazards arising from the development or activity;
(f) the impact of the development or activity on traffic in the neighbourhood of the development or activity;
(g) the effect of the development or activity on local climate;
(h) the social and economic impact of the development or activity;
(i) the visual impact of the development or activity on the scenic quality of land in the neighbourhood of the development or activity;
(j) the effect of the development or activity on soil erosion and the silting up of rivers or lakes;
(k) the effect of the development or activity on the cultural and heritage significance of the land.

An environmental impact statement referred to in Section 77(3)(d) of the Act shall be prepared in written form and shall be accompanied by a copy of Form 2 of the Regulation signed by the person who has prepared it.

Procedures for public exhibition of the EIS are set down in clauses 55 to 57 of the Regulation.

Attention is also drawn to clause 115 of the Regulation regarding false or misleading statements in EISs.

Note

Should the development application to which the EIS relates not be made within 2 years from the date of issue of the Director-General's requirements, under clause 52(5) of the Regulation the proponent is required to reconsult with the Director-General.

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NSW NATIONAL PARKS AND WILDLIFE SERVICE

Threatened Species Management

Information Circular No. 2: Threatened Species Assessment under the EP&A Act: The '8 Part Test' of Significance

November 1996

NSW NATIONAL PARKS AND WILDLIFE SERVICE

INTRODUCTION

The *Threatened Species Conservation Act 1995* (TSC Act) commenced on the 1 January 1996. This Act represents a major government initiative in the field of threatened species conservation. It provides for the protection of all threatened plants and animals native to NSW (excluding fish and marine vegetation). The Act places specific responsibilities on applicants, proponents, consent and determining authorities and the NSW National Parks and Wildlife Service (NPWS) in the fields of environmental planning, development control, recovery planning and threat abatement planning The TSC Act also invites public input into these processes.

The TSC Act replaces the legislative regime introduced by the *Endangered Fauna (Interim Protection) Act 1991* and as a result makes substantial amendments to the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *National Parks and Wildlife Act 1974* (NPW Act). One such amendment, which has major implications for the planning system, is the introduction of a set of eight factors which must be considered for informed decisions to be made regarding the effect of a proposed development or activity on threatened species, populations or ecological communities, or their habitats. These factors form part of the threatened species assessment process under the EP&A Act and are collectively referred to as the '8 part test'. This test is analogous to the now repealed section 4A of the EP&A Act (ie. the '7 point test').

Threatened species assessment under the EP&A Act is an integral component of threatened species conservation in NSW. It should be viewed in the context of a range of conservation strategies promoted by the TSC Act. These include recovery planning, threat abatement planning, critical habitat declaration, joint management agreements and strategic land use planning through Part 3 of the EP&A Act.

This Circular aims to describe the legislative and administrative process involved in implementing the '8 part test'.

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1.0 NOTES ON THE IMPLEMENTATION OF THE GUIDELINES

The guidelines contained within this Circular have been prepared for use by consent and determining authorities when considering a proposed development or activity pursuant to Parts 4 and 5 of the EP&A Act. They are also available to provide information and assistance to any other individuals or organisations who may be required to consider the effect of a proposal on threatened species (including populations and ecological communities) and their habitats.

The potential for a proposed development or activity to have a significant effect on threatened species, populations or ecological communities, or their habitats, will vary from proposal to proposal and location to location. These guidelines are designed to facilitate a consistent and systematic approach when deciding whether a proposed development or activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats.

A review of the guidelines will be undertaken 12 months after publication of this Circular. Comment to assist in this review is welcome and should be forwarded in writing to the NPWS, Threatened Species Unit, PO Box 1967, Hurstville, 2220.

2.0 THE '8 PART TEST'

2.1 What is the '8 part test'?

The '8 part test' is a statutory mechanism which allows decision makers to assess whether a proposed development or activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats.

The '8 part test' is contained within section 5A of the EP&A Act and consists of eight factors which need to be addressed for informed decisions to be made regarding the effect of a proposed development or activity on threatened species, populations or ecological communities, or their habitats.

Section 5A of the EP&A Act is repeated below:

For the purposes of this Act and, in particular, in the administration of sections 77, 90 and 112, the following factors must be taken into account in deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats:

(a) in the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction,

(b) in the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised,

(c) in relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed,

(d) whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community,

(e) whether critical habitat will be affected,

(f) whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region,

(g) whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process,

(h) whether any threatened species, population or ecological community is at the limit of its known distribution.

2.2 *Why do the '8 part test'?*

The ultimate aim of undertaking an assessment such as the '8 part test' is to improve the standard of consideration and protection afforded to threatened species (including populations and ecological communities) and their habitats in the planning and assessment process. The outcome of any threatened species assessment should be that developments and activities are undertaken in an environmentally sensitive manner, and that appropriate measures are undertaken to minimise adverse effects on threatened species, populations or ecological communities, or their habitats. Where this can not be achieved a development or activity should not proceed until the likely effects of the proposal can be ameliorated.

Consent and determining authorities have a statutory obligation, under Parts 4 and 5 of the EP&A Act, to consider whether a proposal is likely to significantly affect threatened species, populations or ecological communities, or their habitats. In deciding whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats, the consent or determining authority must take into account the '8 part test'.

If the application of the '8 part test' reveals that a significant effect is likely then:

- a species impact statement (SIS) must be prepared and the concurrence of the Director-General of National Parks and Wildlife, or consultation with the Minister for the Environment is required; and/or
- the proposal may be modified such that a significant effect on threatened species, populations or ecological communities, or their habitats is unlikely. This may require the original application to be withdrawn and the modified proposal to be submitted for assessment.

2.3 *When is the '8 part test' necessary?*

The '8 part test' is required when a:

a) consent authority is considering a development application under Part 4 of the EP&A Act. It is the responsibility of the consent authority to form a view as to whether the development is likely to significantly affect threatened species, populations or ecological communities, or their habitats. This responsibility is outlined under section 90(1) of the EP&A Act; or

b) determining authority is considering an activity under Part 5 of the EP&A Act. It is the *responsibility of the determining* authority to form a view as to whether the activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats. This responsibility is outlined under section 111(4) of the EP&A Act.

2.4 Who does the '8 part test'?

A technical report which addresses the '8 part test' may be prepared by either specialist officers or consultants appointed by the consent or determining authority or, the consent or determining authority may request that the applicant or proponent provide a report which addresses these factors. Where the applicant or proponent has prepared this report, the report must be forwarded to the consent or determining authority for consideration and assessment.

Ultimately, it is left to the discretion of the consent or determining authority to form a view as to whether a proposed development or activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats.

3.0 THE STAGES OF THREATENED SPECIES ASSESSMENT

The procedure for threatened species assessment under the EP&A Act consists of four stages:

1. preliminary assessment of the study area (including an assessment of the likelihood of the study area supporting threatened species, populations or ecological communities, or their habitats);
2. assessment of the nature of the proposal and its effect on threatened species, populations or ecological communities, or their habitats;
3. evaluation of significance;
4. legislative and administrative outcomes of the '8 part test'.

The following sections outline these stages of threatened species assessment under the EP&A Act.

3.1 STAGE 1: PRELIMINARY ASSESSMENT OF THE STUDY AREA

To establish whether a proposed development or activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats, it is necessary to assess the likelihood of the study area supporting such species, populations or ecological communities, or habitats.

In order to assess the likelihood of the study area supporting threatened species, populations or ecological communities, or their habitats, the following information is required:

a) a description of the study area, including details of the types and condition of the habitat(s) in, and adjacent to, the land to be affected by the proposal;

b) a list of those threatened species, populations or ecological communities known to occur in the same or similar habitats in the region; and

c) an assessment of the likelihood of those species, populations or ecological communities identified in b) occurring within the study area given the habitat requirements of the species, populations or ecological communities and the habitats present within the study area.

Table 1 provides a checklist to assist in the preliminary assessment of the study area.

3.1.1 Collation of information describing the study area with regard to threatened species, populations and ecological communities, and their habitats

An accurate description and inventory of the study area is important for any decision relating to threatened species assessment. In effect, the consent or determining authority needs to

consider all available information on threatened species, populations and ecological communities, their distribution, and the availability and distribution of local habitat, in order to be in a position to make a decision as to whether the proposed development or activity is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats.

Appendix E provides a list of useful sources of information. This list should not be considered as a comprehensive list of available information. Further information may be obtained from local conservation or nature organisations/groups, the Australian Museum, the Royal Botanic Gardens and the NPWS. The reliability and age of any records obtained should be taken into account when determining the likelihood of a threatened species, population or ecological community occurring within the study area.

In order to facilitate the application of the '8 part test', it is recommended that councils in a region combine with state government agencies and Catchment Management Committees to engage the services of a consultant(s) who can compile and collate information, relevant to their LGA, on threatened species presence, distribution and habitat availability. The collation of such information will assist in the identification of areas of importance to threatened species, populations and ecological communities.

3.1.2 Is specialist input required?

The need for specialist input will vary depending on the nature of the site, the proposal, surrounding land-uses and the existing level of knowledge of the habitat values of the study area. The NPWS suggests that, in considering whether specialist input is required, consent and determining authorities should consider the following:

- past records of threatened species, populations and ecological communities; and
- assessment of the habitat values of the study area for each species, population or ecological community in view of the habitat requirements of the species, population or ecological community.

Should consideration of the above suggest to the consent or determining authority that threatened species, populations or ecological communities are likely to be present in the study area, then the consent or determining authority should consider requiring the advice of a recognised animal and/or plant specialist before proceeding to Stages 2 and 3.

3.1.3 Consideration of a development or activity proposed in an area where there are no threatened species, populations, or ecological communities, or their habitats and where such species, populations or ecological communities, or habitats are unlikely to occur

If a development or activity is proposed in an area where no threatened species, populations or ecological communities, or their habitats have been recorded and it is considered unlikely that such species, populations or ecological communities, or habitats will occur, the consent or

determining authority is still required to have regard to the '8 part test' in order to satisfy the legislative requirements of sections 90 and 111(4) of the EP&A Act.

A statement addressing the factors of the '8 part test' which highlights the absence and unlikely occurrence of threatened species, populations or ecological communities, or their habitats within the study area, and that the proposed development or activity is unlikely to have a significant effect on threatened species, populations or ecological communities, or their habitats must be made.

Figure 1. Stage 1: Preliminary assessment of the study area

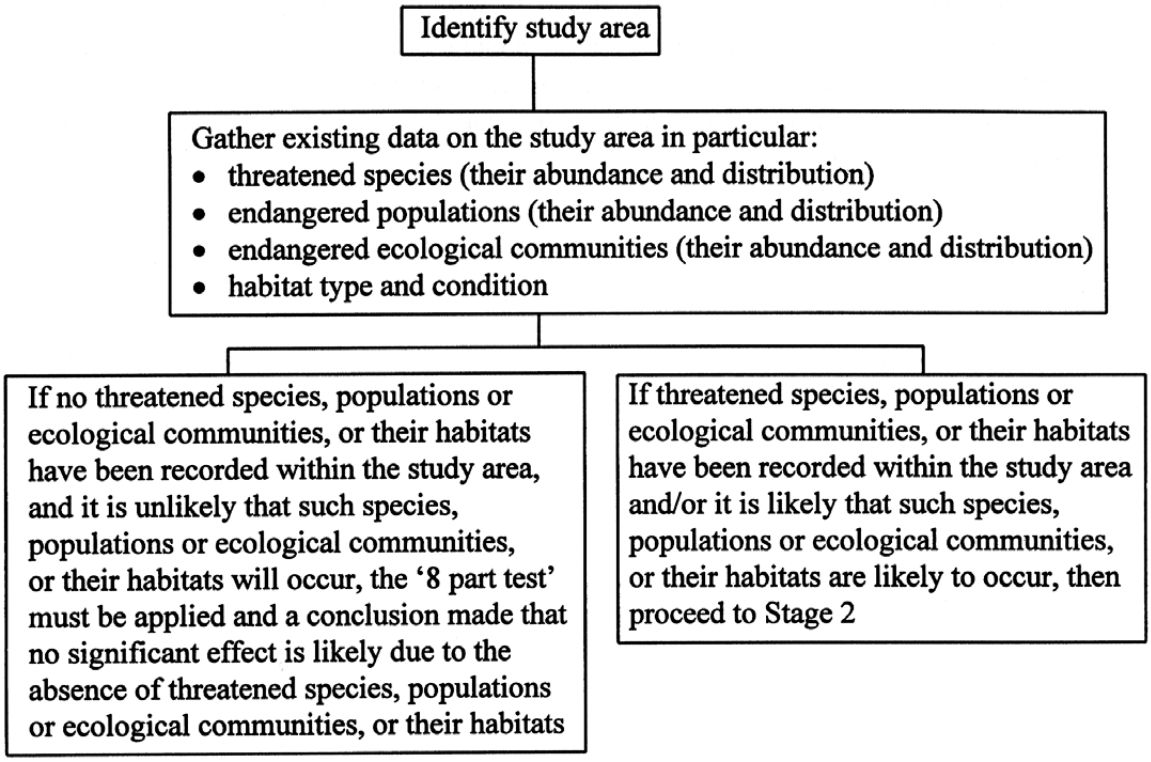


Table 1. Assessing the likely presence of threatened species, populations or ecological communities, or their habitats within the study area

Description of the environment	Characteristics
What threatened species, populations or ecological communities are known or likely to occur within the study area?	
What habitat(s) are present within the study area?	
What is the condition (quality and quantity) of the habitat of the species, populations or ecological communities identified above based on, but not limited to: • availability of foraging substrate; • the availability of trees containing hollows; • density of ground cover including shrubs and fallen trees; • caves, rock outcrops, overhangs, crevices; and • presence or absence of permanent or intermittent water bodies.	
Is the habitat(s) connected with similar habitat(s) occurring outside the study area and what is the extent of interconnectedness and distribution of the habitat(s) within the region?	
Does the study area contain any critical habitat, as declared under Part 3 of the TSC Act?	
What is the nature and extent of disturbance from natural or human-induced causes (incremental loss of habitat, weed encroachment, fire, introduced species, grazing, logging, pollution etc.) that already exist within the study area?	

3.2 STAGE 2: ASSESSMENT OF THE NATURE OF THE PROPOSAL AND ITS EFFECTS ON THREATENED SPECIES, POPULATIONS OR ECOLOGICAL COMMUNITIES, OR THEIR HABITATS

The potential effects of the proposed development or activity are a function of the attributes of the proposal and the characteristics of the study area. The checklist provided in Table 2 will assist in the identification of the key attributes of the proposed development or activity.

The information in Table 2 is normally provided, in the development application or the request for Part 5 approval, to the consent or determining authority by the applicant or the proponent and should be verified by means of site inspections, consultation with the applicant or proponent and the use of specialist advice.

The checklist in Table 3 will assist in identifying potential effects which form the basis on which to decide whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats.

When identifying the potential effects of the proposal, consideration should be given to the nature, extent, frequency, duration and timing of the effects. Consideration should also be given to any possible measures to avoid or ameliorate the effects of the proposal on threatened species, populations or ecological communities, or their habitats.

Table 3 should not be considered as a comprehensive representation of all potential effects. It provides a list of effects which should be considered. Any other issues relevant to the particular proposal and its environment should be considered. It is recommended that focus groups be established to assist in the identification of other issues relevant to the proposal.

Figure 2. Stage 2: Assessment of the nature of the proposal

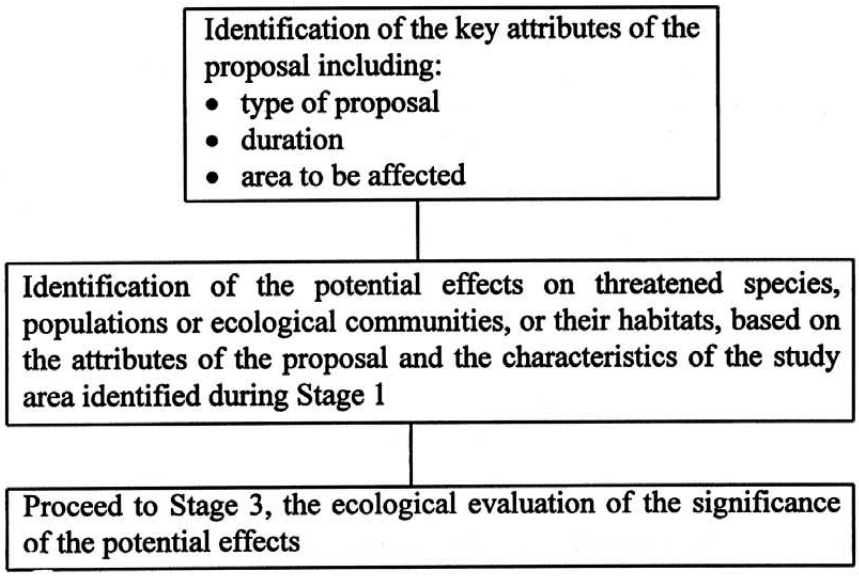


Table 2. Summary of the proposed development or activity

Description of the proposed development or activity

The location of the proposal and any additional areas which are likely to be affected by the proposal, delineated on a map showing the proposal in both a local and regional (ie. based on the regions illustrated in Appendix D) context .....
.....
.....

Type of development or activity (including any ancillary works and intrinsic work stages) .....
.....
.....
.....
.....
.....

Duration and timing of the proposal (including staging, if any) .....
.....
.....

Area affected by the proposal (directly and indirectly) in hectares .....
.....
.....

Other matters .....
.....
.....
.....
.....
.....
.....

Table 3. Identifying potential effects of the proposal on threatened species, populations or ecological communities, or their habitats

Characteristics of the proposal (during construction and operation)	Potential effects
How is the proposal likely to affect the lifecycle of a threatened species and/or population? a) displaces or disturbs threatened species and/or populations b) disrupts the breeding cycle c) disturbs the dormancy period d) disrupts roosting behaviour e) changes foraging behaviour f) affects migration and dispersal ability g) disrupts pollination cycle; h) disturbs seedbanks; i) disrupts recruitment (ie. germination and establishment of plants); j) affects the interaction between threatened species and other species in the community (eg. pollinators, host species, mychorrizal associations); and k) other matters*.	
How is the proposal likely to affect the habitat of a threatened species, population or ecological community? a) disturbs any permanent, semi-permanent or ephemeral water bodies; b) degrades soil quality; c) clears or modifies native vegetation; d) introduces weeds, vermin or feral species; e) removes or disturbs key habitat features such as trees with hollows, caves and rock crevices, foraging habitat; f) affects natural revegetation and recolonisation of existing species following disturbance; and g) other matters*.	

* This should include an assessment as to whether the potential effects are likely to have an immediate or delayed effects on threatened species, populations or ecological communities, or their habitats.

Table 3. cont. Identifying potential effects of the proposal on threatened species, populations or ecological communities, or their habitats

Characteristics of the proposal (during construction and operation)	Potential effects
How is the proposal likely to affect current disturbance regimes? a) modifies the intensity and frequency of fires; b) modifies flooding flows; and c) any other matters*.	
How is the proposal likely to affect habitat connectivity? a) creates a barrier to fauna movement; b) removes remnant vegetation or wildlife corridors; c) modifies remnant vegetation or wildlife corridors; and d) other matters*.	
How is the proposal likely to affect critical habitat? a) removes or modifies key habitat features; b) affects natural revegetation or recolonisation of existing species following disturbance; c) introduces weeds, vermin or feral species d) generates or disposes of solid, liquid or gaseous waste; e) uses pesticides, herbicides, other chemicals; and f) other matters*.	

* This should include an assessment as to whether the potential effects are likely to have an immediate or delayed effects on threatened species, populations or ecological communities, or their habitats

3.3 STAGE 3: EVALUATION OF SIGNIFICANCE

When deciding whether a development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats, the '8 part test' must be applied.

In applying the '8 part test' consent and determining authorities will be required to make decisions based on analysis and professional discretion. The services of an animal and/or plant specialist may be engaged to assist in the decision making process.

The results of the '8 part test' are used to aid the decision-maker to decide whether a proposed development or activity is likely to significantly affect threatened species, populations or ecological communities, or their habitats and therefore, whether the preparation of a SIS is required.

The '8 part test' is not a 'pass/fail' technique based on a score out of eight. Rather, the outcome of each individual factor needs to be considered - first, as to whether an effect is likely, and secondly, whether that effect is significant. If any of the eight factors, individually or in combination, indicates that a significant effect is likely, then a SIS must be prepared. Some of the factors may be difficult to assign a significant effect, for example factors *(f)* and *(h)*. However, consideration of these factors in combination with other factors may indicate that a significant effect is likely.

3.3.1 Application of the '8 part test'

Species which are known to occur or considered likely to occur within the study area can either be assessed individually or as groups of similar species based on taxonomic similarity or habitat specialisation.

3.3.2 Level of assessment

It is not expected that the '8 part test' should produce detailed analysis and evaluation of the potential effects of a proposal on threatened species, populations or ecological communities, or their habitats. This analysis and evaluation will need to be obtained if the decision is made to proceed to the next stage (ie. the preparation of a SIS).

3.3.3 Adequacy of a report which addresses the factors of the '8 part test' that has been prepared by an applicant or proponent and has been forwarded to the consent or determining authority for consideration and assessment

If any of the factors of the '8 part test' are not addressed to the satisfaction of the consent or determining authority, additional information may be requested or the advice of an animal and/or plant specialist should be obtained to assist in the decision making process.

3.3.4 Maintaining a record of information

For increased accountability, the consent or determining authority should maintain a record of the information that they have used to arrive at a decision.

3.3.5 Explanation of the factors contained within section 5A of the EP&A Act

(a) *In the case of a threatened species, whether the lifecycle of the species is likely to be disrupted such that a viable local population of the species is likely to be placed at risk of extinction.*

In order to be in a position to assess this factor, the decision-maker must have an understanding of the lifecycle of each of the threatened species known or likely to occur within the study area. For plants, important lifecycle components consist of seedbanks, recruitment (germination and establishment of plants) and reproduction (including pollination and fecundity). For animals, important lifecycle components include breeding, dormancy, roosting, feeding, migration and dispersal.

A number of components of a species' lifecycle are dependant on the habitat of that species and disturbance regimes. The removal or modification of habitat and the disruption of the current disturbance regimes may be detrimental to the survival of that species. It is important therefore, that the decision-maker not only has an understanding of the species' lifecycle but also an understanding of the way in which a species utilises its habitat and exists under a regime of disturbance.

Components of a species' habitat and the regime of disturbance which may be essential to the lifecycle of a species include, but are not limited to:

- trees with hollows. Such trees are utilised by hollow-dependent species as diurnal and nocturnal roosts or as breeding or hibernation sites. Hollow-dependent species are particularly sensitive to the removal of mature trees with suitable hollows during the breeding and/or hibernation period;
- caves or rock crevices. Caves and rock crevices provide shelter and den sites for, for example, scansorial (ie. capable of or adapted for climbing) mammals and reptiles. Caves also provide some bat species with suitable breeding and hibernation roosts;

- permanent, semi-permanent or ephemeral water bodies. Most species of amphibian are dependent on water bodies for at least part of their lifecycle. Some flora species, for example some orchids such as, *Phaius australis* and *Phaius tankervilliae* are dependant on swampy habitats. The degradation or destruction of these habitats is leading to a decline in the numbers of species dependent upon permanent, semi-permanent or ephemeral water bodies;
- foraging substrate. Species such as the Glossy Black-Cockatoo feed exclusively on particular plant species. Such species are particularly sensitive to the removal of foraging habitat; and
- fire and flooding regimes. For many plant species there may be few or even no above ground plants observable at any one point in time, even though the species has a large seedbank and at some point in the future will be commonly found at a site. For many plant species fire and rain influence the above ground abundance. This means that plant abundance for such species will vary widely over time in response to the timing of the recruitment of the species. Many species only recruit new individuals after a disturbance such as fire or flooding. The disruption of the disturbance regime may affect the viability of the population.

The decision-maker must identify, based on a knowledge of the species' lifecycle and habitat requirements, which stages of the species' lifecycle are likely to be disrupted by the proposed development or activity.

If the proposal is likely to affect any part of the lifecycle of a threatened species, the decision maker must then evaluate the significance of this effect by deciding whether the effect of the proposal is such that a viable local population of the species is likely to be placed at risk of extinction.

A local population should be considered as the population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary of the study area can be demonstrated.

The local population should be considered to be viable (ie. a population that has the capacity to live, develop and reproduce under normal conditions) unless the contrary can be conclusively demonstrated through analysis of records and references.

(b) In the case of an endangered population, whether the lifecycle of the species that constitutes the endangered population is likely to be disrupted such that the viability of the population is likely to be significantly compromised.

As identified in factor *a)*, a species' lifecycle is often a function of species-habitat interaction. Therefore, the issues raised in factor *a)* are applicable when considering whether the lifecycle of the species that constitutes an endangered population is likely to be effected by the proposed development or activity.

When evaluating the significance of the effect, consideration must be given to whether the lifecycle of the species which makes up the endangered population will be disrupted

such that its survival is jeopardised. This should include consideration of the relative significance of the study area as a proportion of the endangered population and its habitat.

It should be noted that this factor refers only to those endangered populations listed on Part 2 of Schedule 1 of the TSC Act and includes any recent determinations made by the Scientific Committee.

(c) In relation to the regional distribution of the habitat of a threatened species, population or ecological community, whether a significant area of known habitat is to be modified or removed.

A quantitative and qualitative approach to assessing whether a significant area of known habitat is to be modified or removed should consist of the following steps:

- an assessment of the amount of habitat of the threatened species, population or ecological community that occurs within the region;
- an assessment of the amount of habitat of the threatened species, population or ecological community that occurs within the study area;
- a calculation of the amount that the habitat of the study area represents in relation to the regional distribution of that habitat;
- a calculation of the amount of the habitat of the study area which is to be removed or modified by the proposed development or activity;
- a calculation of the amount of the habitat of the region that will be removed or modified by the proposed development or activity; and
- an assessment of the ecological integrity of the habitat to be affected.

Whether a significant area of habitat will be removed or modified will depend not only on the local and regional abundance of the habitat but also upon the habitat requirements of the threatened species, populations or ecological communities and the degree of tolerance that such species, populations or ecological communities have to habitat removal or modification.

Note, that the reference of 'regional' within this factor refers to the regions defined in the Interim Biogeographic Regionalisation of Australia (Appendix D).

(d) Whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat for a threatened species, population or ecological community.

When deciding whether an area of known habitat is likely to become isolated from currently interconnecting or proximate areas of habitat, it is necessary to identify and assess the patterns and extent of habitat connectivity to determine the strategic significance of the study area. It may form part of a corridor, be a cul-de-sac area of habitat or an isolate. Landsat imagery, aerial photographs, topographic maps and data

obtained from ground investigations are useful information sources for assessing this point.

Consideration should be given to the dispersal and genetic exchange mechanisms of individual species and whether the isolation of currently interconnecting or proximate areas of habitat for threatened species, populations or ecological communities will adversely affect the maintenance of gene flow and the ability to sustain viable populations.

Consideration should be given to the potential for the proposed development or activity to contribute to the incremental creation of an isolating barrier. It should also be noted that isolation can occur by various habitat modifications and not only by the clearing of vegetation.

(e) Whether critical habitat will be affected.

In considering this factor it is necessary to determine whether the proposed development or activity is to occur on land that is, or is a part of, critical habitat and/or whether the proposal is likely to affect (directly or indirectly) areas of critical habitat present in the vicinity of the proposal.

Reference must be made to the Register of Critical Habitat which is kept by the Director-General of National Parks and Wildlife and is open for public inspection during ordinary business hours. Copies of, or extracts from, the register may be purchased on request.

Maps showing the location of critical habitat are kept by the Director-General of National Parks and Wildlife. Copies are held by:

- the Director-General of the Department of Land and Water Conservation;
- the Director-General of Urban Affairs and Planning;
- each council within whose area the whole or part of the critical habitat is located;
- landholders of land on which critical habitat is located (including public authorities who are landholders);
- holders of leases and other interests granted by the Crown; and
- other public authorities known by the Director-General to exercise relevant functions in relation to the land.

Local environmental plans (LEPs) and regional environmental plans (REPs) relating to areas which include critical habitat should identify the land that is declared as critical habitat. These plans are available for public inspection at the Department of Urban Affairs and Planning, the office of the council to which a LEP/REP applies or such other premises operated or controlled by the council.

(f) Whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region.

To evaluate whether a threatened species, population or ecological community, or their habitats, are adequately represented in conservation reserves (or other similar protected areas) in the region, it is necessary to analyse each species, population or ecological community, or their habitats in several contexts such as, biological and physical attributes, the extent of decline since European settlement, relative abundance and current distribution.

Whether a species, population or ecological community, or their habitats can be considered adequately represented will depend on the location of the conservation reserves (or other similar protected areas), the biological nature, distribution and past and present abundance of the species, population or ecological community.

The habitat available in the current reserves system needs to be carefully evaluated against the specific requirements of threatened flora and fauna. The excision of large areas of land for agriculture has led to a reserve system that is based upon the remaining areas of land which represent particular land types (ie. steep, higher altitude, inaccessible and relatively low productivity). Therefore remnants on private land may represent habitat of a type different to that found in adjacent reserves.

It should be noted that existing conservation reserves may not provide an unbiased representation of the known regional biodiversity. Some species may benefit from the bias while others are disadvantaged.

Information as to what threatened species, populations or ecological communities are present in conservation reserves within the region may be obtained from the recovery plans prepared by the NPWS, the NPWS Atlas of NSW Wildlife, NPWS District offices, the database held by the Royal Botanic Gardens, Sydney, biodiversity studies undertaken by the NPWS and survey reports published in scientific journals.

The information contained within the NPWS Atlas of NSW Wildlife database is based on reported sightings and is presented as Australian Map Grid reference points. The Royal Botanic Gardens database contains the location of sites of specimen collections and is presented as latitude and longitude reference points. The data contained within the NPWS Atlas of NSW Wildlife and the Royal Botanic Gardens' database may be obtained on request with the payment of a processing fee.

Note, that the reference of 'region' within this factor refers to the regions defined in the Interim Biogeographic Regionalisation of Australia (Appendix D).

(g) Whether the development or activity proposed is of a class of development or activity that is recognised as a threatening process.

When deciding whether the proposal is of a class of development or activity that is recognised as a threatening process reference must be made to Schedule 3 of the TSC Act which lists **key threatening processes**. In addition, processes that are generally recognised by the scientific community as being detrimental to a species, population or ecological community, or their habitats (habitat clearance and degradation, introduction of weeds, vermin or feral species etc.) should also be considered.

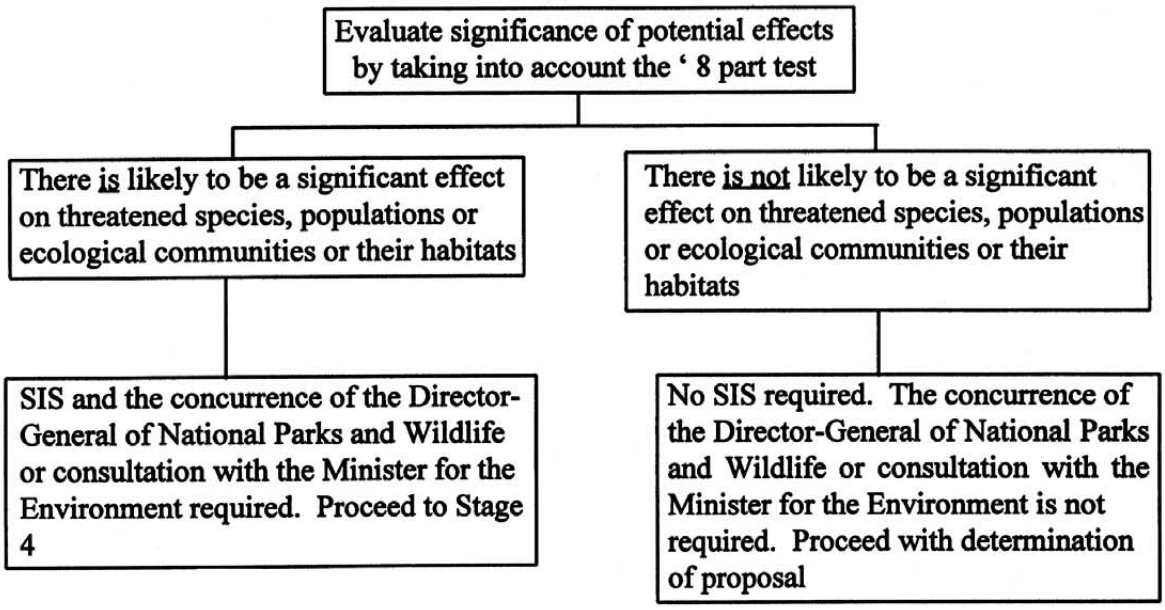
(h) Whether any threatened species, population or ecological community is at the limit of its known distribution.

Threatened species, populations or ecological communities at the limit of their distribution may be more sensitive to disturbance. Furthermore, their loss could result in regional extinction and range contraction, as well as loss of genetic diversity within the species, population or ecological community. Greater caution should therefore be applied to the management of their habitat.

In order to be in a position to be able to assess this factor, the decision-maker must ascertain the current known distribution of the species, populations or ecological communities known or expected to occur in the study area. From such information, the decision-maker will be able to identify whether any species, populations or ecological communities is at the limit of its known distribution.

Useful sources of information include databases such as the NPWS Atlas of NSW Wildlife and the Royal Botanic Gardens' database, recovery plans, flora and fauna reference books and scientific journals.

Figure 3. Stage 3: Evaluation of significance



3.4 STAGE 4: LEGISLATIVE AND ADMINISTRATIVE OUTCOMES OF THE '8 PART TEST'

3.4.1 What happens if the '8 part test' indicates that there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats?

If the consent or determining authority decides that the proposal is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats then:

(a) if Part 4 of the EP&A Act applies, the development application, pursuant to section 77(3)(d1) of the EP&A Act, must be accompanied by a SIS prepared in accordance with Division 2 of Part 6 of the TSC Act; or

(b) if Part 5 of the EP&A Act applies then, pursuant to section 112(1B) of the EP&A Act, the determining authority must not carry out an activity, or grant approval to an activity unless a SIS, or an environmental impact statement that includes a SIS has been prepared in accordance with Division 2 of Part 6 of the TSC Act; or

(c) the proposed development or activity may be modified such that a significant effect is unlikely. This will involve searching for alternatives and/or suitable amelioration. The '8 part test' must be applied to any modified proposal therefore ensuring that the effect will in fact, be insignificant.

In addition to the preparation of a SIS, the concurrence of the Director-General of National Parks and Wildlife or consultation with the Minister for the Environment is required pursuant to sections 77A, 77B, 112B or 112C of the EP&A Act, before the consent or determining authority can make a decision to grant the proposal.

3.4.2 Relationship between the '8 part test' and SISs

A SIS is prepared when the '8 part test' determines that a significant effect on threatened species, populations or ecological communities, or their habitats is likely. A SIS provides a more detailed assessment of threatened species issues and proposes measures to manage and mitigate adverse impacts on threatened species, populations or ecological communities, or their habitats resulting from the proposal. The information contained in the '8 part test' may be used in the preparation of a SIS.

3.4.3 Advising the applicant or proponent of the need to prepare a SIS

If the consent or determining authority decides that the proposed development or activity is likely to have a significant effect on threatened species, populations or ecological

communities, or their habitats, the consent or determining authority must advise the applicant or proponent of the need to prepare a SIS.

It is then up to the discretion of the applicant or proponent to decide whether to proceed with the development application or request for Part 5 approval and prepare a SIS, or to withdraw the application.

The decision to prepare a SIS should not be made without undertaking the '8 part test' and making reference to the register of critical habitat kept by the Director-General of National Parks and Wildlife.

3.4.4 Requests for Director-General's Requirements for SISs

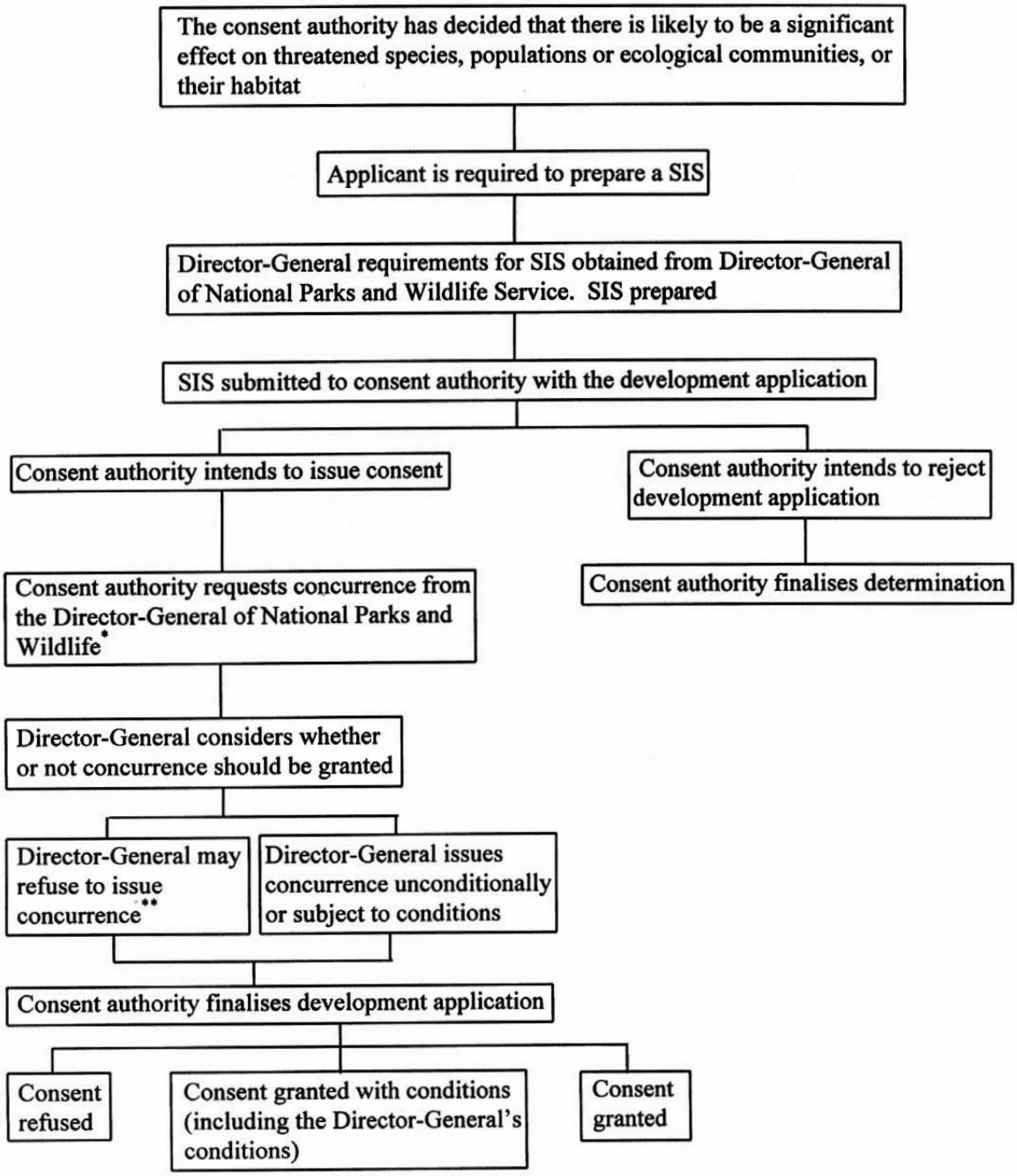
Prior to the preparation of a SIS a request for Director-General's requirements pursuant to section 111 of the TSC Act must be forwarded to the relevant NPWS Zone Office (Appendix A and B). Requests for Director-General's requirements should be accompanied by an '8 part test' and a copy of the development application or request for Part 5 approval and, any Statement of Environmental Effects or Review of Environmental Factors that may have been prepared. This ensures that the proper process of threatened species assessment under the EP&A Act is undertaken and that applicants and proponents undertake a level of assessment appropriate to the expected impacts.

The request for Director-General's requirements must be made by the applicant or proponent of the proposed development or activity.

The SIS must be prepared in accordance with sections 109 and 110 of the TSC Act and must comply with any requirements notified by the Director-General of National Parks and Wildlife.

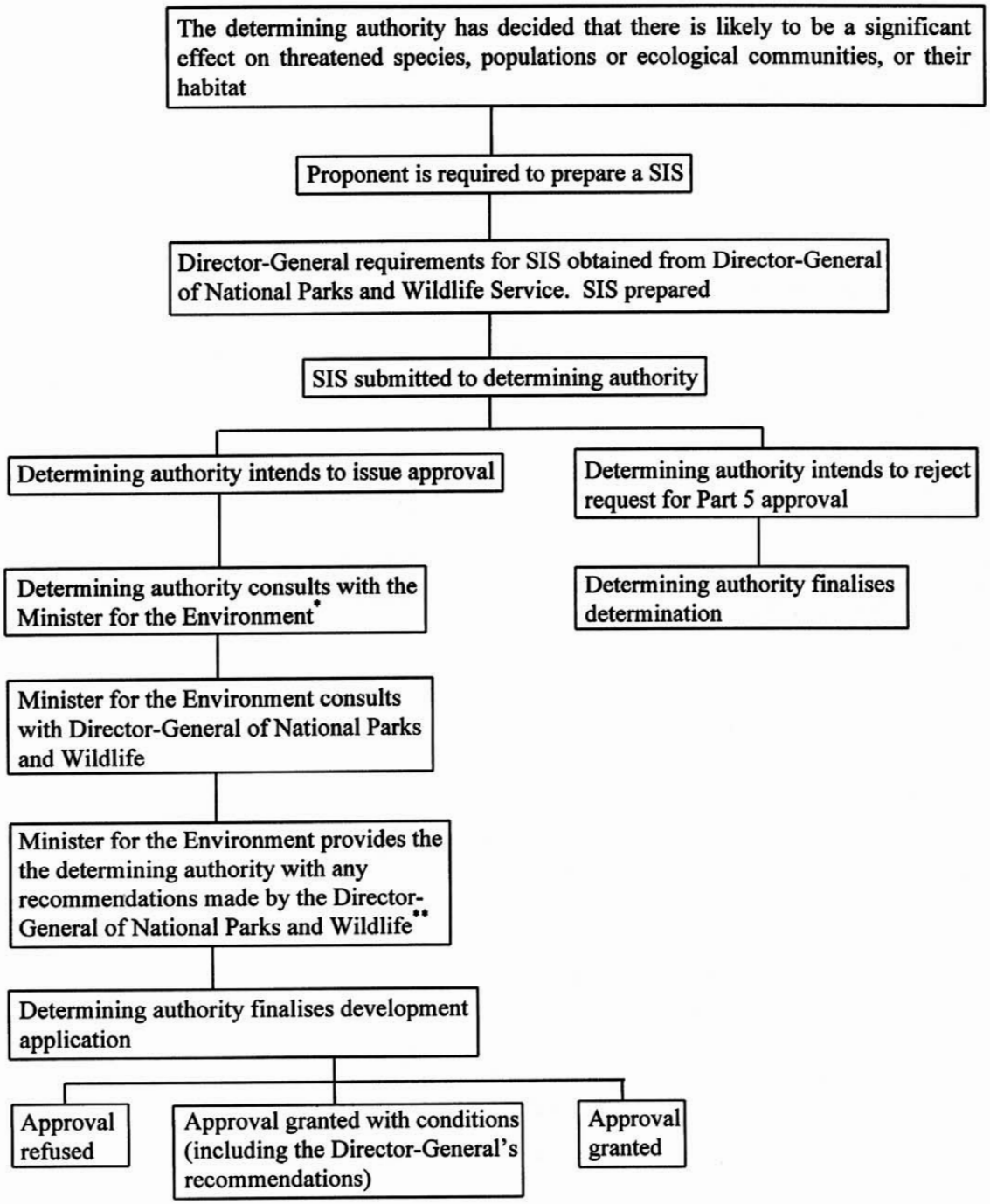
The NPWS is currently preparing an information circular which will outline the process and standards for SIS preparation.

Figure 4a. Stage 4: Outcomes arising from the evaluation of significance under Part 4 of the EP&A Act



* Where a Minister is a consent authority the need for concurrence is replaced by the requirement to consult with the Minister for the Environment, pursuant to section 77A(5).
** Consent authority obliged to refuse consent pursuant to s77A(1) and (2).

Figure 4b. Stage 4: Outcomes arising from the evaluation of significance under Part 5 of the EP&A Act



* Where a Minister is <u>not</u> the determining authority the need to consult with the Minister for the Environment is replaced by the requirement to obtain the concurrence of the Director-General of National Parks and Wildlife, pursuant to section 112C(1).

** If the Minister who is the determining authority does not accept any one or more of the recommendations, then the Minister's reasons for not accepting them must be outlined in the determination.

4.0 CONCLUSION

4.1 Relationship between '8 part test' recommendations and the proposal

The ameliorative measures proposed by both the '8 part test' (and any SIS produced) should be considered as being part of the proposal being considered for development consent under Part 4 of the EP&A Act or approval under Part 5 of the EP&A Act. These measures should therefore be fully detailed and integrated in the development or activity proposal and should be understood and accepted by the proponent of the development or activity.

4.2 Developments and activities which do not require consent or approval

Actions which do not require any form of consent under Part 4 or approval under Part 5 of the EP&A Act but may result in:

- the harming or picking of a threatened species, population or ecological community;
- damage to critical habitat; or
- damage to the habitat of a threatened species, population or ecological community,

must be assessed under the licensing provisions of Part 6 of the TSC Act.

The Director-General of National Parks and Wildlife, pursuant to section 94 of the TSC Act, is required to give consideration to the same factors as those contained within section 5A of the EP&A Act (ie. the '8 part test') when determining whether the proposed action is likely to have a significant effect on threatened species, populations or ecological communities, or their habitats.

The licensing provisions of Part 6 of the TSC Act will be addressed in subsequent information circulars released by the NPWS.

4.3 What is the role of the NPWS?

The NPWS can provide specialist advice on threatened species issues and impacts to consultants, applicants, proponents, consent and determining authorities undertaking threatened species assessment under the EP&A Act. However, it is not the responsibility of the NPWS to decide whether or not a SIS is required.

The NPWS has a decision-making role where concurrence under sections 77A or 112C has been requested, and for activities where the NPWS is a determining authority under Part 5 of the EP&A Act.

Where the concurrence of the Director-General of National Parks and Wildlife is required or where advice from the NPWS is sought, the relevant NPWS Zone Office should be the first point of contact.

The NPWS is currently preparing an information circular which explains the role of the NPWS in the concurrence and consultation provisions under the EP&A Act.

4.4 Consultants

The Threatened Species Unit maintains a register of fauna and flora consultants who have either contacted the NPWS directly or have responded to an advertisement calling for expressions of interest in consultancy work in animal and plant assessment. The data contained within the register may be obtained by contacting the Threatened Species Unit on (02) 9585 6575.

4.5 Acknowledgments

This information circular has been produced by the NPWS in consultation and with the assistance of the Department of Urban Affairs and Planning.

ROBYN KRUK
DIRECTOR-GENERAL

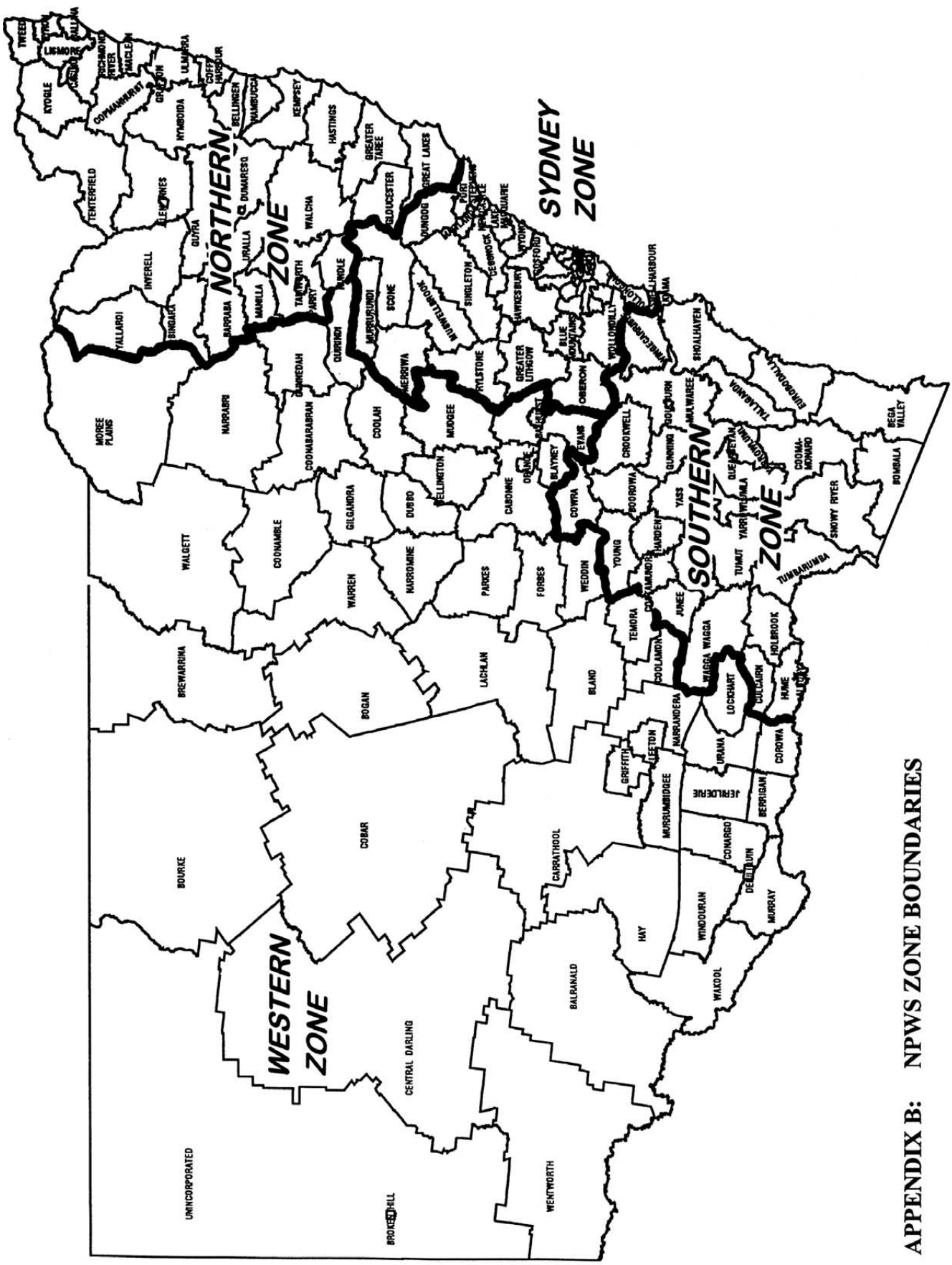
APPENDIX A: NPWS ZONE OFFICE CONTACTS

NPWS Western Zone Office
PO Box 1007
DUBBO NSW 2830
phone: (068) 832 222
fax: (068) 832 261

NPWS Southern Zone Office
PO Box 2115
QUEANBEYAN NSW 2620
phone: (06) 299 9700
fax: (06) 299 4281

NPWS Northern Zone Office
PO Box 914
COFFS HARBOUR NSW 2450
phone: (066) 515 946
fax: (066) 516 187

NPWS Sydney Zone Office
PO Box 1967
HURSTVILLE NSW 2220
phone: (02) 9585 6444
fax: (02) 9585 6442



APPENDIX B: NPWS ZONE BOUNDARIES

APPENDIX C: GLOSSARY

Activity means:

(a) the erection of a building;
(b) the carrying out of a work in, on, over or under land;
(c) the use of land or of a building or work;
(d) the subdivision of land;
(e) any act, matter or thing prescribed in an environmental planning instrument under section 26 of the EP&A Act as an activity,

but does not include any act, matter or thing for which development consent under Part 4 is required or has been obtained or is prohibited under an environmental planning instrument.

Consent authority, in relation to a development application means:

(a) the council having the function to determine the application; or
(b) the Minister, public authority (other than a council) or Director-General of Urban Affairs and Planning where specified in an environmental planning instrument.

Conservation reserves consists of those areas gazetted as National Parks, Nature Reserves and State Recreation Areas under the *National Parks and Wildlife Act 1974*, and those areas designated as Flora Reserves under the *Forestry Act 1916* (NSW DLWC, 1996).

Critical habitat means habitat declared to be critical under Part 3 of the TSC Act.

For the purposes of the TSC Act and other Acts, amended by the TSC Act, critical habitat is the whole or any part or parts of an area or areas of land comprising the habitat of an endangered species, an endangered population or an endangered ecological community that is critical to the survival of the species, population or ecological community.

Determining authority means a Minister or public authority:

a) by or on whose behalf an activity is to be carried out; or
b) whose approval is required in order to enable the activity to be carried out.

Development, in relation to land, means:

(a) the erection of a building on that land;
(b) the carrying out of a work in, on, over or under land;
(c) the use of land or of a building or work on that land; and
(d) the subdivision of that land,

but does not include any development of a class or description prescribed by the EP&A Act for the purpose of this definition.

Development application means an application for consent under Division 1 of Part 4 of the EP&A Act, to carry out development.

Ecological community means an assemblage of species occupying a particular area.

Endangered ecological community means an ecological community identified as such in Part 3 of Schedule 1 of the TSC Act.

Endangered population means a population identified as such in Part 2 of Schedule 1 of the TSC Act.

Endangered species means a species identified as such in Part 1 of Schedule 1 of the TSC Act.

Habitat means an area or areas occupied, or periodically or occasionally occupied, by a species, population or ecological community and includes any biotic or abiotic component.

Key threatening process means a threatening process identified as such in Schedule 3 of the TSC Act.

Likely* is taken to be a real chance or possibility.

Lifecycle means the sequence of events from the origin as a zygote, to the death of an individual (Lincoln *et al*, 1982).

Limit of its geographic range means the final or furthest boundary or point that a plant or animal species continues or extends to, in relation to the known geographical extent of distribution of that species (NSW DLWC, 1996).

Local population means a population that occurs within the study area, unless the existence of contiguous or proximal occupied habitat and the movement of individuals or exchange of genetic material across the boundary of the study area can be demonstrated.

Population means a group of organisms, all of the same species, occupying a particular area.

Proponent in relation to an activity, means:

a) any person proposing to carry out the activity;
b) State Forests of NSW in respect to forestry activities authorised by State Forests on land under the management of State Forests; or
c) any determining authority which the Minister certifies in writing to be the proponent of a particular activity or for which the regulation declares to be the proponent of an activity of the kind specified in the regulation.

Region means, for the purposes of the provision in which it is used, a bioregion defined in a national system of bioregionalisation that is determined (by the Director-General by order published in the Gazette) to be appropriate for those purposes. If the bioregion occurs partly within and partly outside New South Wales, the region consists only of so much of the bioregion as occurs within New South Wales.

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* Denotes that these terms have been referred to in a number of Land and Environment Court cases (see references at the end of this document).

The Director-General of National Parks and Wildlife, has determined pursuant to section 4(1) of the TSC Act and section 4(6A) of the EP&A Act that the national system of bioregionalisation identified in the map entitled "An Interim Biogeographic Regionalisation of Australia" and its accompanying report, "An Interim Biogeographic Regionalisation of Australia (IBRA): A Framework for Setting Priorities in the National Reserves System Cooperative Program". Version 4.0, published by the Australian Nature Conservation Agency on 31 March 1995, is appropriate for the purposes of the provisions in which the term "region" is used. Appendix E illustrates the IBRA regions which are applicable to NSW.

Risk of extinction - a species is at risk of extinction if its numbers are reduced to such a critical level, or its habitats have been so drastically reduced, that it is in danger of becoming extinct.

Significant* is taken to mean important, weighty or more than ordinary.

Species of animal or plant includes any defined sub-species and taxon below a sub-species and any recognisable variant of a sub-species or taxon.

Study area means the subject site and any additional areas which are likely to be affected by the proposal, either directly or indirectly.

Threatened species means a species identified as such in Part 1 or 4 of Schedule 1 or in Schedule 2 of the TSC Act.

Threatened species, populations and ecological communities means any species, populations and ecological communities identified as such in Schedules 1 and 2 of the TSC Act.

Threatened species, populations or ecological communities means a species, population or ecological community identified in either Schedule 1 or Schedule 2 of the TSC Act.

Threatening process means a process that threatens, or may have the capability to threaten, the survival or evolutionary development of species, populations or ecological communities.

Viable population means a population that has the capacity to live, develop and reproduce under normal conditions.

* Denotes that these terms have been referred to in a number of Land and Environment Court cases (see references at the end of this document).



APPENDIX D: REGIONS OF NEW SOUTH WALES

APPENDIX E: USEFUL SOURCES OF INFORMATION

Blakers, M., Davies, S.J.J.F., Reilly, P.N. (1984). The Atlas of Australian Birds.

Briggs, J.D & Leigh J.H. (1995). Threatened Australian Plants. CSIRO Publishing.

Cogger, H.G. (1996). Reptiles and Amphibians of Australia. Reed Books, Chatswood.

Harden, G.J. (1990-1993). Flora of New South Wales Vols 1-4. New South Wales University Press, Kensington.

Strahan, R. (1995). The Mammals of Australia. Reed Books, Chatswood.

NPWS Atlas of NSW Wildlife*

Royal Botanic Gardens Database, Sydney*

The Natural Resources Data Directory (available on CD ROM from Department of Land and Water Conservation)

Urban Bushland Biodiversity Survey Technical Reports (available late December from NPWS Sydney Zone)

Endangered Fauna of Western NSW (available from NPWS Western Zone)

North-East Forests Biodiversity Study Reports (available from NPWS Northern Zone)

Birds of Particular Conservation concern in the Western Division of NSW (1995) (available from NPWS Armidale District Office)

Reptiles of Particular Conservation concern in the Western Division of NSW (1996) (available from NPWS Armidale District Office)

Mammals of Particular Conservation concern in the Western Division of NSW (available October 1996 from NPWS Armidale District Office)

Any relevant Recovery Plans and/or Threat Abatement Plans

Any relevant LGA studies

Any relevant FISs/SISs/EISs

Any relevant fauna and/or flora surveys

* The NPWS Atlas of NSW Wildlife and the Royal Botanic Gardens' database are valuable resources, however, they should not be taken as a complete representation of our knowledge of the occurrence of species within NSW. These databases can only serve as an indication of what has been recorded within an area.

APPENDIX F: REFERENCES

Bailey v Forestry Commission of New South Wales (1989) 67 LGRA 200

Byron Shire Business for the Future Inc v Byron Council and Holiday Villages (Byron Bay) Pty Ltd (1994) 84 LGERA 434

Jarasius v Forestry Commission of New South Wales (1988) 71 LGRA 79

Lincoln, R.J., Boxshall, G.A. & Clark, P.F. (1982). A Dictionary of Ecology, Evolution and Systematics. Cambridge University Press, Cambridge.

Oshlack v Richmond River Shire Council and Iron Gates Development Pty Ltd (1993) 82 LGERA 222.

NSW Department of Land and Water Conservation. (1996). Definitions and Exemptions: State Environmental Planning Policy No. 46 - Protection and Management of Native Vegetation.

Thackway, R. & Cresswell, I.D. (1995). An Interim Biogeographic Regionalisation for Australia: A Framework for Setting Priorities in the National Reserves System Cooperative Program. Version 4.0. Australian Nature Conservation Agency, Canberra.

Section 2

Section 2
Project Description

2.0 PROJECT DESCRIPTION

2.1 Mineral Resource

The Cowal mineralisation is hosted within a sequence of Ordovician volcaniclastic rocks (informally named the Lake Cowal Volcanic Complex). The volcaniclastic sequence is intruded by several Late Ordovician diorite/gabbro stocks and mafic to intermediate dykes. There are numerous faults and shear zones which transect the orebody. The host rocks do not outcrop and are overlain by a Tertiary aged lateritic profile and Quaternary sediments.

Gold mineralisation primarily occurs in dilational quartz-carbonate-sulphide and carbonate ± quartz-sulphide veins. The veins occur throughout the deposit, yet observations during the 1995 feasibility study indicate that the proximity to faults and shear zones is the primary control. The veins have a consistent, and similar strike orientation of 305-310° and dip 30°-35° to the south-west. The veins are parallel-sided and range in thickness from less than 1 mm to 10 mm.

Sulphide mineralisation in the veins consists of pyrite, sphalerite, chalcopyrite, pyrrhotite and galena. Adularia is a common auxiliary mineral.

Some 76 Mt of ore (comprising approximately 3.2 million ounces of contained gold or 2.7 million ounces of recoverable gold) is to be mined and processed. Contained gold is the total mass of gold contained within the ore to be mined. Recoverable gold is that portion of the contained gold which is economically extractable. The gold ore is differentiated into oxide (20%) and primary ore (80%). The two ore types would be selectively handled and separated during mining and processing due to the different mineral processing requirements for gold extraction.

2.2 General Arrangement

The general arrangement of the Cowal Project has been designed to minimise environmental impact using the following criteria:

- Incorporation of environmental considerations and enhancements into all Project components.
- Construction of appropriate structures to enable the secure permanent diversion of up-catchment runoff, control of site water runoff and secure on-site containment of potentially contaminated water.
- Creation of a safe operating environment for employees, contractors and visitors (eg. through the separation of mine equipment and general traffic).
- Creation of a compact site layout in order to minimise the overall disturbance area and ore and waste haulage distances.
- Provision of all weather access to major infrastructure components.
- Progressive rehabilitation of the mine site during operation and complete rehabilitation following cessation of mining.
- Rehabilitated landforms to be compatible with the ecological status and critical conservation values of the Lake and its immediate surrounds.

The general arrangement of the mine site during construction (Year -1) and operational Years 1, 4, 8 and 9 to 13 is shown on Figures 2-1 to 2-5. Section 5 presents further general arrangements showing how progressive rehabilitation is achieved as well as representation of final site rehabilitation. The major infrastructure components included in the general arrangement design are:

- Open pit;
- Processing plant and associated infrastructure;
- Run-of-mine (ROM) ore stockpile pad;
- Low grade ore stockpile pad;
- Tailings storages;
- Waste rock emplacements;
- Lake protection bund;
- Temporary isolation bund;
- Sedimentation and erosion control structures;
- Water supply borefield and connecting pipeline;
- Open pit de-watering borefield and associated pipelines;
- Power supply line;
- Main access road;
- Internal roads and haul roads;
- Administration/site office area;
- Sewage treatment plant; and
- Contractors' areas.

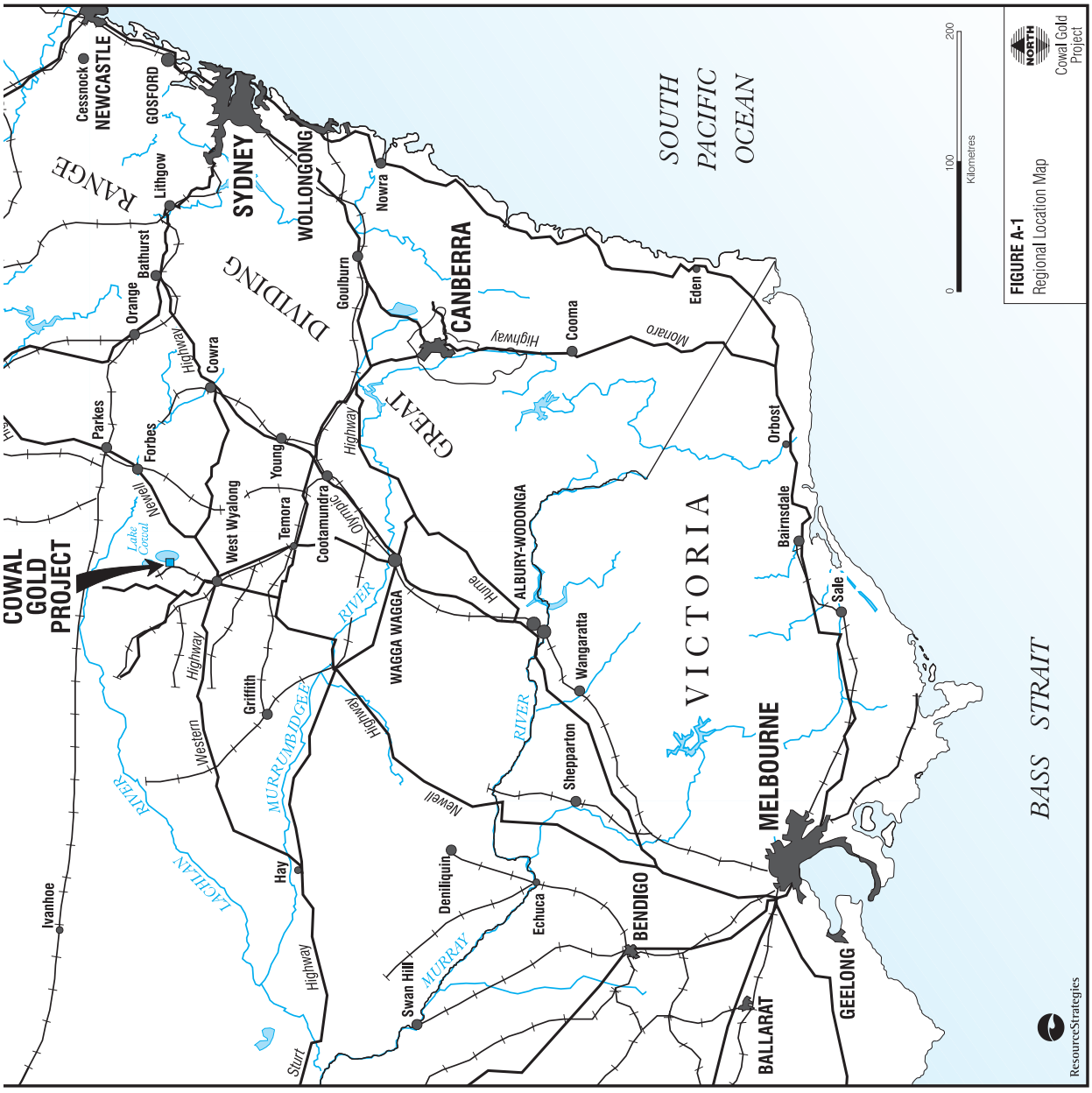
The location and design of the mine site layout incorporates the following key attributes:

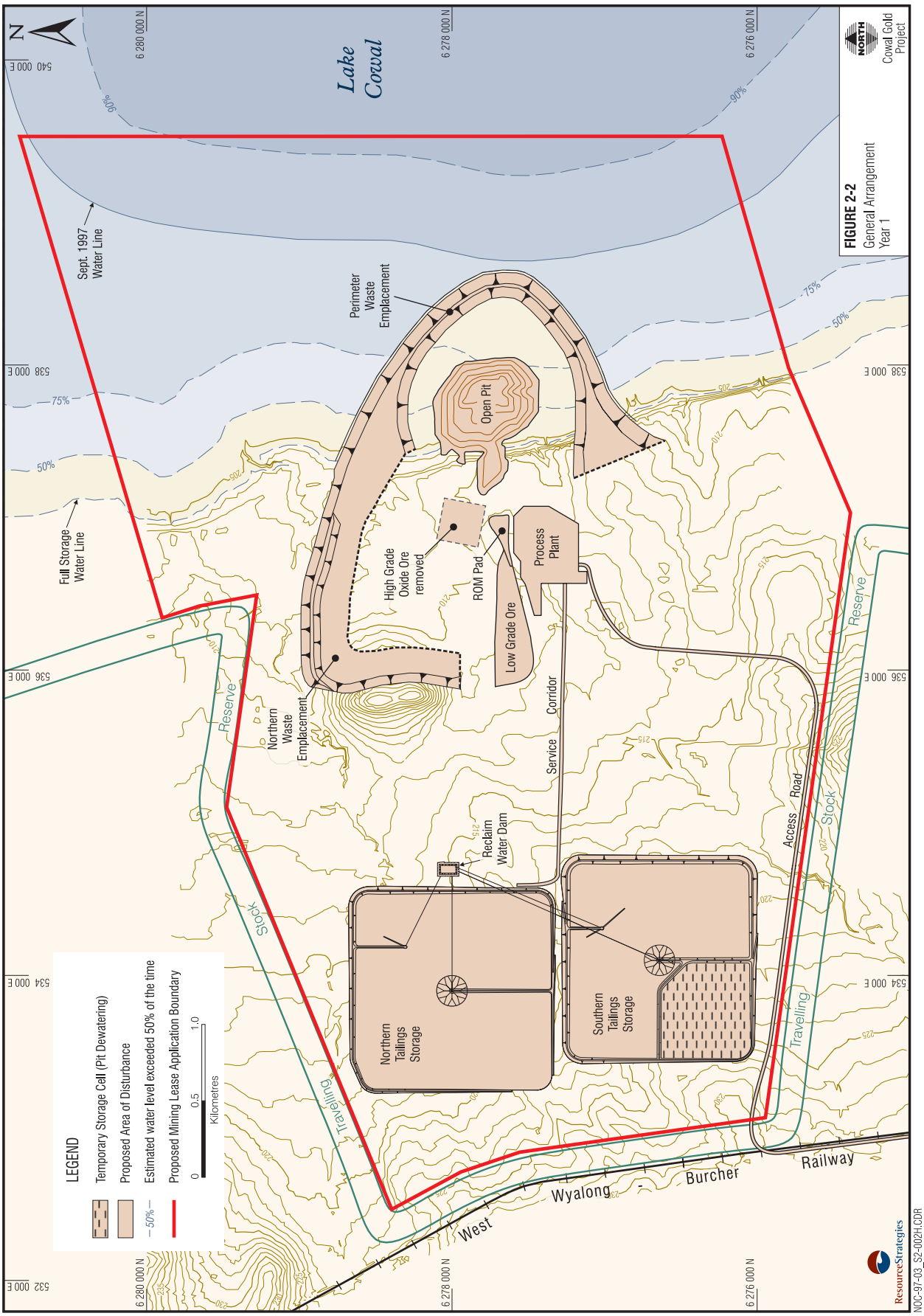
- Location of major infrastructure components (processing plant, ore stockpiles, waste rock emplacements) within a relatively small area adjacent to the open pit.
- Siting of the ore stockpile areas in close proximity to the processing plant.
- Location and design of the waste emplacement to form a low profile, stable final landform whilst, at the same time, minimising haul distances from the pit.
- Design of a lake protection bund and temporary isolation bund between the Lake and the open pit that is revegetated immediately after construction is completed. The revegetated landform (new Lake foreshore) has been designed to enhance its long term stability and compatibility with Lake foreshore features (Section 5).
- Siting of two tailings storages approximately 3.5 km to the west of the pit.

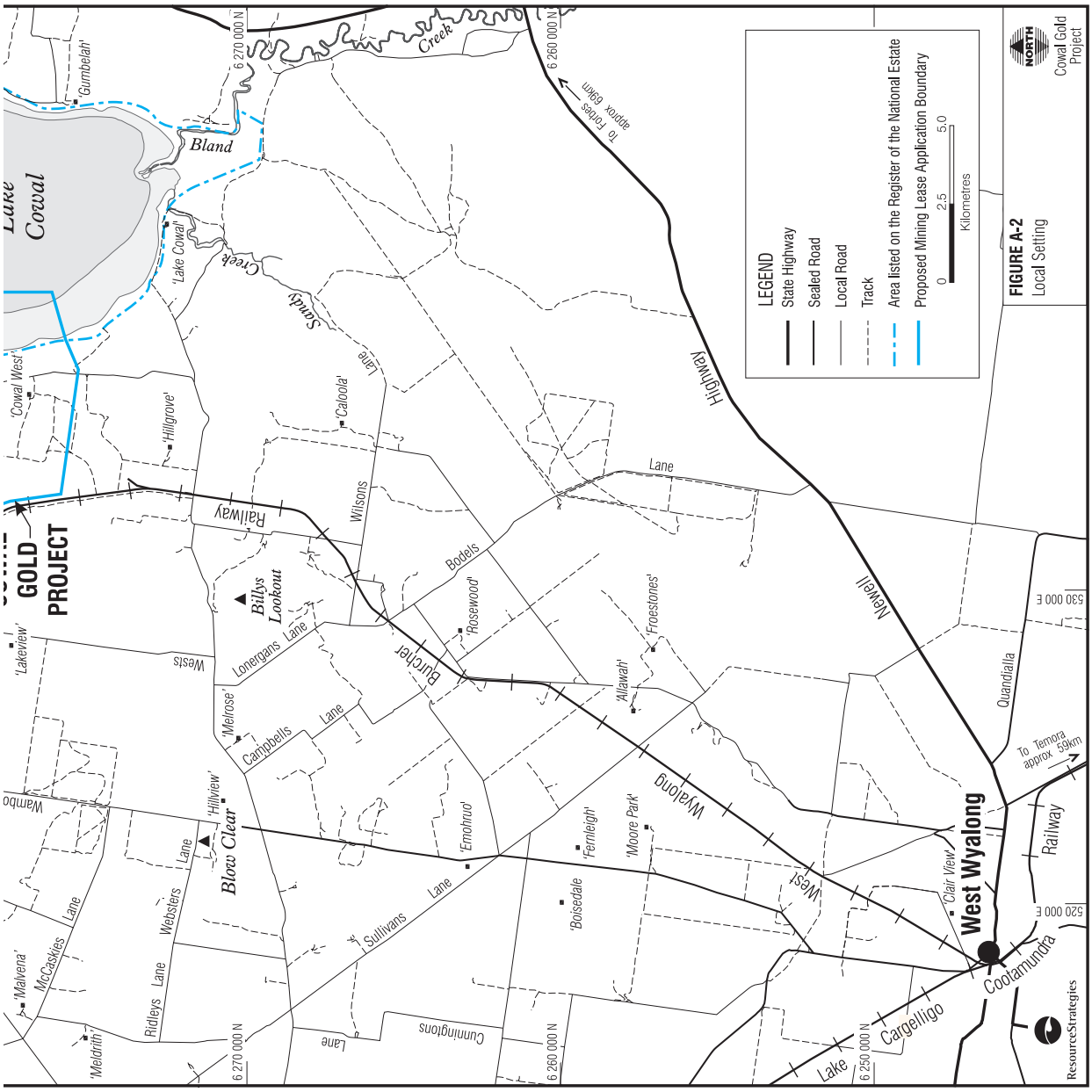
An overview of the proposed mine development is presented below.

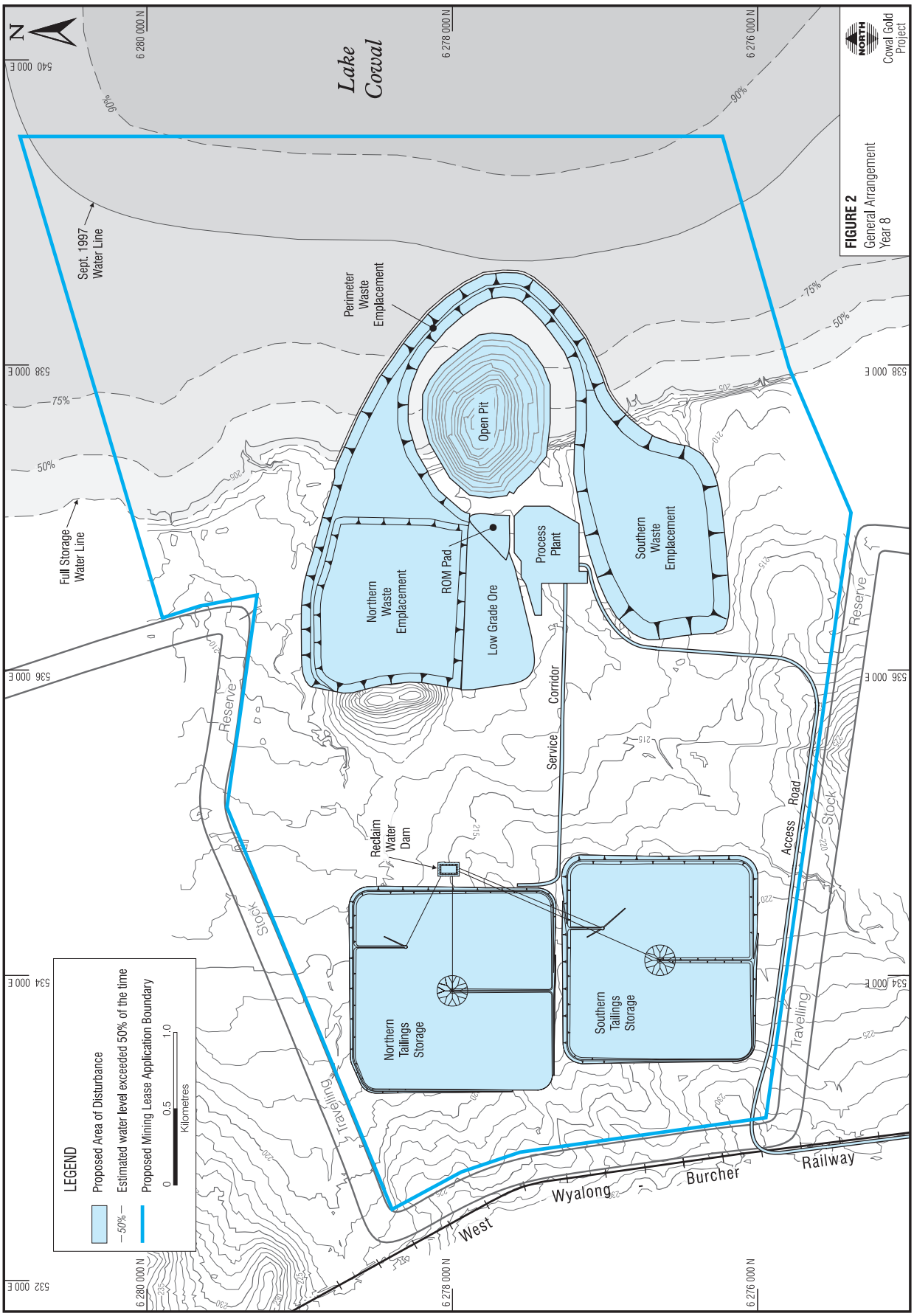
2.2.1 Mining Method Overview

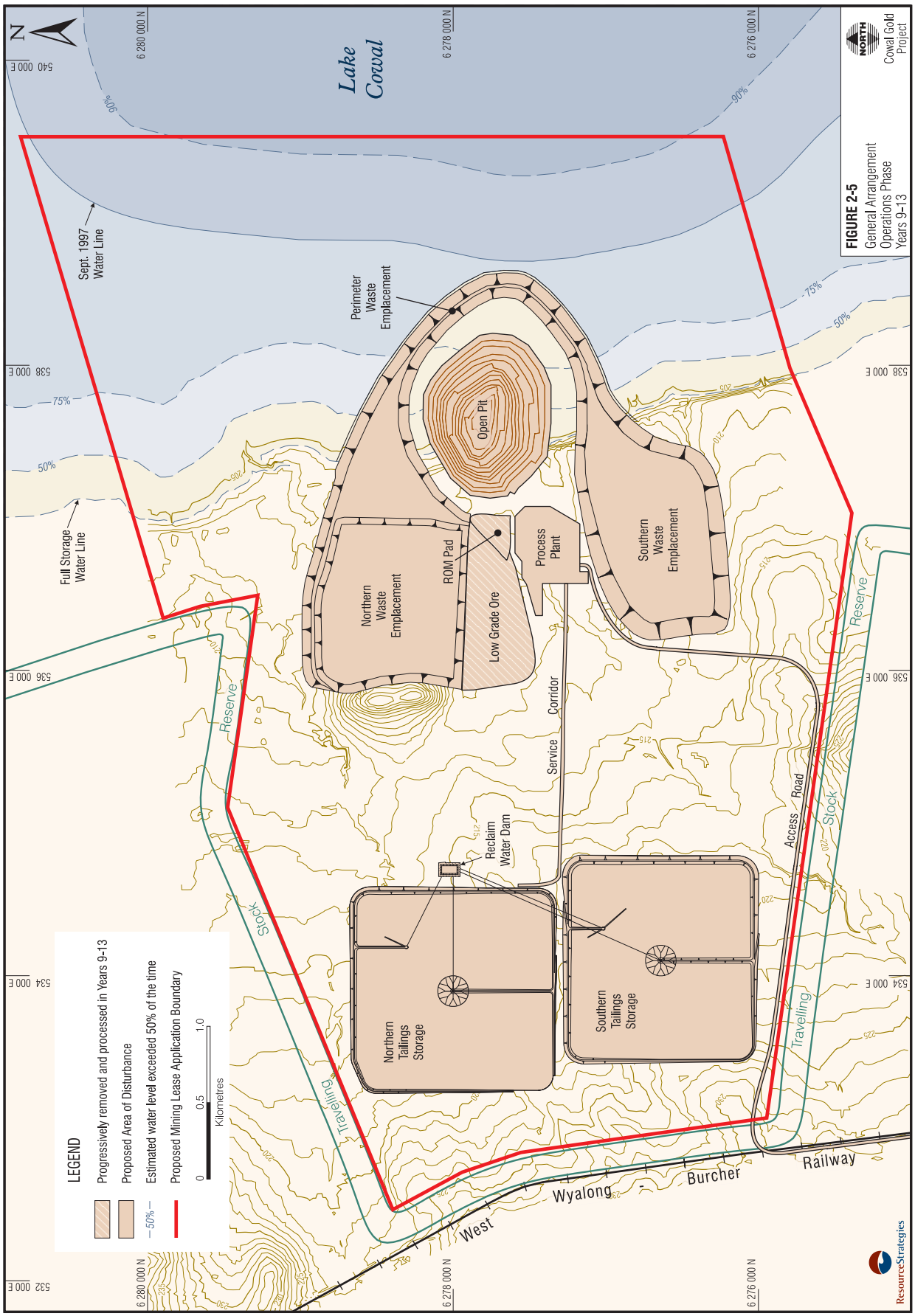
The disseminated distribution of gold bearing veins, relatively low grades and geometry of the Cowal orebody means that the mining of the deposit lends itself to open pit methods rather than underground extraction. Open pit


COWAL GOLD PROJECT
Lake Cowal
SYDNEY
NEWCASTLE
Cessnock
GOSFORD
WOLLONGONG
Nowra
CANBERRA
Goulburn
Lithgow
Bathurst
Orange
Cowra
Parkes
Forbes
Young
West Wyalong
Temora
Cootamundra
Griffith
Hay
Ivanhoe
Deniliquin
Swan Hill
Echuca
Shepparton
Wangaratta
ALBURY-WODONGA
WAGGA WAGGA
Cooma
Eden
Orbost
Bairnsdale
Sale
MELBOURNE
BENDIGO
BALLARAT
GEELONG
Highway
Western
Newell
Hume
Monaro
Olympic
RANGE
DIVIDING
GREAT
VICTORIA
SOUTH PACIFIC OCEAN
BASS STRAIT
MURRUMBIDGEE RIVER
MURRAY RIVER
LACHLAN RIVER
Sturt
0
100
200
Kilometres
NORTH
FIGURE A-1
Regional Location Map
Cowal Gold Project
ResourceStrategies
NOC-97-03_FF-023A.CDR


N
Lake Cowal
Cowal Gold Project
FIGURE 2-2
General Arrangement
Year 1
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
High Grade Oxide Ore removed
ROM Pad
Process Plant
Low Grade Ore
Northern Waste Emplacement
Service Corridor
Reclaim Water Dam
Northern Tailings Storage
Southern Tailings Storage
Access Road
Stock Reserve
Travelling Stock
Wyalong - West
Burcher Railway
90%
75%
50%
6 280 000 N
6 278 000 N
6 276 000 N
532 000 E
534 000 E
536 000 E
538 000 E
540 000 E
LEGEND
Temporary Storage Cell (Pit Dewatering)
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
ResourceStrategies
NDC-97-03_S2-002H.CDR


LEGEND
State Highway
Sealed Road
Local Road
Track
Area listed on the Register of the National Estate
Proposed Mining Lease Application Boundary
0
2.5
5.0
Kilometres
NORTH
Cowal Gold Project
FIGURE A-2
Local Setting
Lake Cowal
Bland
Creek
Gumbelah
'Cowal West'
'Lake Cowal'
Sandy Creek
'Hillgrove'
'Caloola'
Lane
Wilsons
Railway
Bodels
'Rosewood'
'Froestones'
'Allawah'
Billys Lookout
Lonergans Lane
Wests
'Lakeview'
'Melrose'
Campbells Lane
Buckiter
Newell
Highway
Wyalong
West
Quandialla
To Temora approx 59km
Railway
'Clair View'
West Wyalong
Cootamundra
Cargelligo
Lake
To Forbes approx 69km
6 270 000 N
6 260 000 N
6 250 000 N
520 000 E
530 000 E
Blow Clear
'Hillview'
Wambo
Lane
Websters Lane
McCaskies Lane
'Malvena'
Ridleys Lane
'Meldrith'
'Emohruo'
Sullivans Lane
'Fernleigh'
'Moore Park'
'Boisedale'
Cunningtons Lane
ResourceStrategies
NOC-97-03_FF-007C.CDR


N
Lake Cowal
Cowal Gold Project
FIGURE 2
General Arrangement
Year 8
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Reclaim Water Dam
Northern Tailings Storage
Southern Tailings Storage
Reserve
Stock
Travelling
Access Road
Railway
Burcher
Wyalong
West
6 280 000 N
6 278 000 N
6 276 000 N
532 000 E
534 000 E
536 000 E
538 000 E
540 000 E
50%
75%
90%
LEGEND
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
NOC-97-03_LT-002B.CDR


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Reclaim Water Dam
Northern Tailings Storage
Southern Tailings Storage
Access Road
Travelling Stock Reserve
Railway
Wyalong - West
Burcher
75%
50%
90%
6 280 000 N
6 278 000 N
6 276 000 N
532 000 E
534 000 E
536 000 E
538 000 E
540 000 E
LEGEND
Progressively removed and processed in Years 9-13
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
FIGURE 2-5
General Arrangement
Operations Phase
Years 9-13
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-005H.CDR

mining typically offers increased economies of scale by extracting larger tonnages of low grade ore and using relatively low cost bulk mining methods.

The open pit mining method proposed for the Cowal Project is typical of open pit mining operations throughout Australia and the world. The waste rock (rock containing no commercial gold) and ore (rock containing commercially viable quantities of gold) is broken through a routine sequence of in-pit drilling and blasting. Broken rock is loaded into large rear dump trucks using hydraulic excavators and hauled from the pit to be placed within dedicated waste rock emplacements or, in the case of ore, direct to the primary crusher or run-of-mine (ROM) stockpile. A provisional mining and ore processing schedule for the Cowal Project is presented in Table 2-1. A detailed mining schedule is presented in Table 2-4 and a detailed processing schedule is presented in Table 2-6.

The open pit mining method allows for the progressive deepening and widening of the pit as overburden is removed and the orebody exposed. The Cowal open pit would be progressively developed (deepened and widened) during the eight years of mining.

2.2.2 Ore Processing Overview

Broken ore would be hauled directly (or if necessary transferred from the ROM pad) to a primary crusher located adjacent to the processing plant where it would be crushed to a nominal 175 mm. The crushed ore would be conveyed to a crushed ore stockpile before being transferred by conveyors to the grinding circuit (semi-autogenous grinding (SAG) mill and ball mill).

The finely ground ore follows separate processing streams depending on whether oxide or primary ore is being milled. Primary ore would pass through a flotation circuit where the gold-containing sulphide minerals would be preferentially floated off as a concentrated "froth". This froth would be re-ground and transferred to a conventional Carbon in Leach (CIL) cyanide leaching circuit. The oxide ore would go directly to a separate and larger cyanide leaching circuit.

The gold extracted in the cyanide leaching circuit would be concentrated in the gold recovery circuit. The final product would consist of dorè bars which would be poured and temporarily stored in a dedicated gold room. The finely pulverised residual rock left over after flotation and leaching processes (tailings) would be treated to destroy cyanide to the prescribed limits then pumped to one of two tailings storages. Further detail on ore processing is presented in Section 2.6.

2.2.3 Associated Infrastructure Overview

Other infrastructure associated with mining and ore processing at the Cowal Project includes the water supply system, power supply network, external access route and internal roads. Raw water requirements for the Project would primarily be met through open pit dewatering, recycling within the processing plant and the tailings water decant and return system. Where the demand exceeds the available supply from these sources, make-up water would be pumped from an external groundwater borefield located approximately 20 km to the east-northeast. The borefield is located within the Bland palaeochannel and would be linked to the Project via a buried pipeline.

Electrical power supply to meet the demands of the Project would be supplied by a new 132kV line to be constructed from Temora. Details of the electricity transmission line are given in Appendix D. Road access to the site would be via an upgraded route from West Wyalong. Within the proposed MLA, haul roads and internal roads would be constructed as necessary to provide transport links between the processing plant, tailings storages, waste rock emplacements and open pit.

2.3 Project Construction

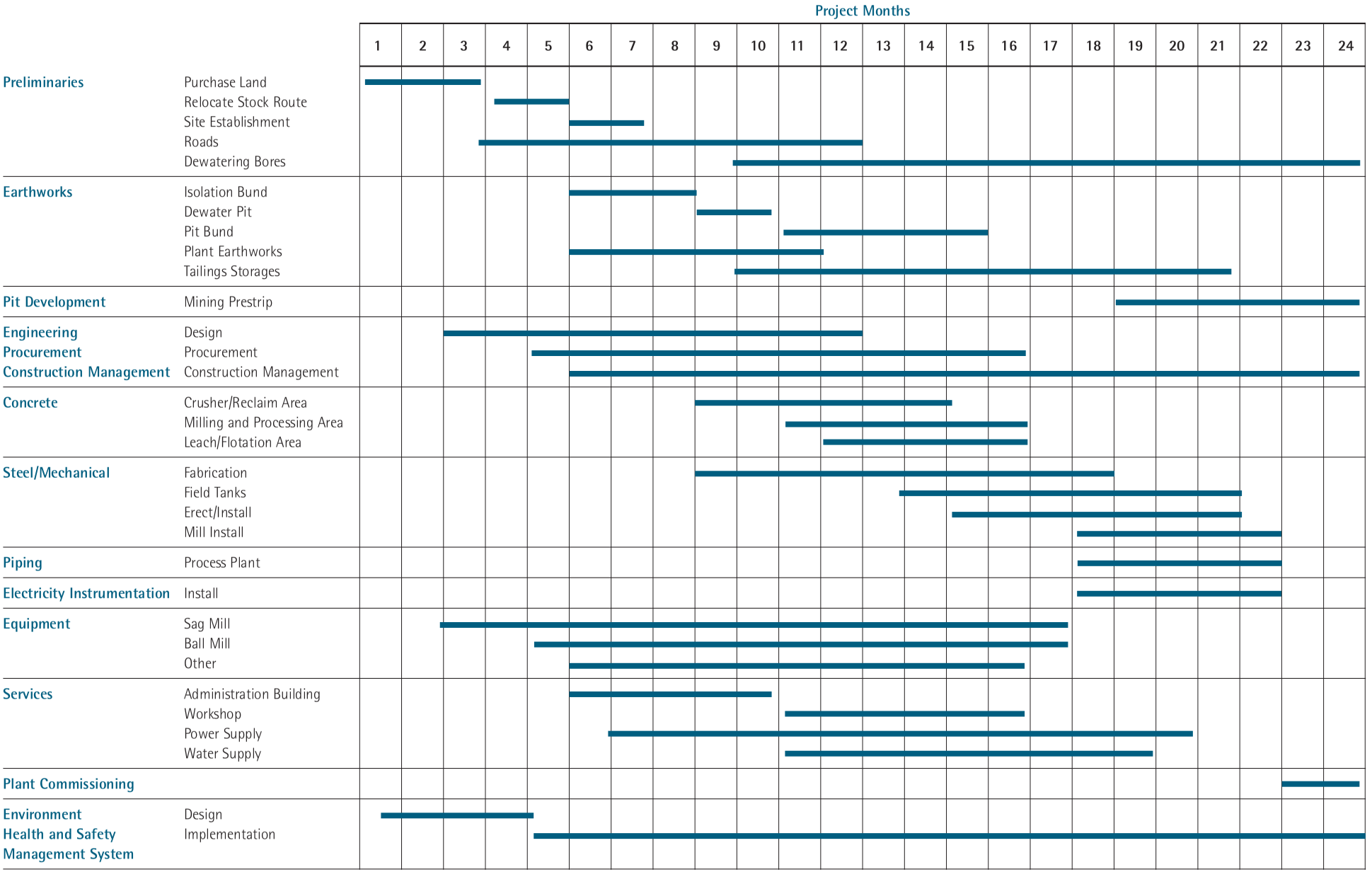
2.3.1 Pre-Construction and Construction Schedule

Table 2-2 presents a schedule for the proposed construction activities including the installation of the pit dewatering bores, temporary isolation bund, reconstructed foreshore,

Table 2-1 Provisional Mining and Processing Schedule

Phase	Year	Mined Ore (Mt)	Mined Waste (Mt)	Mined Total (Mt)	Total Ore Processed (Mt)
Construction/Pre-production	-2	0	0	0	0
	-1	1.7	13.8	15.5	0
Mining and Processing Operation	1	11.3	18.5	29.8	6.9
	2	10.6	20.9	31.5	6.1
	3	10.7	27.5	38.2	6.0
	4	9.7	24.4	34.1	6.0
	5	10.0	15.5	25.5	6.0
	6	7.7	2.5	10.2	6.0
	7	7.9	2.4	10.3	6.0
	8	6.6	2.6	9.2	6.1
Processing Only Operation	9	-	-	-	6.9
	10	-	-	-	6.0
	11	-	-	-	6.0
	12	-	-	-	6.0
	13	-	-	-	2.2
Total		**76.2**	**128.1**	**204.3**	**76.2**

Table 2-2 Construction Phase Schedule



tailings storages, processing plant, access road, administration building, and miscellaneous infrastructure. Construction of the tailings storage is detailed in Section 2.7.

The construction phase of the Cowal Project is scheduled to run for a period of approximately two years.

Pre-construction Stage
Prior to construction earthworks commencing, various pre-construction activities would be initiated. These would include the following:

- receipt of relevant approvals and licences to operate;
- completion of land acquisition;
- development of site management procedures (ie. sedimentation and erosion control, topsoil stripping and management);
- ordering of long lead time items for the processing plant; and
- tender and granting of construction contracts.

The pre-construction stage is estimated to take approximately five months and would include the design and development of an integrated Environmental Health and Safety Management System for the Project.

General Construction Stage
The general construction stage would involve development of the major infrastructure components of the mine in preparation for actual mining of the orebody.

The key activities include the construction of a new public road, internal main access road, other internal roads and haul roads, installation of power and water supply facilities, construction of the processing plant, tailings storage starter embankments, construction of the temporary isolation bund and lake protection bund surrounding the open pit. Dewatering of the open pit using a series of bores would also be initiated. The resulting water would be stored in temporary storage areas located in the south-west corner of each tailings storage.

Construction/Pre-production Stage
Towards the end of the construction phase all of the mine's major infrastructure components would be tested and commissioned prior to actual mining commencing. This stage would involve commissioning of the processing plant, tailings storages, and the power and water supply networks.

The construction/pre-production stage would also involve pre-stripping the open pit area. Earthmoving equipment would be used to selectively strip and stockpile soils and weathered overburden. The weathered sequence consists of the following layers in order of occurrence from the surface:

- a thin non-saline organic rich layer of lake sediment (up to 0.3 m thick and predominantly occurring below the Lake high water mark);
- a thicker layer of low salinity Lake sediment (extending from approximately 0.3 m to 5 m below the surface);
- transported cover material consisting of interbedded clay, sand and gravel varying in depth over the pit area (5 m to 55 m);
- oxide material broadly differentiated into soft oxide material (occurring at depths of 40 m to 65 m and consisting of extremely weathered clayey silt saprolite) and hard oxide material (occurring at depths 60 m to 90 m and consisting of partially weathered host rocks); and
- primary material – unweathered host rock generally occurring at depths below 90 m and consisting of volcaniclastics, diorites and lavas.

Assessments of the physical and chemical properties of these layers have been performed and are detailed in Appendices B (Soils) and C (Waste Characterisation). The use of the pre-stripped materials for construction and rehabilitation purposes is dictated by their properties.

Some 500,000 tonnes of soft oxide ore would be mined during the pre-stripping stage and placed in a temporary stockpile located north of the processing plant area (Figure 2-1). This stockpile would be processed and removed in Year 1 of operations once the processing plant is commissioned (Figure 2-2). In addition, approximately 1,180,000 tonnes of low grade ore would be mined and placed in the low grade stockpile (Figure 2-1).

2.3.2 Site Preparation

Prior to the commencement of construction activities, appropriate site management procedures for surface preparation would be formulated. These procedures would include management of vegetation removal, sedimentation and erosion control and soil stripping/placement. These activities are discussed further in Sections 2.5, 2.7 and 2.9 and detailed in Section 5.

2.3.3 Construction Issues

Due to the location of the proposed open pit below the high water mark of Lake Cowal, a series of isolation embankments would be constructed. These would be located between the Lake and the open pit in order to prevent inflow of water from the Lake into the open pit development area during periods of high water levels (Figure 2-6). In order of construction timing and proximity to the Lake these structures are:

- temporary isolation bund; and
- lake protection bund.

Details of the construction of these structures and other construction phase issues particular to the Cowal Project are presented below.

Temporary Isolation Bund
The temporary isolation bund would be located closest to the Lake and is designed to control water inflow to the pit development area from the Lake during construction of the lake protection bund.

The temporary isolation bund would be constructed using inert rock material likely to be sourced during pre-stripping of the waste rock emplacement and open pit. Borrow pits may also be used to source suitable material where necessary. The bund would have batter slopes of 1(V):5(H) and 1(V):4(H) on the Lake and open pit sides respectively.

The height of the bund would increase from zero at the edges of the arc to a maximum of up to 2 m in the centre.

The temporary isolation bund would be developed by end-tipping fill, working at both ends of the temporary isolation bund/shoreline intersection in an arc toward the centre. The movement of trucks during construction would be used to achieve the required compaction levels of the bund.

Fill used for construction would be tested for geochemical and geotechnical suitability prior to construction commencing. Suitable fill would be sufficiently impermeable, with low dispersivity and low salinity and would not be acid forming.

Following completion of the temporary isolation bund, any water that has collected in the now enclosed open pit development area (or water that permeates the bund wall following construction) would be de-watered to a water storage area adjacent to the eastern edge of the open pit before construction of the lake protection bund commences. Water collected in this storage would be pumped to a temporary storage cell located in the tailings storage. Details of the Project's Water Management System are provided in Section 2.9.

The temporary isolation bund is a short-term feature used to isolate the pit from the Lake during the construction phase while the lake protection bund is constructed. Accordingly, once this new bund is constructed and revegetated, its isolation function would be superseded. Decommissioning and rehabilitation of the temporary isolation bund would be in accordance with rehabilitation and long term compatibility goals (Section 5).

Lake Protection Bund

The lake protection bund is a low permeability embankment designed to prevent water inflow (during periods of high lake water level) from the Lake into the open pit development area over the life of the mine and over the long term.

The design of the lake protection bund has been formulated to meet the following objectives:

- Provision of a low permeability barrier between the open pit and Lake Cowal.
- Development of a revegetated, low profile stable permanent landform.
- Revegetation of the embankment and remnant isolation bund as early as possible in the mine life to permit early re-establishment of the foreshore ecotone (Section 5).

The lake protection bund would be located behind the temporary isolation bund (closer to the pit). It would be constructed to RL 208.25 m. Below RL 207.75 m it would be built as a two-zone earthfill embankment and would meet specific engineering criteria for compaction to ensure that the required compaction densities are achieved. Topsoils within the footprint of the bund would be excavated to a depth of approximately 1 m if required.

The lake protection bund would be constructed from suitable low salinity lake sediments sourced from within the open pit development area. Once the structure is constructed to its final height, topsoil (organic lake bed sediments previously stripped from the open pit development area) would be applied to the surface to provide a suitable growth medium for reformation of the foreshore habitat and ecotone.

Perimeter Waste Rock Emplacement

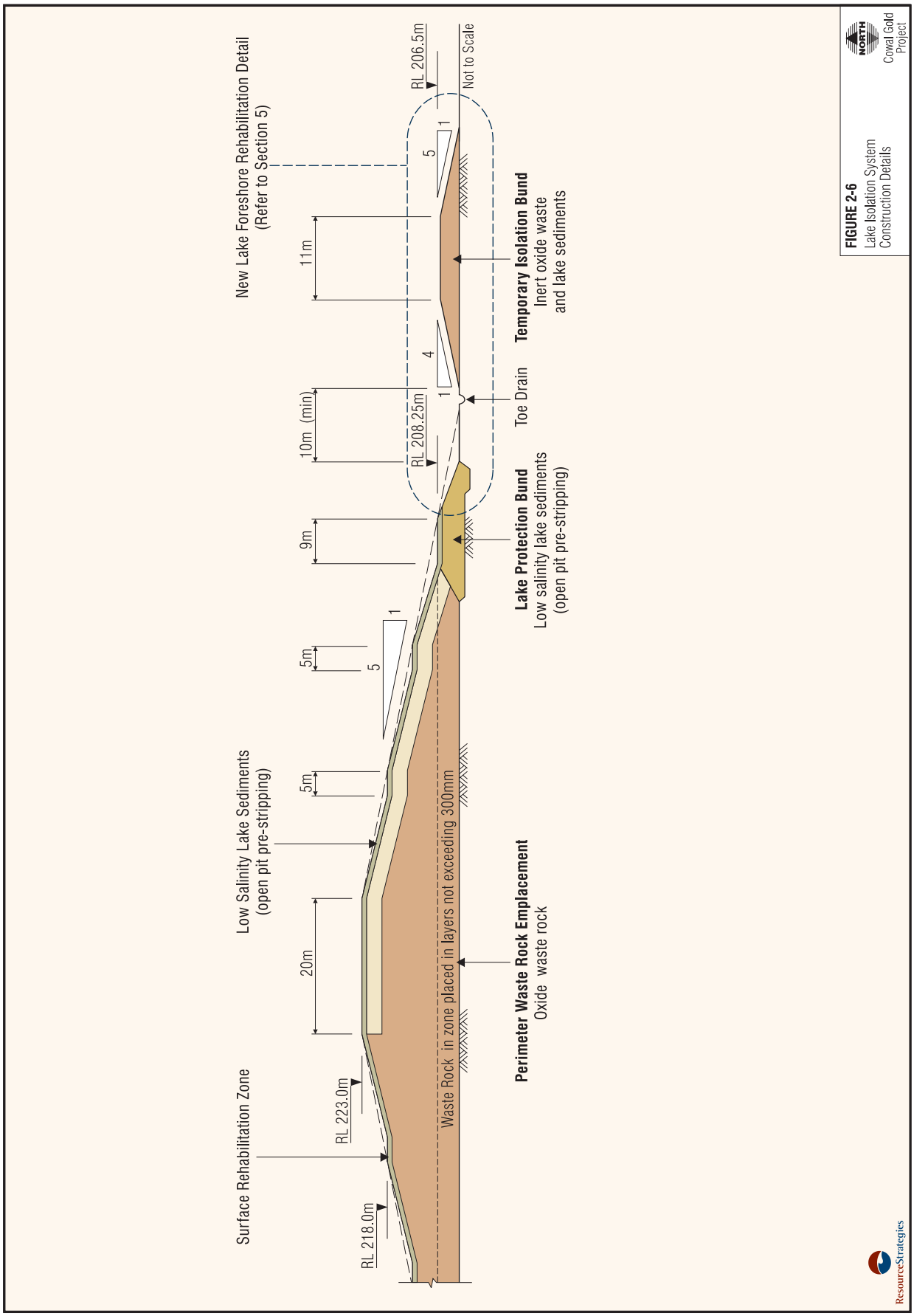
The perimeter waste rock emplacement would be constructed to RL 223 m and would surround the pit to the north, east and south. The emplacement would be located behind the lake protection bund (Figure 2-6) and would be constructed from oxide mine waste rock with the outer face constructed from low salinity topsoils/soils. The emplacement elevation has been designed to reduce potential noise and light impacts of mining and processing on the surrounding environment.

The perimeter waste rock emplacement would be constructed in approximately 5 m lifts built up to a maximum height of approximately 18 m above ground level. The outer batter profiles would be 1(V):5(H) with reverse graded berms installed at vertical height intervals of approximately 5 m. Development of the emplacement would commence during pre-stripping with the eastern portion reaching the final RL of 223 m and other parts being built up to RL 216 m (Figure 2-1). During Year 1 the embankment would be lengthened and raised to the final RL on the northern and southern sides of the open pit (Figure 2-2). This would complete the shielding of the open pit to the east, north and south. Placement of the remaining waste rock material in the following years would occur in the northern waste emplacement (up to RL 243 m) and southern waste emplacement (RL 223 m). Section 2.5.3 describes the waste rock emplacement construction process.

Borrow Pits

The main access road to the mine site, haul roads and other internal roads would be constructed using in-situ rock and soil materials. Borrow pits would be excavated to provide the necessary crushed gravel and clay materials. Local clay would be excavated for use as liner material and in the low permeability central cores of the tailings storages and embankments/bunds surrounding the pit. Borrow pits would be located within the proposed tailings storage areas. Additional borrow pits for road construction would be located within existing council borrow pits. Road aggregate would be sourced from existing established quarries.

Waste rock from the open pit would be used for construction material in preference to opening new borrow pits or quarries. However the geotechnical and geochemical properties of potential rock would be used as the primary tool in assessing suitability for construction.


New Lake Foreshore Rehabilitation Detail
(Refer to Section 5)
RL 206.5m
Not to Scale
11m
5
1
4
1
10m (min)
RL 208.25m
Toe Drain
Temporary Isolation Bund
Inert oxide waste
and lake sediments
9m
Lake Protection Bund
Low salinity lake sediments
(open pit pre-stripping)
5m
5
1
Low Salinity Lake Sediments
(open pit pre-stripping)
5m
20m
Perimeter Waste Rock Emplacement
Oxide waste rock
Waste Rock in zone placed in layers not exceeding 300mm
Surface Rehabilitation Zone
RL 223.0m
RL 218.0m
FIGURE 2-6
Lake Isolation System
Construction Details
Cowal Gold
Project
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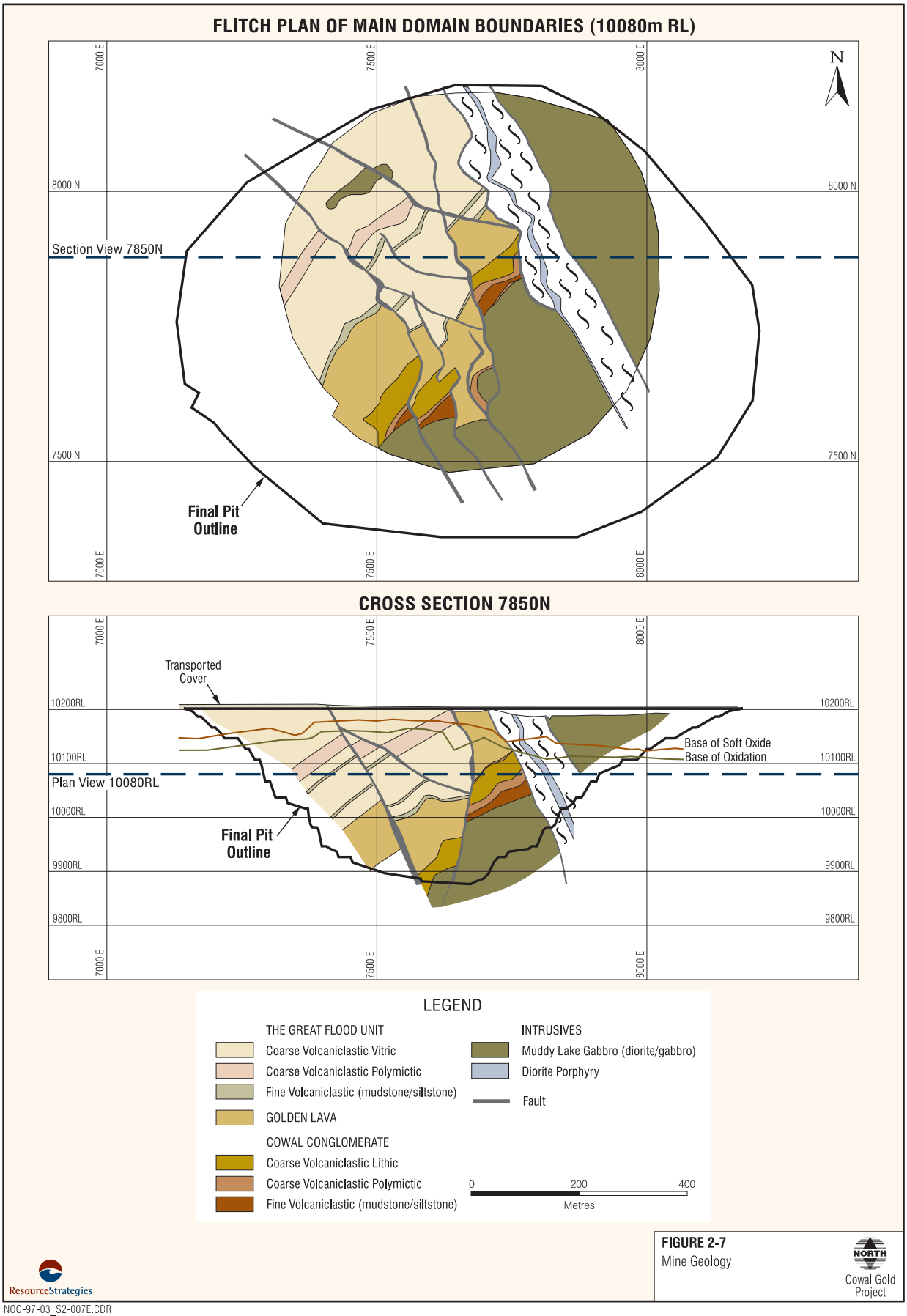


FIGURE 2-7
Mine Geology

Cowal Gold Project

ResourceStrategies

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Soil Stripping
The general strategy of soil management would be to strip soil resources from beneath all proposed mine disturbance areas within the proposed MLA. Stripped non-saline soils would be stored in dedicated stockpile areas for re-use during construction and progressive rehabilitation works. Stripped soils not suitable for construction or rehabilitation would be placed in the waste rock emplacements. Soil resource management strategies are detailed in Section 5 and Appendix B.

Electricity Transmission Line
A new high voltage line (132 kV) would be constructed from Temora, located approximately 90 km to the south, to supply the Project's operational power requirements (Appendix D).

Concrete Batch Plant
All concrete requirements for the Project during construction would be supplied from a batch plant to be temporarily located on site.

2.3.4 Transport Issues
An assessment of the existing traffic conditions in the immediate Project area and the estimated increase in traffic generated during construction and operation is contained in Appendix J.

Transport activity would vary significantly over the two year construction period. Traffic generation from the site would be associated with the movement of an average of 200 employees on a daily basis, six days a week. Mine traffic during the construction phase would consist of light, heavy and oversize vehicles.

Light Traffic
During the construction phase light traffic would consist of cars and mini buses used for employee travel to and from the site. The number of light vehicles travelling to and from the site is expected to vary as construction progresses. However, it is anticipated that the overall average would be in the order of 40 light vehicles per day. Car pooling and the use of buses and mini-buses would be encouraged for construction workers in order to minimise the quantity of light vehicle traffic.

Heavy Traffic
Heavy vehicle traffic would also vary during the construction phase (typically linked to the scheduling of activities). An average of two heavy vehicles per day during construction is anticipated. Heavy vehicles would be required for the delivery of construction materials (fabricated materials), mobilisation of mine plant and delivery of mine and process consumables.

Oversize Traffic
Oversize traffic (including overweight, overheight or overlength loads unable to be dismantled and transported via conventional heavy transport means) is expected to occur mainly during the construction phase. An average of one oversize vehicle per week is anticipated.

2.4 Mine Operation

2.4.1 Open Pit Mining Schedule
The proposed mining method is a conventional open pit, occurring in stages as the pit is widened and progressively deepened. Figure 2-7 shows the final pit plan and section in relation to key geological features. The mining schedule is presented in Table 2-1. The final mine pit would be approximately 1,000 m long, 850 m wide and 325 m deep.

Peak mining activity would occur in Year 3 (38.2 Mt). The bulk of mining activity would occur during Years 1 to 5.

Mining of the open pit is expected to cease in Year 8. At this point, the Project would process previously stockpiled ore (approximately 26.7 Mt) to Year 13.

2.4.2 Pit Dewatering
Potential surface water and groundwater inflows would be managed as part of a pit dewatering programme. Potential sources of water inflow are from surface water runoff during wet weather and groundwater inflows (from intersected aquifers).

Surface Water Inflows
Significant surface water inflow is most likely to be the result of occasional heavy rainfall events. The catchment area draining to the open pit during operation would be restricted to the pit itself and a small perimeter area enclosed by an external bund. Water management structures would be installed to divert water from other areas of the site outside this bund to site runoff collection ponds. The pit would also act as a final water containment point in extreme rainfall events.

The open pit design includes water management structures (face seepage collection drains) and in-pit sumps in the floor of the pit. The in-pit sumps would be sized to store runoff from a medium sized (1 in 10 year) rainfall event. Pumps would be installed with sufficient capacity to remove the ponded water from the design event to the process water storage pond within 48 hours.

Groundwater Inflows
Groundwater and mine dewatering assessments undertaken by Coffey Partners International Pty Ltd (1995a, October 1997) indicate the open pit would intersect three known aquifers during development. Flow modelling indicates that groundwater inflow from these aquifers may be approximately 10 ML/day over the first three months of operation, reducing to approximately 5 ML/day over the life of the mine.

Using the predicted groundwater inflow rates, a staged pit dewatering programme has been developed. The programme involves the installation of a line of five sacrificial bores to the south of the anticipated pit outline for Year 1. These bores would be used for a period of approximately 12 months (or until the pit is expanded beyond the Year 1 outline). In addition to the sacrificial bores, 21 bores would be installed in a ring outside the final pit outline. Fifteen of these bores (permanent bores) would be operational

throughout the life of the mine. The remaining six bores (deferred bores) would be commissioned approximately 6 months prior to the sacrificial bores being lost. Figure 2-8 shows the approximate proposed location of the pit dewatering bores.

The dewatering programme would be initiated approximately 6 months prior to the commencement of the pre-production stage to allow time for groundwater levels to drop. The location of the dewatering bores would be targetted to coincide with structures/features (shear zones, fractured dykes and faults). A network of piezometers would also be installed to monitor draw-down levels during the life of the mine.

Water pumped from the dewatering bores is expected to be highly saline and would be pumped to the tailings storages. Detail on water management strategy and design is provided in Section 2.9.

2.4.3 Mine Fleet

Mining equipment required to extract the ore and waste rock would consist of hydraulic excavators, haul trucks (180 and 135 tonne capacity), front end loaders, dozers (wheeled and tracked), graders and drill rigs. The estimated number of each equipment type during each year of mining is presented in Table 2-3.

2.5 Mine Waste Management

2.5.1 Waste Rock Quantities

Approximately 128 Mt of waste rock would be removed from the pit during the 8 years of mining. The maximum quantity of waste rock to be mined in any one year would be 27.5 Mt (Year 3). Following Year 3, waste rock quantities would progressively decrease as the ore-to-waste ratio improves. The type of ore and quantity of waste rock to be removed during each year of operation is presented in Table 2-4.

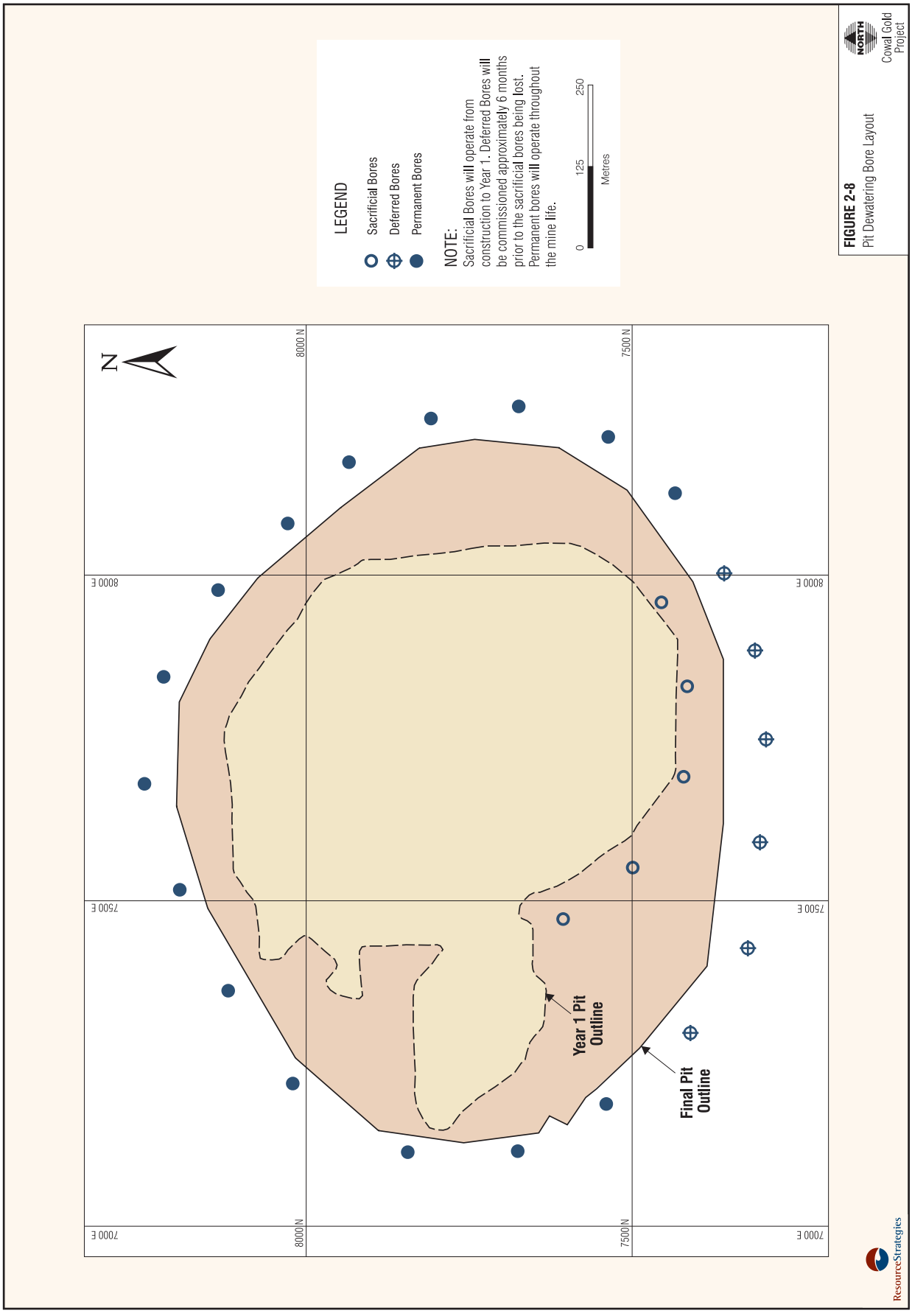
Table 2-3 Contractor Mining Equipment Schedule of Requirements

Item	Approximate Capacity	Typical Number Required in each Year of Operation								
		Year-1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Hydraulic excavator	350 t	1	1	1	1	1	1	1	1	1
Hydraulic excavator	200 t	1	1	1	1	1	1	1	1	1
Trucks	180 t	3	3	4	6	6	4	2	2	2
Trucks	135 t	2	3	3	3	3	3	2	2	2
Front-end Loader	992D	1	1	1	1	1	1	1	1	1
Tracked dozer	D10N	2	2	2	2	2	2	2	2	2
Wheel dozer	Tiger 690	1	1	1	1	1	1	1	1	1
Water tanker	70,000 l	1	1	1	1	1	1	1	1	1
Grader	16G	1	1	1	1	1	1	1	1	1
Drills	165-204 m	–	2	3	3	3	3	2	2	2

Table 2-4 Mine Production Schedule[1]

Oxide Ore	Ore Type	Unit	Year of Operation									Total Tonnes & Average Grade (g/t)
			Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Years 9-13	
	Soft Oxide Ore	Tonnes	500,000	3,625,700	213,400	172,200	71,400	21,000	0	0	0	0	4,603,700 1.45
	Soft Oxide Ore (Low Grade)	Tonnes	1,180,600	3,433,400	711,872	816,200	229,620	41,000	0	0	0	0	6,412,692 0.73
	Hard Oxide Ore	Tonnes	0	2,095,000	370,000	380,000	60,000	85,000	0	0	0	0	2,990,000 1.38
Primary Ore	Upper Volcanic	Tonnes	0	253,330	930,472	1,402,252	1,240,826	3,030,380	703,580	249,300	131,640	0	7,941,780 1.56
	Upper Volcanic (Low Grade)	Tonnes	0	1,115,514	3,342,904	3,668,752	3,384,592	3,827,910	1,711,860	1,899,140	1,335,140	0	20,275,812 0.74
	Lower Volcanic/ Lava/Other	Tonnes	0	322,604	2,579,022	2,552,100	3,163,654	2,808,960	2,953,000	4,066,540	1,771,946	0	20,217,826 1.66
	Diorite	Tonnes	0	422,084	2,490,506	1,716,596	1,595,520	160,660	2,343,420	1,684,160	3,373,860	0	13,786,806 1.71
	Waste Rock	Tonnes	13,819,400	18,451,086	20,945,220	27,515,040	24,385,780	15,533,970	2,459,760	2,360,040	2,570,560	0	128,040,856
	Total Mining	Tonnes	15,500,000	29,718,718	31,583,396	38,223,140	34,131,392	25,508,880	10,171,620	10,249,180	9,183,146	–	204,269,472

[1] North Limited (1997)


LEGEND
Sacrificial Bores
Deferred Bores
Permanent Bores
NOTE:
Sacrificial Bores will operate from construction to Year 1. Deferred Bores will be commissioned approximately 6 months prior to the sacrificial bores being lost. Permanent bores will operate throughout the mine life.
0
125
250
Metres
N
8000 N
7500 N
7000 E
7500 E
8000 E
Year 1 Pit Outline
Final Pit Outline
FIGURE 2-8
Pit Dewatering Bore Layout
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-008D.CDR

2.5.2 Geochemical Characteristics of Pre-strip Materials and Waste Rock

Geochemical characterisation has been conducted for open pit waste rock material and mine tailings in order to identify waste types, assist the development of waste handling strategies and minimise potential adverse environmental impacts (EGi, 1997). The geochemical characterisation included evaluation of acid forming characteristics and assessment of element enrichment and solubility. A detailed account of the geochemical characterisation of mine waste is presented in Appendix C.

Samples of Lake sediments, oxide waste and primary waste were tested in the soil assessment and geochemical characterisation progamme. In summary:

- Lake sediments from within the pit area were found to be non-acid forming with low salinity for the first 5 m in depth and saline afterwards;
- oxide and primary waste types were also classified as non-acid forming. However, high natural salinities (oxide waste) and the potential to develop high salinity/soluble salts (primary waste) were identified.

2.5.3 Waste Rock Emplacement Construction

Waste rock would be placed in a continuous waste emplacement surrounding the open pit consisting of three areas:

- Northern waste rock emplacement;
- Southern waste rock emplacement; and
- Perimeter waste rock emplacement.

The development of the emplacement areas over the mine life is shown on Figures 2-1 to 2-5 and Table 2-5.

Northern Waste Rock Emplacement

The northern waste rock emplacement has been designed to contain the majority of the waste rock generated from the mine. The emplacement will be located to the north-west of the pit, adjacent to the low grade ore pad (Figures 2-1 to 2-4). The emplacement would have a roughly square plan shape and would occupy an area of approximately 150 ha. The outer batters would be constructed with reverse graded berms installed as necessary. Waste rock would be placed in the northern waste rock emplacement from Years 1 to 8 starting on the outside (northern edge) and working inwards, progressively raising the height to a final RL of 243 m. Figure 2-9 shows the proposed construction sequence of the waste rock emplacement.

The northern waste rock emplacement has been designed to meet the long term goal of containing potentially saline seepage generated from waste emplacement areas during operation and post-closure. Construction would involve surface preparation works to facilitate the direction of any permeating waters towards the open pit. The existing topography of the footprint would be altered by stripping topsoil and subsoil from the southern portion of the footprint. In addition, oxide waste rock would be placed and compacted (using haul truck movements) in the northern portion of the footprint. The resulting basement for the emplacement would slope towards the open pit and would provide drainage control. Any waters permeating through the emplacement are expected to be intercepted by this layer and preferentially flow towards the open pit.

Southern Waste Rock Emplacement

The southern waste rock emplacement would be constructed during Years 1 to 5. It is located to the south-west of the open pit, adjacent to the processing plant and workshop area. The emplacement would be constructed to a final RL of 223 m and occupy an area of approximately 115 ha.

Surface preparation works to facilitate drainage of any infiltrating waters towards the open pit would also be constructed for the southern waste rock emplacement.

Perimeter Waste Rock Emplacement

The perimeter waste rock emplacement forms an arc on the eastern side of the pit from the main waste rock emplacement to the southern waste rock emplacement. The emplacement would occupy an area of approximately 50 ha. It forms part of the series of embankments (ie. temporary

Table 2-5 Waste Emplacement Construction Details

Design Detail/Year	Northern Waste Rock Emplacement	Southern Waste Rock Emplacement	Perimeter Waste Rock Emplacement
RL @ Year -1	Not yet constructed	Not yet constructed	216 and 223
RL @ Year 1	223	Not yet constructed	223
RL @ Year 2	223	217	223
RL @ Year 3	226.5	223	223
RL @ Year 4	237	223	223
RL @ Year 5	240	223	223
RL @ Year 6	241	223	223
RL @ Year 7	242	223	223
RL @ Years 8 to 13	243	223	223
Final Top Surface RL	243	223	223
Approximate Final Surface Area (ha)	150	115	50

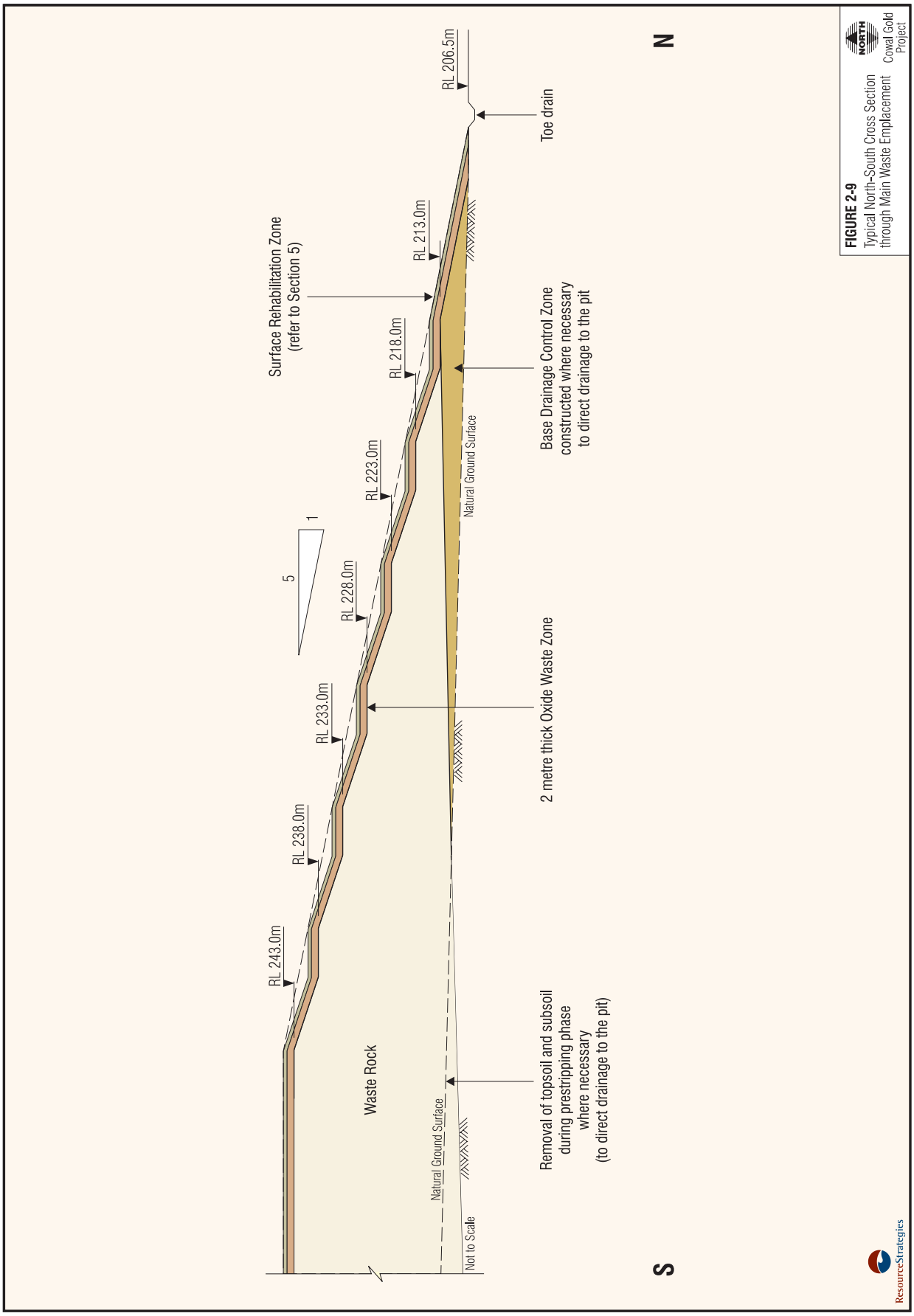


FIGURE 2-9
Typical North–South Cross Section through Main Waste Emplacement
Cowal Gold Project

isolation bund and lake protection bund) between the open pit and Lake Cowal. Section 2.3.3 and Figure 2.6 provides a description of the construction of these embankments.

2.6 Ore Processing

2.6.1 Process Overview

Figures 2-10 and 2-11 show simplified process flow sheets for the processing of oxide and primary ores.

The oxide ore would be processed at a nominal rate of about 7 Mtpa and primary ore at approximately 5.5 to 6.4 Mtpa.

The processing plant has been designed for an overall availability of 90%. The estimated hourly feed capacity of the plant is approximately 890 tph for oxide ore and approximately 815 tph for primary ore.

The plant has been designed in a "U"-shape for compactness and ease of access. Figure 2-12 shows the proposed layout for the processing plant and administrative area.

2.6.2 Ore Segregation

Ore segregation into primary and oxide ore types would be necessary as distinct processing technologies would be applied to each type within the mineral processing system. Oxide ore makes up approximately 20% of total ore mined with the remaining 80% being primary ore. The majority of the oxide ore would be processed in Years 1 and 9 (approximately 6 Mt each) with some processed in Years 2 and 8.

Low grade ore (oxide and primary) would be placed in a dedicated stockpile during mining (Years 1 to 8). This material would be processed during Years 9 to 13.

Table 2-6 is a provisional processing schedule indicating the modelled volumes and grades of each ore type over the life of mine.

2.6.3 Primary Crushing

A single gyratory crusher would be installed for crushing ore. It would be located on the southern side of the ROM pad. The crusher would be loaded by rear dumping trucks on one side of a dump hopper. Crushed ore would be transported by a conveyor to a stockpile. Water sprays to minimise the potential for dust generation would be fitted.

2.6.4 Grinding

Ore would be reclaimed from the crushed ore stockpile and conveyed to the grinding circuit. The grinding circuit consists of a semi-autogenous (SAG) mill and ball mill. The SAG and ball mills would have 11 m and 6.7 m diameters respectively. Water would be added to the mills to transport the finely ground ore as a slurry. Ground primary ore would go to the flotation circuit, while oxide ore would go to the cyanide leaching circuit.

2.6.5 Flotation (Primary Ore)

The flotation circuit would only be used for the processing of primary ore. The purpose of a flotation circuit is to concentrate the gold-bearing portion of the ore slurry (as described in Section 2.6.11). The ore slurry would come from the grinding circuit and would be mixed with process reagents in a series of flotation tanks. Within the flotation tanks a gold-containing froth (overflow) representing approximately 8% of the ore feed and containing some 93% of the gold would be collected.

A re-grind mill would be used to grind the flotation concentrate from a grain size of approximately 80 µm to 80% passing 15 µm. The re-ground flotation concentrate slurry would pass to the CIL circuit for leaching (Section 2.6.6).

Once the gold-bearing froth has been removed, the residual material (tailings) would be pumped to a thickener that separates (using flocculants) some of the excess water for process water recycling (primarily in the grinding circuit). The tailings would then be recombined within tailings from the CIL circuit and pumped to the tailings storages for disposal.

2.6.6 Primary Ore Concentrate Leach and Adsorption Circuit

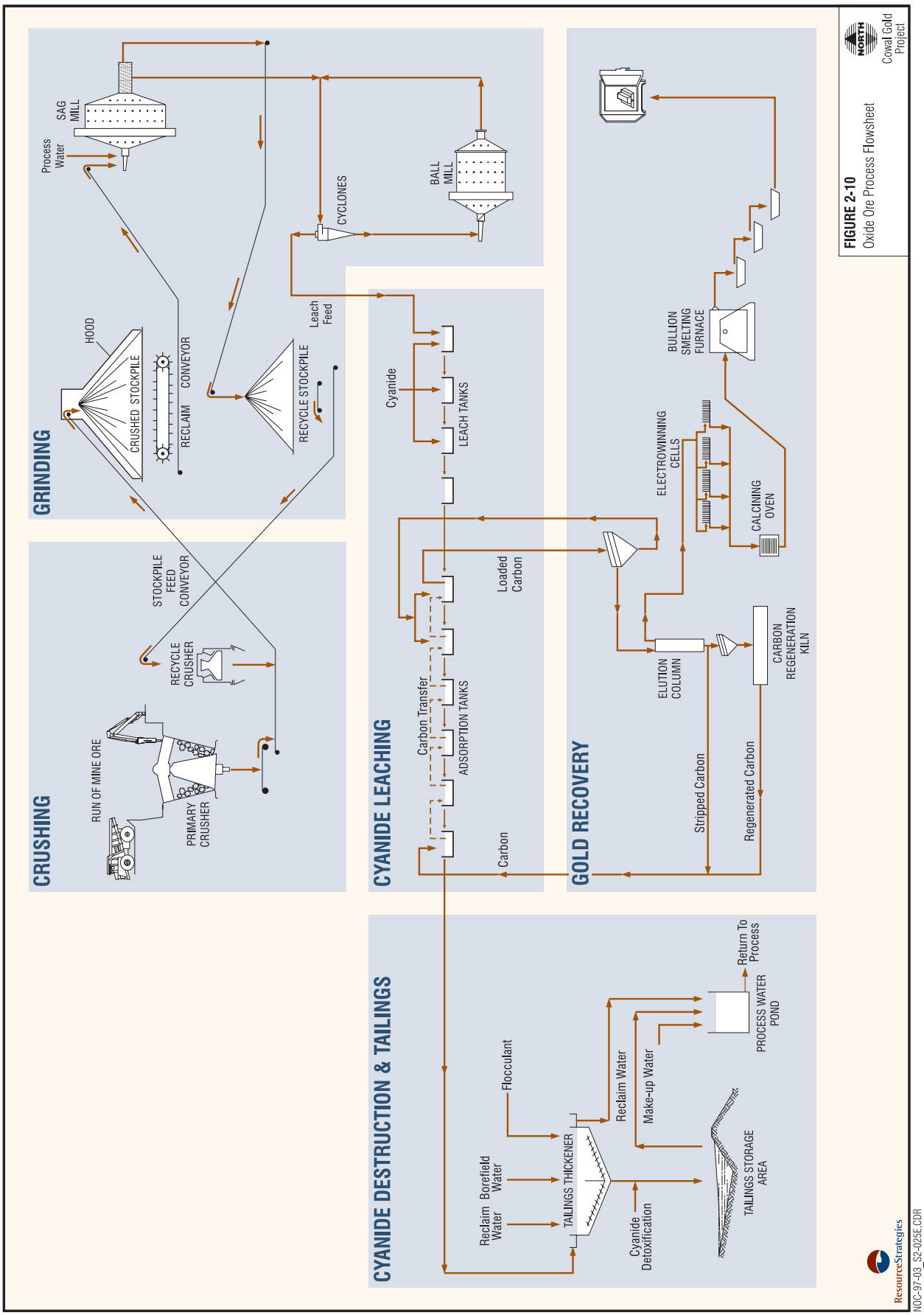
The primary ore leach/adsorption circuit would consist of a series of 8 enclosed agitated CIL tanks (7.6 m diameter by 8 m high) where sodium cyanide and oxygen would be added to leach gold from its host mineral. The flotation concentrate slurry would be fed directly to the first of the eight tanks at a nominal rate of 33 tonnes per hour. The concentrate slurry would overflow continuously from tank 1 through to tank 8 in the series with the expected overall leaching time being approximately 48 hours (at a feed rate of 33 tonnes per hour). Leaching time may be reduced to 24 hours if the ore addition rate is increased to the maximum capacity of 65 tonnes per hour.

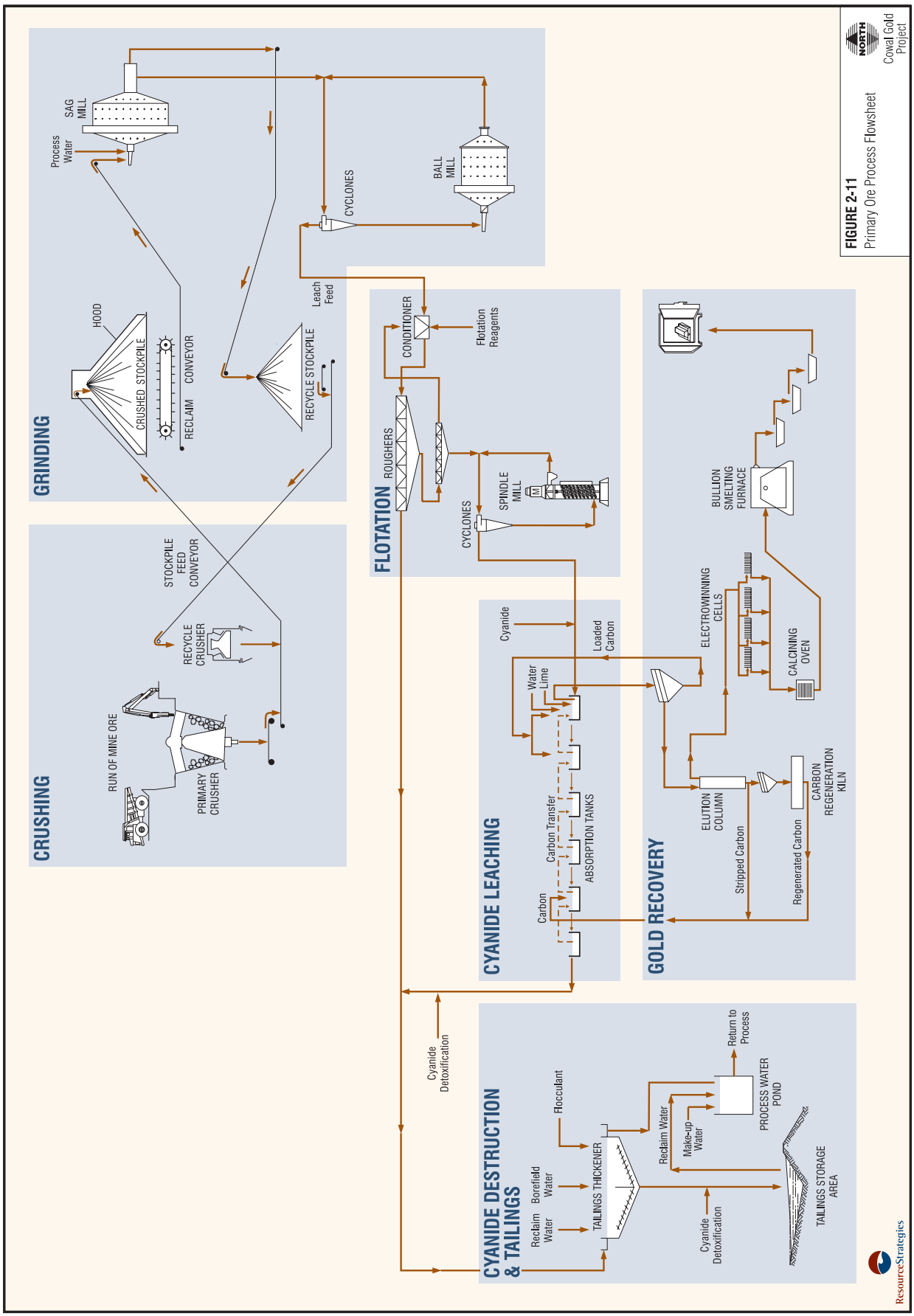
By passing from tank to tank the slurry would progressively lose its gold content as the gold is first liberated then adsorbed onto carbon pellets also contained in the tanks. The slurry from the last tank (tank 8) would be effectively barren and would be removed, thickened and, following treatment to destroy cyanide, (Section 2.6.9) deposited as tailings.

The carbon would be added to the circuit via tanks 7 and 8 and would be progressively transferred from tanks 7/8 to tank 1. The flow of carbon would be counter current to the flow of the slurry. The quantity of gold adsorbed onto the carbon would progressively increase as it passes from tank to tank. The loaded carbon in the first tank would be removed in 2 tonne batches screened from the slurry and would be transferred to the gold recovery circuit. Once the gold has been removed the carbon would be regenerated and returned for reuse.

2.6.7 Oxide Ore Leach and Adsorption Circuit

The oxide ore leach and adsorption circuit would consist of ten agitated tanks (16.5 m diameter by 16 m high), four for leaching and six for leaching/adsorption. The ground oxide ore from the grinding circuit would be fed into the tanks at a nominal rate of 889 tonnes per hour with an estimated residence time of 22 hours. Sodium cyanide and compressed air would be added to the first three tanks.


GRINDING
CRUSHING
CYANIDE LEACHING
GOLD RECOVERY
CYANIDE DESTRUCTION & TAILINGS
SAG MILL
Process Water
BALL MILL
CYCLONES
HOOD
CRUSHED STOCKPILE
RECLAIM CONVEYOR
RECYCLE STOCKPILE
Leach Feed
STOCKPILE FEED CONVEYOR
RECYCLE CRUSHER
RUN OF MINE ORE
PRIMARY CRUSHER
Cyanide
LEACH TANKS
Loaded Carbon
Carbon Transfer
ADSORPTION TANKS
Carbon
BULLION SMELTING FURNACE
ELECTROWINNING CELLS
CALCINING OVEN
ELUTION COLUMN
CARBON REGENERATION KILN
Stripped Carbon
Regenerated Carbon
Return To Process
PROCESS WATER POND
Flocculant
Reclaim Water
Make-up Water
Borefield Water
Reclaim Water
TAILINGS THICKENER
Cyanide Detoxification
TAILINGS STORAGE AREA
FIGURE 2-10
Oxide Ore Process Flowsheet
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-025E.CDR


GRINDING
SAG MILL
Process Water
BALL MILL
CYCLONES
HOOD
CRUSHED STOCKPILE
CONVEYOR
RECLAIM
RECYCLE STOCKPILE
Leach Feed
CRUSHING
STOCKPILE FEED CONVEYOR
RECYCLE CRUSHER
RUN OF MINE ORE
PRIMARY CRUSHER
FLOTATION
ROUGHERS
CONDITIONER
Flotation Reagents
CYCLONES
SPINDLE MILL
CYANIDE LEACHING
Cyanide
Loaded Carbon
Water Lime
Carbon Transfer
ABSORPTION TANKS
Carbon
GOLD RECOVERY
BULLION SMELTING FURNACE
ELECTROWINNING CELLS
CALCINING OVEN
ELUTION COLUMN
CARBON REGENERATION KILN
Stripped Carbon
Regenerated Carbon
CYANIDE DESTRUCTION & TAILINGS
Cyanide Detoxification
Flocculant
Return to Process
Reclaim Water
Borefield Water
TAILINGS THICKENER
Reclaim Water
Make-up Water
PROCESS WATER POND
Cyanide Detoxification
TAILINGS STORAGE AREA
FIGURE 2-11
Primary Ore Process Flowsheet
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-026E.CDR

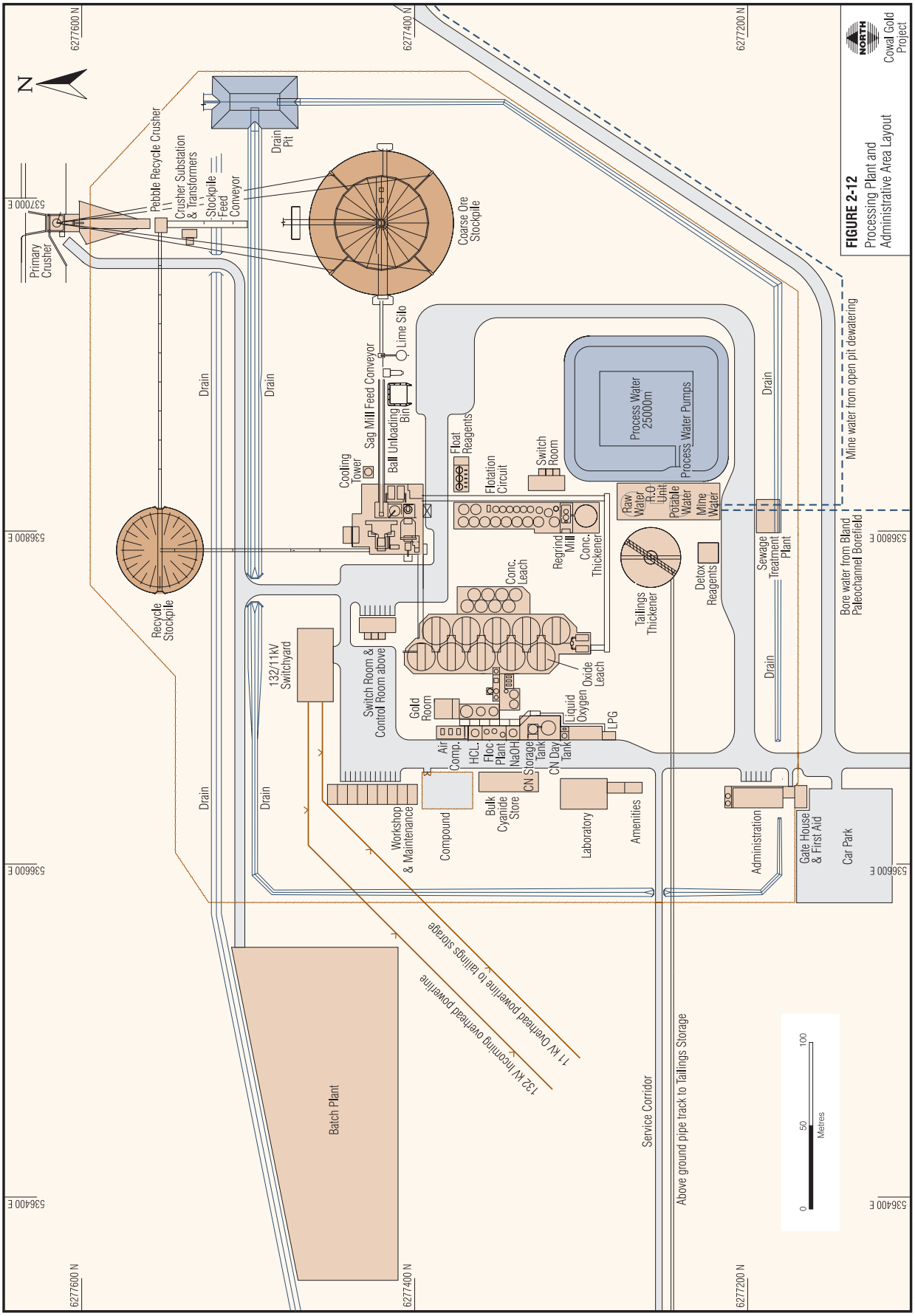

Cowal Gold Project
FIGURE 2-12
Processing Plant and Administrative Area Layout
N
6277600 N
6277400 N
6277200 N
537200 E
536800 E
536600 E
536400 E
Primary Crusher
Pebble Recycle Crusher
Crusher Substation & Transformers
Stockpile Feed Conveyor
Drain Pit
Coarse Ore Stockpile
Lime Silo
Sag Mill Feed Conveyor
Ball Unloading Bin
Cooling Tower
Float Reagents
Flotation Circuit
Switch Room
Process Water 25000m
Process Water Pumps
Raw Water
R.O Unit
Potable Water
Mine Water
Drain
Sewage Treatment Plant
Bore water from Bland Paleochannel Borefield
Mine water from open pit dewatering
Recycle Stockpile
Regrind Mill
Conc. Thickener
Conc. Leach
Tailings Thickener
Detox Reagents
132/11kV Switchyard
Switch Room & Control Room above
Oxide Leach
Gold Room
Liquid Oxygen
LPG
Air Comp.
HCL.
Floc Plant
NaOH
CN Storage Tank
CN Day Tank
Workshop & Maintenance
Compound
Bulk Cyanide Store
Laboratory
Amenities
Administration
Gate House & First Aid
Car Park
Batch Plant
132 kV Incoming overhead powerline
11 kV Overhead powerline to tailings storage
Service Corridor
Above ground pipe track to Tailings Storage
0
50
100
Metres
NOC-97-03_S2-012E.CDR

Table 2-6 Processing Schedule

	Ore Type	Unit	Year of Operation													Total Tonnes Average Grade (g/t)
			Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Years 9	Year 10	Year 11	Year 12	Year 13	
Oxide Ore	Oxide Ore	Tonnes	0	6,220,699	583,400	0	0	0	0	0	789,601	0	0	0	0	0	7,593,700 1.42
	Oxide (Low Grade)	Tonnes	0	0	0	0	0	0	0	0	0	6,412,692	0	0	0	0	6,412,692 0.73
Primary Ore	Upper Volcanic	Tonnes	0	200,000	980,000	1,400,000	1,200,000	3,000,000	750,000	280,000	131,780	0	0	0	0	0	7,941,780 1.56
	Lower Volcanic/ Lava/Other	Tonnes	0	300,000	2,600,000	2,500,000	3,000,000	3,000,000	2,800,000	4,200,000	1,817,826	0	0	0	0	0	20,217,826 1.66
	Diorite	Tonnes	0	167,972	1,920,000	2,100,000	1,800,000	0	2,450,000	1,520,000	3,373,593	455,241	0	0	0	0	13,786,806 1.71
	Other Primary (Low Grade)	Tonnes	0	0	0	0	0	0	0	0	0	50,000	6,000,000	6,000,000	6,000,000	2,225,812	20,275,812 0.74
	Total	Tonnes	0 –	6,888,671 1.43	6,083,400 1.48	6,000,000 1.53	6,000,000 1.69	6,000,000 1.48	6,000,000 1.78	6,000,000 1.73	6,112,800 1.85	6,917,933 0.81	6,000,000 0.74	6,000,000 0.74	6,000,000 0.74	2,225,812 0.74	76,228,616 1.31
	Output	Gold (oz) produced	0	289,625	244,639	246,461	272,186	237,597	286,341	280,861	306,025	159,443	104,207	104,207	104,207	38,658	2,674,457

The leaching solution from the fourth leach tank would be fed to the first adsorption tank and would pass from tank to tank in the series progressively removing the gold. The resultant barren slurry would be removed, thickened and, following treatment to destroy cyanide, (Section 2.6.9) deposited as tailings.

As for the primary ore concentrate circuit, carbon would be added to the last adsorption tank in the series. It would then be transferred from tank to tank until it reaches the first adsorption tank. The loaded carbon would be removed from the first adsorption tank in 2 tonne batches, screened from the slurry and transferred to the gold recovery circuit. Once the gold has been removed the carbon would be regenerated and returned for reuse.

2.6.8 Gold Recovery

The loaded carbon from the primary concentrate and oxide ore leaching circuits would be washed with hydrochloric acid in an enclosed system and rinsed to remove impurities. Gold would be eluted from the carbon using a heated cyanide and caustic soda solution (again in an enclosed system). Once the gold has been removed from the carbon, the carbon would be cleaned and reactivated to be reused in the cyanide leaching circuits. Electrowinning cells would be used to plate out the gold on stainless steel wool cathodes. The gold would then be smelted in a gas-fired furnace to produce impure gold dorè bars containing silver and minor impurities of copper and iron. These bars represent the final product and would be sold to a refinery for purification.

2.6.9 Cyanide Use During Ore Processing

A detailed study has been undertaken on the use, toxicity and management of cyanide at the Cowal Gold Project (Appendix G). Cyanide has been shown to be the only proven method for extracting gold at the Cowal Project.

Sodium cyanide would be trucked to the site, most likely in solid briquette form packaged in either dedicated isotainers or a heavy plastic bag (capable of taking the weight of all of the 1 tonne of contents) enclosed in plywood. The cyanide would be unloaded directly into a storage area located near the processing plant. The cyanide would be taken from the store as required and mixed in a dedicated mixing tank from where it would be conveyed to the oxide and primary leaching circuits. Cyanide consumption for the oxide and primary circuits has been estimated at 0.8 and 0.3 kg of cyanide per tonne of ore respectively.

Barren slurry (once the gold has been removed) exiting the oxide ore leaching circuit would pass directly to the thickener. The thickener is designed to remove water from the slurry and therefore thicken the tailings. In the case of the oxide ore, this process is estimated to recycle approximately 25% of the cyanide for reuse. Passing through a cyanide destruction point prior to discharge to the tailings storages would further reduce the cyanide concentration in the tailings. The CN_{WAD} concentration of tailings entering the tailings storages would be less than 30 mg/L for 100% of the time and less than 20 mg/L for 90% of the time (Section 4.4.5).

Approximately 92% of primary ore from the flotation circuit becomes tailings. These tailings do not contain cyanide. The remaining 8% of primary ore would be passed onto the primary ore leaching circuit for further processing. The resulting barren slurry from the primary ore leaching circuit (containing cyanide) would pass through the first of two cyanide destruction points before being combined with the tailings from the primary ore flotation circuit. The dilution effect of combining the two tailings streams would further reduce cyanide levels by about a 20:1 dilution. The combined tailings would be thickened before passing through a second cyanide destruction point. The tailings would then be discharged to the tailings storages.

The heated cyanide used in the elution of gold from carbon passes into the electrowinning circuit where it would be recycled.

Oxide tailings would pass through a single destruction point after leaving the thickener. A second back-up destruction point would also be available prior to the thickener.

2.6.10 Cyanide Destruction

Cyanide destruction would be achieved by using Caro's acid. This destruction method has been tested on oxide and primary ore from the Cowal Project and was found to deliver fast and effective destruction down to low levels if necessary. The main by-product from the destruction process is cyanate which itself would decay through natural processes.

Caro's acid is a mixture of sulphuric acid and hydrogen peroxide, both of which would be separately transported and stored on site. The two cyanide destruction points would be served by two Caro's acid mixing chambers. The quantity of Caro's acid added to the tailings would be regulated by an on-line free cyanide measurement to ensure cyanide in the tailings is destroyed down to licensed levels. Appendix G provides further detail of the Caro's acid destruction process at the Cowal Project.

2.6.11 Tailings Disposal

Approximately 76 Mt of tailings would be produced over the life of the mine. The quantity of gold removed during processing is relatively small and almost all material passing through the processing plant would go to the tailings storage.

The tailings would be pumped at approximately 55% solids to the tailings storages. The pipeline would run at ground level, through culvert road crossings and with a bunded corridor. Tailings would be discharged into the tailings storages via spigots located around the perimeter.

With an average field dry density in the range between 1.50 t/m^3 to 1.55 t/m^3, total tailings requiring storage would be approximately 50 Mm^3. Tailings would be deposited in two storages located approximately 3.5 km west of the Lake shoreline.

Geochemical characterisation has been conducted on oxide and primary flotation/ concentrate recombined tailings (EGi,

Table 2-7 Cowal Gold Project - Materials Used and Stored at the Site

Area of Processing Plant	Process Consumable (or equivalent)	Role in Processing	Approximate Rate of Use	Likely Transported State	Likely Packaging/ Delivery	Approximate Quantity Stored On-Site
Crushing and Grinding	Grinding Media (Balls)	Grinding ore prior to processing	25 t per delivery	solid	Delivery by semi-tipper Storage in bunker	415 t
Flotation Circuit	Interfroth 50	Frother	90 tpa	powder	Delivery by truck 200 L drums	20 t
	SIBX (sodium isobutyl xanthate)	Sulphide collector	522 tpa	liquid	200 L drums	60 t
CIL Circuit	Sodium Cyanide (NaCN)	Gold extraction	6,090 tpa (oxide) 1,800 tpa (sulphide)	briquettes or liquid	Road tanker or bulk bag	200 t
	Quicklime (Calcium Oxide - CaO)	pH control in CIL circuit	56,700 tpa (oxide) 246 tpa (sulphide)	powder	1 t bulka bag or 25 t isotainer	1500 t
	Carbon	Gold adsorption	150 tpa	solid granules	Drums or 0.5 t bulk bags	10 t
	Oxygen	Aeration of leach tanks	120,000 Lpa	liquid	Bulk tanker	23 t
Gold Recovery	Hydrochloric Acid (HCl)	Acid wash to dissolve carbonate prior to carbon stripping	702 tpa	liquid	Bulk tanker	30 t
	Sulfamic Acid (NH_2SO_3H)	Assists electrolysis and gold refining	0.12 tpa	liquid	Bulk tanker	30 t
	Borax ($N_2B_4O_7$)	Flux in smelting	2 tpa	powder	Delivery by truck 25 kg bags	1 t
	Silica Flour (SiO_2)	Flux in smelting	1 tpa	powder	Delivery by truck 25 kg bags	0.3 t
	Soda Ash ($NaCO_3$)	Flux in smelting	0.5 tpa	powder	Delivery by truck 25 kg bags	0.3 t
	Caustic Soda (NaOH)	Neutralising agent in acid stripping	248 tpa	liquid	Bulk tanker	1 t
	Flocculants (Magnafloc 155)	Flocculant in thickeners	<60 tpa	solid granular powder	Bags	15 t
	LPG	Gold recovery room furnace	146,000 Lpa	liquid	Bulk tanker	27 t
	A238 Aeropromotor	Gold collector	318 tpa	liquid	Delivery in truck 200 L drums	40 t
Cyanide Destruction	Hydrogen Peroxide (H_2O_2)	Cyanide destruction (oxidising agent)	1,400 tpa (oxide) 2,100 tpa (primary)	liquid	Bulk tanker	30 t
	Sulphuric Acid (H_2SO_4)	Cyanide destruction (oxidising agent)	8,400 tpa (oxide) 12,600 tpa (primary)	liquid	Bulk tanker	50 t
Mining Operations	Diesel Fuel	Fuel for diesel engines and explosive mixture	15 million Lpa	liquid	Bulk tanker	500,000 L
	Ammonium Nitrate	Explosive	7,500 tpa	Solid	Bags/bulk	150 t
	Detonators/Primers	Explosive	20 tpa	Solid	25 kg boxes	20 t

Note: Minor quantities in occasional shipments of petrol, lubricant, oils, paints, oxygen, acetylene, laboratory gases, sodium nitrate (flux) and emulsion.

1997). The characterisation included an evaluation of the acid forming potential, assessment of trace element concentration/solubility and cyanide chemistry in the tailings liquor (ie. cyanide speciation and decay characteristics). Appendix C contains the Cowal Project geochemical characterisation results.

In summary, oxide and primary tailings were both classified as non-acid forming. Leach columns used to assess the long term leaching behaviour and seepage chemistry of the tailings indicate sulphate salts may be generated following deposition. The tailings pore water and ponded surface water (containing any generated salts, metals and cyanide forms) would be captured by the tailings underdrainage network and decant tower for recycling in the processing plant.

Cyanide from the Cowal Project processing plant can arrive at the tailings storage in three forms, as free cyanide, as a range of cyano-metal complexes or as thiocyanate. These forms are interchangeable depending on the chemical make-up of the liquor in the tailings storage. The bulk of decay in the tailings storage would happen through the process of volatilisation. Other significant decay paths include: association/ disassociation of metal complexes; anaerobic biodegradation to relatively innocuous non-cyanide species; and degradation of iron cyanide complexes by UV radiation to WAD and FREE cyanide species. A detailed description of the decay mechanisms of these forms is provided in Appendix G.

The use of saline groundwater (as opposed to fresh water) for raw water in gold processing would increase the decay of cyanide within the entrained tailings liquor once deposited in the storage (EGi, 1997). Rapid decay of CN from the ponded tailings liquor would result in CN_{WAD} concentrations for oxide tailings from 5 to 10 mg/L and 10 to 15 mg/L for the primary tailings. Once discharge ceases it is expected that CN_{WAD} complexes would decay to very low concentrations within two to three months.

2.6.12 Process Consumables

Table 2-7 details the types of chemicals and reagents (or equivalents) to be used during mineral processing along with their role, likely storage volumes and storage requirements.

Frothers (eg. Interfroth 50) are used in the flotation process to increase bubble surface tension and allow sulphide minerals (containing the gold) to be carried to the surface. Interfroth 50 would be delivered to site in 200 L drums and transferred to a dedicated storage area. From the storage area it would be pumped to the grinding and flotation circuits. Approximately 90 tpa of Interfroth 50 would be required.

Sulphide collectors (eg. SIBX) are used in flotation to attach to sulphide minerals and provide the capability of adhering to air bubbles. SIBX would be delivered in 200 L drums and would be used at a rate of approximately 522 tpa.

Up to 56,700 tpa of Quicklime would be delivered by bulk tankers and loaded into lime silos. Quicklime would be used to control pH in the CIL circuit.

Approximately 150 tpa of carbon would be required for the gold adsorption process. The carbon would be delivered as solid granules in drums or 0.5 t bulk bags.

Hydrochloric acid is required to dissolve carbonates in recovered carbon prior to stripping gold from the carbon. Approximately 702 tpa would be used in ore processing. The acid would be delivered by bulk tanker and stored in a 30 m^3 capacity storage tank. Approximately 248 tpa of sodium hydroxide would be used as a neutralising agent in acid stripping. It would be stored in a 30 m^3 capacity storage tank.

Caro's acid would be used in the cyanide destruction process. The two chemicals required to make Caro's acid, hydrogen peroxide and sulphuric acid, would be transported to the site by bulk tanker. Up to 2,100 tpa of hydrogen peroxide and 12,600 tpa of sulphuric acid would be required.

Grinding balls would be delivered by semi-tipper trucks and emptied into a 415 t capacity bulk storage bunker. The balls would be delivered to the SAG (100 mm to 150 mm diameter) and ball mills (50 to 65 mm diameter) via a mechanical loader to either the SAG mill feed conveyor (automatically discharged) or to the ball mill feed chute by monorail crane.

2.6.13 Process Services

Water requirements within the process plant would include the following:

- washdown and cleanup;
- process water requirements;
- reagent mixing; and
- dust control.

Water make-up requirements would be supplied in priority order from:

- return water from the tailings storages;
- pit dewatering;
- site water runoff storages; and
- the palaeo-channel borefield.

Section 2.8 details the Project water supply system.

Process water would be recycled from concentrate and tailings thickener to the process water dam.

Compressed air would be used for processing and utility requirements and would be supplied at total maximum air demand of 3,000 m^3/hr. Three air compressors would be installed with one unit operating and two units spare at any one time. Instrument air demand is 90 m^3/hr.

2.6.14 Process Control

The process control system or distributed control system (DCS) would consist of the following eight control areas:

- crushing plant;
- stockpile reclaim grinding and classification;
- flotation circuit;

- cyanidation and tailings disposal;
- desorption;
- plant services and reagents;
- borefield, tailings storage and water management; and
- cyanide destruction.

All control systems would be automated and operated from a main control room located near the grinding mills. Secondary control would be available at the crushing plant with local control provided for specific monitoring and control of individual plant components.

The DCS would operate with the aim of maintaining optimum tonnage throughput and grind size.

2.6.15 Plant Operation

The processing plant would operate 24 hours per day for seven days per week with 2 or 3 shifts per day. An overall availability of 90% is planned (including all shutdown time which may result from equipment repair or maintenance requirements).

2.6.16 Summary of Major Processing Plant

The major equipment components of the processing plant are outlined in Table 2-8 along with their anticipated location and power requirements. Figure 2-12 shows the processing plant layout including major plant components.

2.7 Tailings Storage

2.7.1 Design of the Tailings Storage Facilities

The tailings disposal strategy for the Cowal Gold Project is to provide secure, long term storage within two dedicated storage facilities. The operating aims of the facilities would be to:

- provide a temporary water storage area for groundwater from the pit dewatering operation during construction and the first year of operation;
- maximise the dry density and long term strength of the storage structure;
- maximise water re-use from the structures; and
- minimise ponding.

The tailings storages would be located approximately 3.5 km west of the Lake shoreline. The storages would be stage constructed throughout the mine life, by raising the height of the embankment in advance of the storage requirements. An initial starter embankment would be built during the construction phase and would provide storage for the first one to two years of production. As the storages fill, the embankment would be raised in a series of upstream lifts (Figure 2-13). Table 2-9 shows the tailings storage development strategy.

During the construction phase the volume of water produced during pit dewatering would exceed the raw water demand (Section 2.4.2). This excess water would be temporarily stored in two storage areas located in the south-west corner of the tailings storages (Figure 2-1). Once the processing plant is commissioned this water would be used. The temporary water storages are expected to be emptied in Year 1. Once emptied these areas would be used for tailings storage.

Tailings would be deposited peripherally via a spigotted ring main allowing for the controlled development or "build-up" at any point around the surface of the tailings storages.

The subaerial tailings depositional technique would promote the segregation of the coarse fraction on the perimeter and finer fraction towards the centre of the dam. The different

Table 2-8 Major Processing Plant Equipment[1]

Plant Equipment Item	Number	Description	kW	Capacity	Comments
Primary Crusher	1	Gyratory	450	1,065 tph	CSS 150 mm
SAG Mill	1	–	13,500	-	11 m diameter, 5.3 m length
Ball Mill	1	–	6,750	-	6.7 m diameter, 10.7 m length
Cyclones	16	–	0	-	600 mm diameter
Rougher Flotation Cells	8	–	175 each	150 m^3 each	6.2 m diameter, 3.3 m height
Cleaner Flotation Cells	6	–	55 each	30 m^3 each	4 m diameter, 3.3 m height
Concentrate Thickener	1	–	–	178 m^3/hr	14 m diameter
Leach Tank Agitators	3	–	90	–	Carbon steel, rubber core
Adsorption Tank Agitators	6	Axial flow impeller	90	–	Carbon steel, rubber core
Tailings Thickener	1	High rate thickener	15	890 tph	35 m diameter, carbon steel internal epoxy
Oxide Leach Tanks	4	–	0	3,200 m^3/h each	16.5 m diameter, 16 m height
Adsorption Tanks	6	–	0	3,200 m^3/h each	16.5 m diameter, 16 m height
Primary Adsorption Tanks	8	–	0	365 m^3	7.62 m diameter, 8 m height
Electrowinning Cells	4	–	0	9.00 catho	1.3 m x 0.8 m x 0.8 m
Bullion Smelting Furnace	1	Hydraulic tilting furnace	0.6	–	Operating temp. 1,200°C

[1] All figures approximate

particle settling rates would result in a tailings beach with maximum slopes toward the centre, and a beach which progressively becomes shallower towards the centre. As a result, water contained within the tailings would drain towards a pond area and decant towers located in the centre of the storage, thus maximising the exposure of the tailings surface to air-drying and increasing in-storage tailings dry densities. Figure 2-14 shows the proposed tailings storages in operation.

The main engineering components required for the operation of the tailings storage facilities are:

- starter embankment;
- upstream embankment lifts;
- low permeability storage floor blanketing;
- storage floor underdrainage and recovery system;
- decant towers and associated pipelines;
- earthfill causeway to the decant tower structure; and
- lined tailings water reclaim pond.

2.7.2 Construction Materials

Geotechnical testwork has been performed on potential construction materials within the Project area to determine their characteristics and potential uses. Further control testing would be performed periodically to confirm construction suitability.

Materials required for construction would be pre-stripped from borrow areas within the footprint of the tailings storages and areas of the open pit. The types of construction materials required include:

- Clay fill – used for lining areas, the floor and embankment;
- Rock fill – used for construction of the starter embankment and upstream lifts;
- Filter material – used at the clay fill/rock fill interface; and
- Rip Rap – used for scour protection of outer embankment and spillway surfaces.

Geotechnical surveys and testing of materials from the proposed tailings storage areas indicate significant quantities of in-situ clays suitable for use as clay fill in the construction of the embankments. These clays are stable and have low permeability and high strength when compacted.

Suitable waste rock taken from the open pit during pre-stripping operations would be used as rockfill in construction of the starter embankments. Soft oxide waste rock from the pit (mined after commissioning of the tailings storage facility in the operational phase of the Project) would be stockpiled on the western side of the southern waste rock emplacement. This material would be used for constructing the upstream lifts as required.

Table 2-9 Tailings Storage Development Strategy

Approximate Timing	Northern Tailings Storage Embankment Crest Level (RL m)	Southern Tailings Storage Embankment Crest Level (RL m)
Year -1	222.5	229.5
Year 1	222.5	229.5
Year 2	226.0	229.5
Year 3	226.0	232.5
Year 4	226.0	232.5
Year 5	226.0	235.0
Year 6	228.5	235.0
Year 7	228.5	237.0
Year 8	231.5	237.0
Year 9	231.5	240.0
Year 10	233.5	240.0
Year 11	233.5	241.5
Year 12	233.5	241.5

2.7.3 Embankment Details

Figure 2-13 shows starter embankment construction detail and subsequent storage facility development over the life of mine.

Starter Embankment

The starter embankments of the two storages would be constructed over an estimated 10 month period during the construction phase.

The starter embankments would be excavated to the depth of suitable foundation. Excavated material not suitable for embankment construction would be selectively placed within the storage facility away from foundations and borrow areas.

The starter embankments would consist of two zones: a structural zone and a downstream rehabilitated zone. Material placed in the structural zone would be spread in 300 mm thick layers and compacted to the required density. The batter angles of this zone would be 1(V):2(H) as indicated on Figure 2-13.

The downstream rehabilitated zone would involve flattening the outer batters. Section 5 provides details on the rehabilitation strategy for the tailings storages.

Upstream Lifts

Upstream lifts would be constructed using the same two zone method. Soft oxide waste rock stockpiled during mining operations would be used for construction. The lift section would extend from the existing embankment crest and would be supported by the dry tailings beach.

2.7.4 Seepage Control

Detailed flow modelling and predictive chemistry studies have been used to engineer the tailings storage design to minimise the potential for seepage. The proposed mitigation measures are outlined below:

- Excavation of surface material (soil and weathered rock) to a suitable foundation depth beneath the embankment footprint. This would assist in preventing shallow, lateral migration of tailings water beneath the embankment.

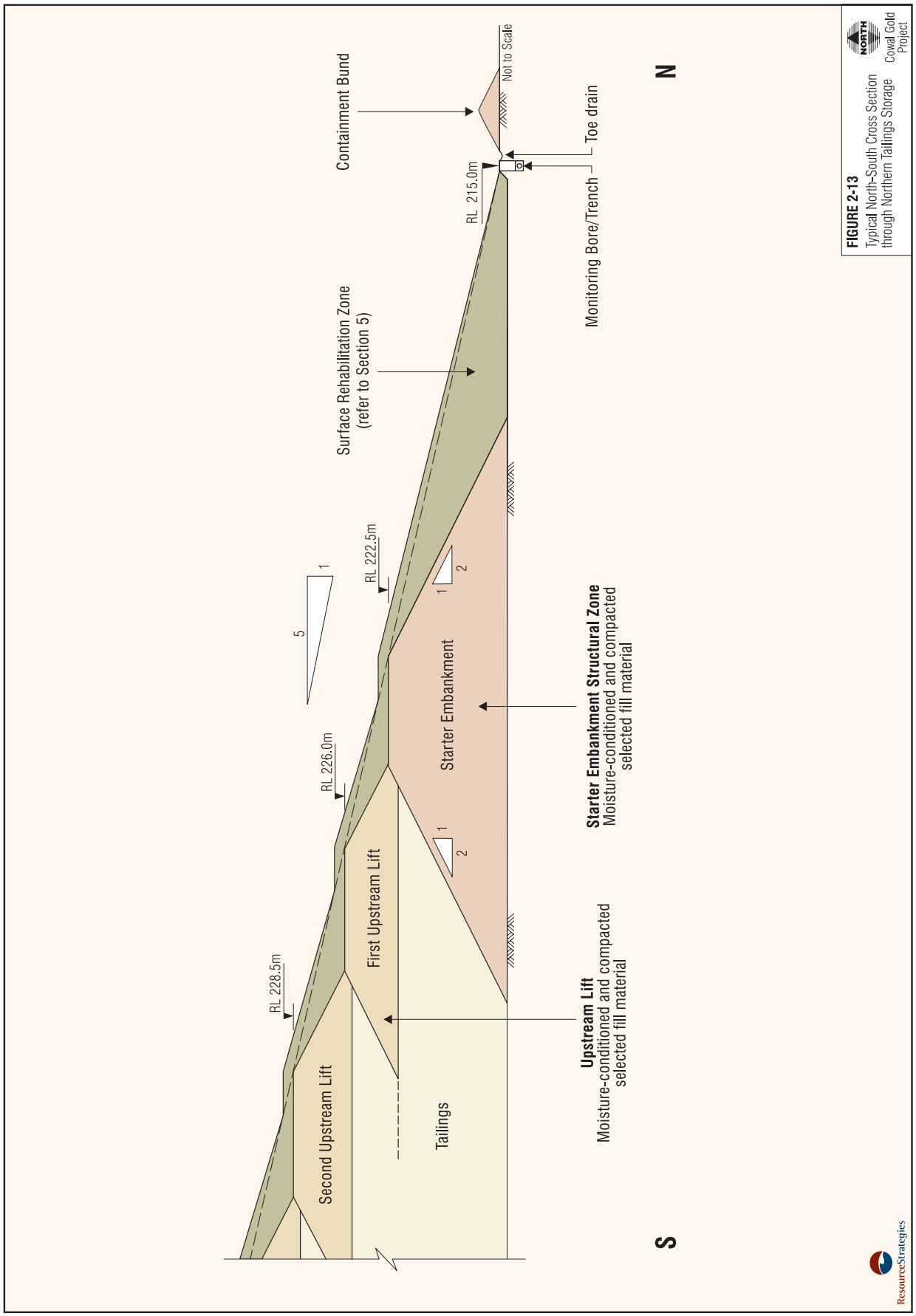


FIGURE 2-13
Typical North–South Cross Section through Northern Tailings Storage

NORTH
Cowal Gold Project

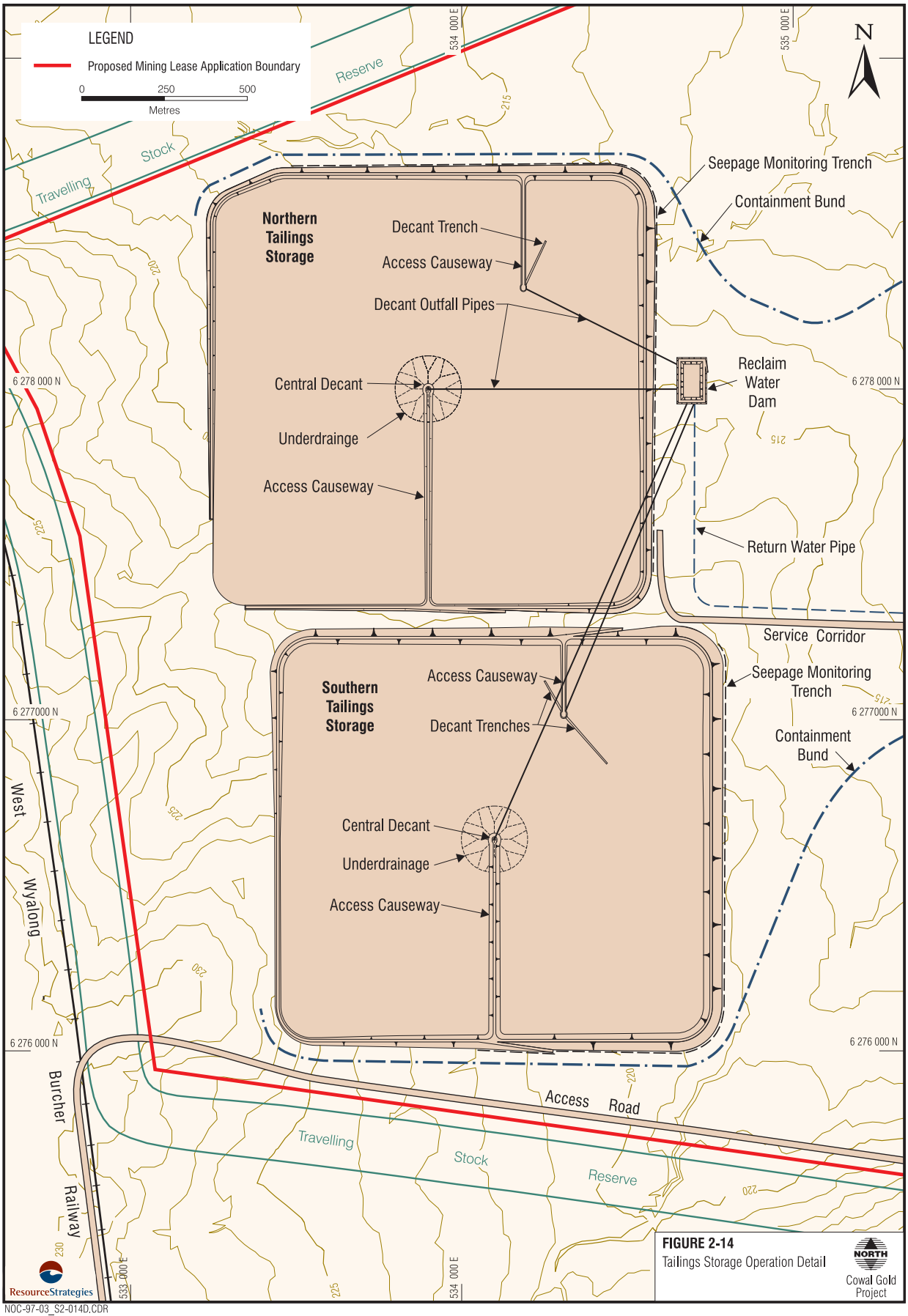


FIGURE 2-14
Tailings Storage Operation Detail

Cowal Gold Project

- Direct seepage control would be implemented through the construction of a low permeability base over the footprint of the storage. The base would be moisture conditioned and compacted to a low permeability.
- Installation of an under-drainage pipe network draining the tailings storage floor to centrally located decant towers. Tailings water collected in the decant towers would be pumped to the reclaim pond before being pumped back to the processing plant for recycling (Figure 2-14).

2.7.5 Tailings Water Management

Implicit within the operating aim of the tailings storages is the maximisation of water re-use through an under-drainage pipe network, decant towers, reclaim pond and water return pipeline to the process water storage pond (Figure 2-14).

Following tailings deposition, supernatant water would drain to the central pond and decant towers. The decant towers would be surrounded by rock platforms accessible via rockfill causeways. The decant system (including access causeway) would be progressively raised during the development of the tailings storages.

An underdrainage pipe network would be installed to facilitate drainage of the tailings mass to the decant tower. The underdrainage network would consist of a herringbone network of corrugated 400 mm polyethylene agricultural pipes laid on the floor of the storage footprint. The under-drainage pipe network would extend out approximately 100 m from the decant towers (Figure 2-14).

Supernatant water collected in the decant towers would be discharged to a reclaim pond located outside and downstream of the tailings storages.

The reclaim pond would be lined with a synthetic membrane. Variability in evaporation rates is expected to be the dominant influence on supernatant water volumes in the tailings storage facilities and hence water levels in the reclaim pond.

2.8 Project Water Supply

The main water usage for the Project would be associated with ore processing. Other water supply requirements include water for dust suppression on haul roads and roads, potable and non-potable uses around the mine site.

The water demand for ore processing would vary according to ore type but is expected to range between 16 ML/day for soft oxide ore and 7 ML/day for primary ore. Additional water demand for other mine site activities is expected to be between 0.5 to 1 ML/day.

The majority of water used in the processing operations would be recycled within the plant. Water losses from the system would include tailings pore water (the portion not returned via the decant towers) and evaporative loss principally from the tailings dam (variable according to seasons). The average demand for make-up water over the mine life is some 4 ML/day but actual make-up requirements would vary according to the ore type being processed and climatic conditions.

The proposed raw water supply scheme (to make up losses from the system) involves collecting internal site runoff and developing groundwater resources. The proposed raw water supply scheme layout, shown on Figure 2-15, is described below:

(i) *Bland Creek Palaeochannel Borefield.* A borefield of four production bores would be developed within the Bland palaeochannel located approximately 20 km to the east-northeast of the Project site. Groundwater investigations and supply feasibility assessments by Coffey Partners International Pty Ltd (1995b) indicate that the borefield could maintain a supply of up to 10 ML/day for a 7 to 8 year period. The bores would be constructed with a pumping capacity of 3 to 4 ML/day each. The borefield reticulation system would include a break pressure/balancing storage after the final bore, a buried 600 mm (approx.) diameter pipeline to the Project site and power supply along existing road reserves. The proposed bores and pipeline route are shown on Figure 2-16. It is proposed to bury the pipeline, where possible, along its entire route. Balancing storages would be designed to fit in the road reserve or if required, on private land in an existing cleared area.

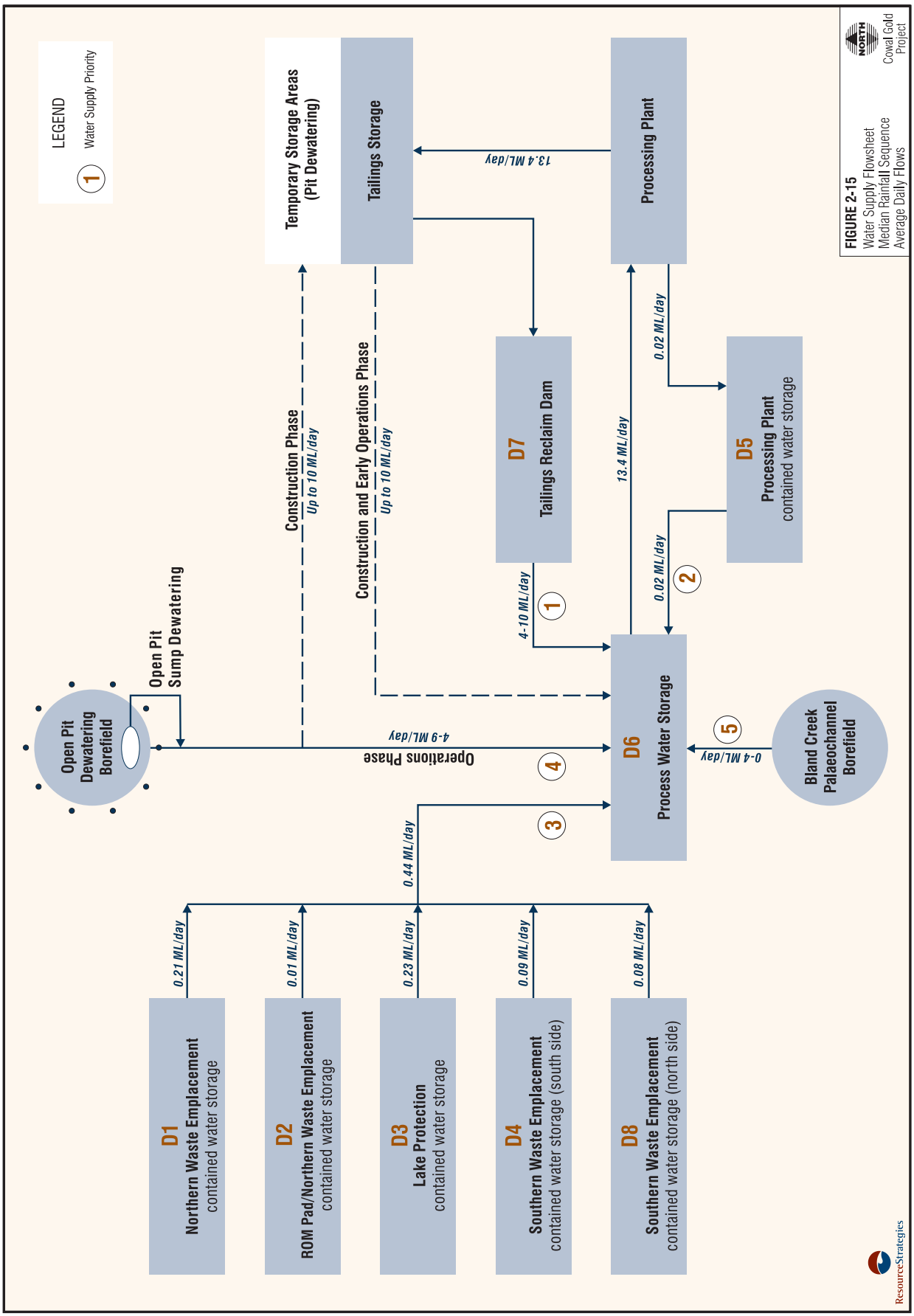
(ii) *Open Pit Dewatering Borefield.* As described in Section 2.4.2 a dewatering borefield would be constructed around the pit during the construction phase. The predicted dewatering rates are approximately 10 ML/day over the first three months, reducing to approximately 5 ML/day over the life of mine. The groundwater to be dewatered is highly saline and is not suitable for uses such as dust suppression on roads or potable water. Water obtained from the open pit dewatering would initially exceed make-up demands and would be stored in two transient storages constructed within each tailings storage until consumed in providing make-up process water.

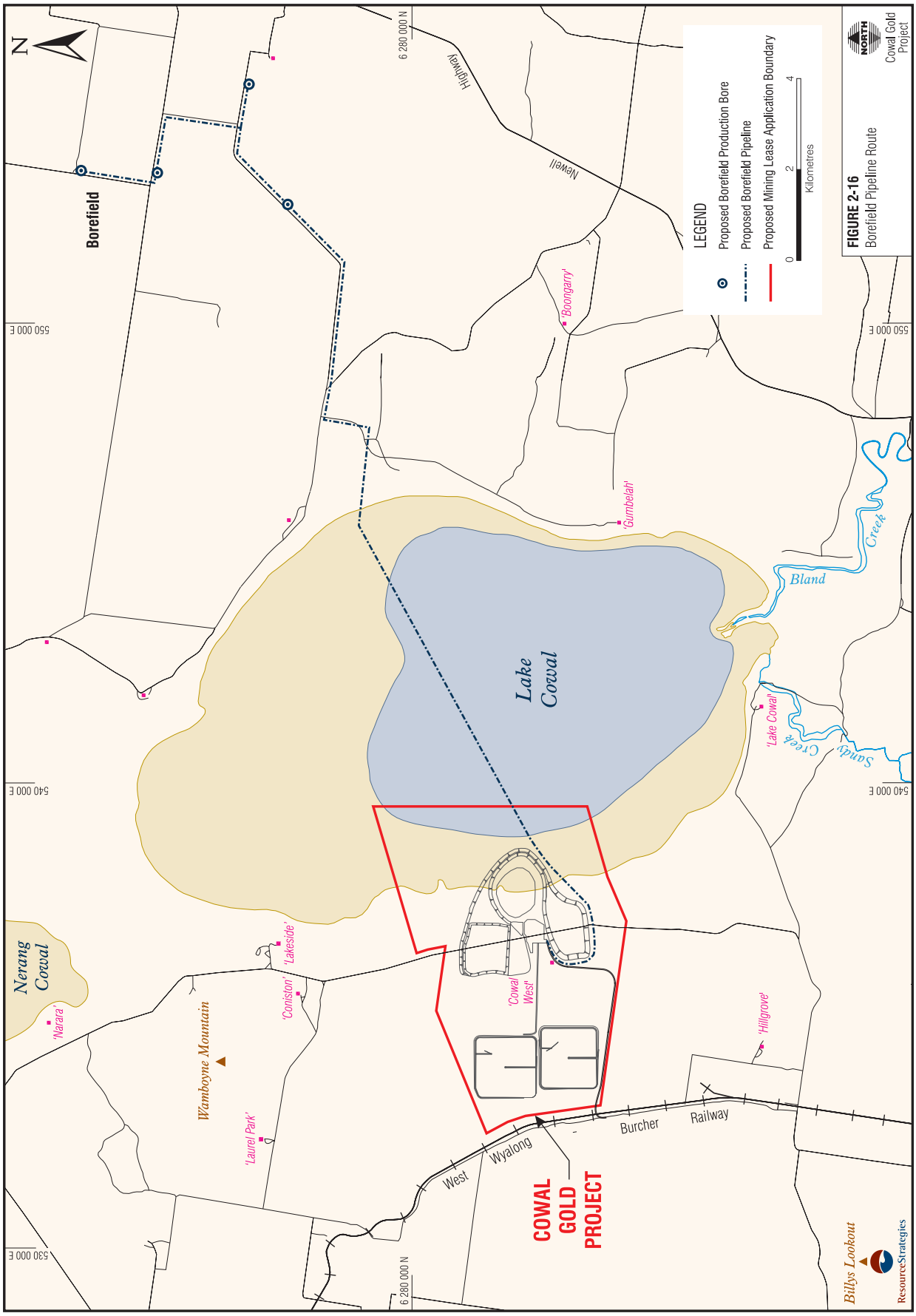
(iii) *Internal Runoff Collection.* Project area runoff would be collected by a series of bunds and collection ponds. Runoff from the waste rock emplacement, open pit area and other disturbed areas would be collected during rainfall events and transferred to the process water pond or other retention ponds for re-use in the processing plant or to satisfy other operational requirements. Further detail on the water management structures is provided in Section 2.9.

2.9 Project Water Management

2.9.1 Overview

The overall objective of the Cowal Project water management system is to contain all potentially contaminated water (contained water) generated within the Project area while diverting all other water around the


LEGEND
1 Water Supply Priority
Temporary Storage Areas (Pit Dewatering)
Tailings Storage
Processing Plant
13.4 ML/day
Construction Phase
Up to 10 ML/day
Construction and Early Operations Phase
Up to 10 ML/day
D7
Tailings Reclaim Dam
0.02 ML/day
D5
Processing Plant
contained water storage
13.4 ML/day
4-10 ML/day
1
0.02 ML/day
2
Open Pit
Sump Dewatering
Open Pit
Dewatering
Borefield
Operations Phase
4-9 ML/day
4
D6
Process Water Storage
5
0-4 ML/day
Bland Creek
Palaeochannel
Borefield
3
0.44 ML/day
0.21 ML/day
0.01 ML/day
0.23 ML/day
0.09 ML/day
0.08 ML/day
D1
Northern Waste Emplacement
contained water storage
D2
ROM Pad/Northern Waste Emplacement
contained water storage
D3
Lake Protection
contained water storage
D4
Southern Waste Emplacement
contained water storage (south side)
D8
Southern Waste Emplacement
contained water storage (north side)
FIGURE 2-15
Water Supply Flowsheet
Median Rainfall Sequence
Average Daily Flows
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-021F.CDR


N
Borefield
Newell Highway
6 280 000 N
550 000 E
540 000 E
530 000 E
'Boongarry'
'Gumbelah'
Lake Cowal
Bland Creek
Sandy Creek
'Lake Cowal'
Nerang Cowal
'Narara'
Wamboyne Mountain
'Coniston'
'Lakeside'
'Laurel Park'
'Cowal West'
'Hillgrove'
Burcher
Railway
Wyalong West
COWAL GOLD PROJECT
Billys Lookout
ResourceStrategies
NOC-97-03_S2-015F.CDR
LEGEND
Proposed Borefield Production Bore
Proposed Borefield Pipeline
Proposed Mining Lease Application Boundary
0
2
4
Kilometres
NORTH
Cowal Gold Project
FIGURE 2-16
Borefield Pipeline Route

perimeter of the site. The water management system includes both permanent features that would continue to operate post-closure (eg diversions of surface water around the site, creation of new catchment divides and isolation of the Lake from the open pit), and temporary structures (servicing the life of mine requirements only). The water management system would be progressively developed during the construction and operation of the mine as diversion and containment requirements change.

The water management system requires alteration of some existing catchments by the creation of a new "Up-catchment Diversion System" to allow upper catchment surface runoff to flow around the western, northern and southern edges of the site and back into existing drainage lines. This system would be a permanent feature incorporating design elements to ensure its long-term stability as well as compatibility with existing hydrological features, landforms and vegetation.

Below the Up-catchment Diversion System an "Internal Catchment Drainage System" would be constructed to ensure waters generated on the site are contained within the area of disturbance (ie. waters that potentially contain increased sediment loads, salinity or other substances). This system would consist of a series of permanent low mounds designed to act as internal catchment divides around the site.

Within the Internal Catchment Drainage System a series of sediment control structures, catchment dams and waterways would be constructed around individual infrastructure components. These structures form the "Integrated Sediment and Erosion Control System" used during the life of mine. The sediment and erosion control structures would be temporary and would be constructed in a staged manner, as they are required.

The water management system during the construction and operating phases is described below. Discussion of water management during the post-closure phase is contained in Section 5.

2.9.2 Construction Phase

The major components of the water management system during the construction pre-production phase are shown on Figure 2-17 and include the following:

(i) Up-Catchment Diversion System;

(ii) Lake Isolation System

(iii) Internal Catchment Drainage System;

(iv) Integrated Erosion, Sediment and Salinity Control System; and

(v) Pit Dewatering System.

Up-catchment Diversion System

The Up-catchment Diversion System is designed to convey upper catchment water around the western edge of the Project area (near the tailings storage) and into the existing drainage lines to the north and south of the Project site (Figure 2-17). The diversion is a permanent feature designed to direct drainage around the rehabilitated Project site. It would be developed in stages throughout the mine life. During the construction phase the western edge of the diversion surrounding the tailings storage would be formed (Figure 2-17). In Year 3 the northern section and southern section around the Southern Waste Rock Emplacement would be constructed (Figure 2-18).

Construction of the system would involve the reinstatement of natural stream features to enhance its long term stability and compatibility with the existing hydrology of the area. These include features such as a low flow drainage path within a wider flood plain (approximately 65 m wide), meanders and pool/riffle sequences. Appendix F provides a detailed description of the proposed system design.

Lake Isolation System

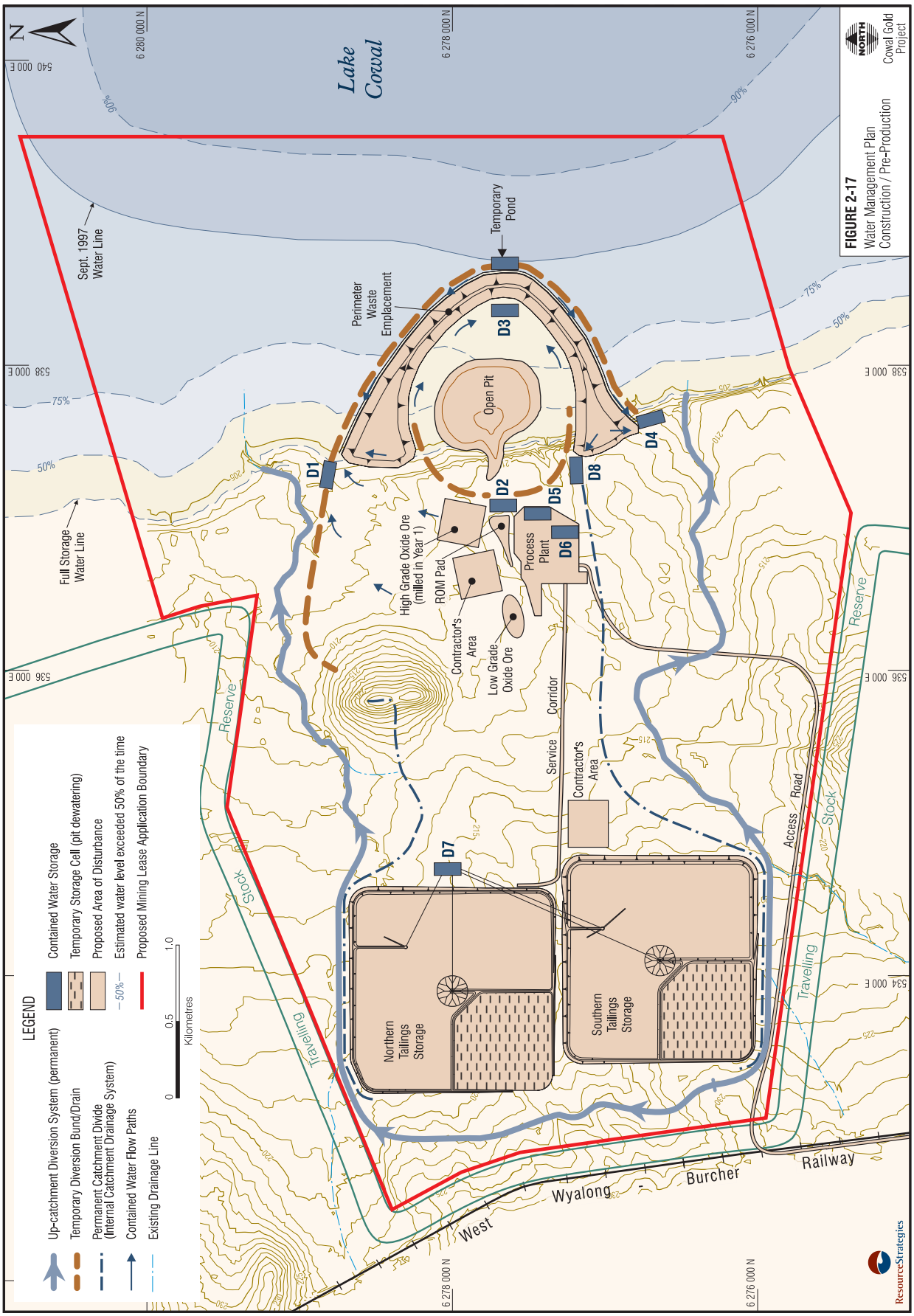
In order to provide a barrier between the open pit and Lake Cowal a Lake Isolation System has been designed to hydrologically isolate the two areas during Project development, mining and post-closure. As described in Section 2.3.3 the Lake Isolation System consists of two components that would provide a permanent arc around the open pit area (temporary isolation bund and lake protection bund). As the Lake Isolation System is developed it would be concurrently rehabilitated to provide a new lake foreshore. Rehabilitation is integral to the system and is discussed in detail in Section 5.

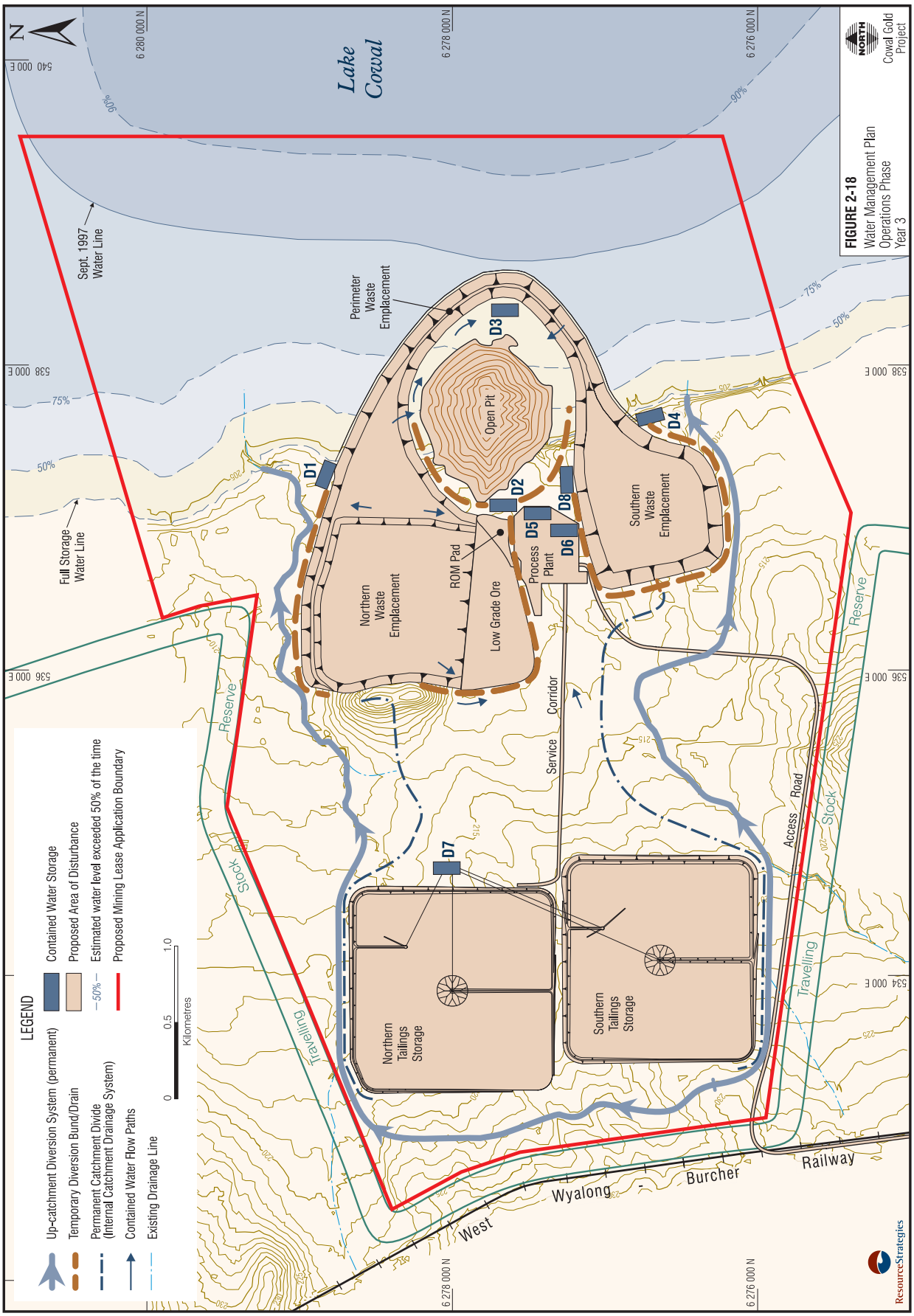
Once the outer surface of the Lake Isolation System has been stabilised and revegetated the runoff from these surfaces is expected to be of suitable quality (comparable to runoff from undisturbed areas) to enable surface water runoff to the Lake.

Internal Catchment Drainage System

The Internal Catchment Drainage System is also a permanent water management feature designed to operate during the life of mine and after mine rehabilitation and closure. The system involves the development of a new permanent catchment divide in the form of a low mound running from Cowal West Hill, surrounding the tailings storages and extending to the processing plant area (Figure 2-17). The mound would be formed during the construction phase of the Project. It is designed to act as a new catchment divide separating water external to the Project site and contained waters generated within the area of disturbance (ie. waters that could contain increased sediment loads, salinity or other substances). Where the topography of the site is such that water would flow alongside the mound, permanent waterways would be developed to direct surface flows.

During the construction and operation of the Project surface water collected within the limits of the Internal Catchment Drainage System would be directed to the process water storage dam for use (as raw water, dust suppression and conditioning of construction materials) in the processing plant. Once the Project is decommissioned, the water within the system would be directed to the open pit. Detail on the water management system for the post operations phase are provided in Section 5.


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Temporary Pond
Perimeter Waste Emplacement
Open Pit
D1
D2
D3
D4
D5
D6
D7
D8
High Grade Oxide Ore (milled in Year 1)
ROM Pad
Process Plant
Contractor's Area
Low Grade Oxide Ore
Service Corridor
Contractor's Area
Northern Tailings Storage
Southern Tailings Storage
Access Road
Stock Reserve
Travelling Stock Reserve
Wyalong West
Burcher
Railway
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
LEGEND
Up-catchment Diversion System (permanent)
Temporary Diversion Bund/Drain
Permanent Catchment Divide (Internal Catchment Drainage System)
Contained Water Flow Paths
Existing Drainage Line
Contained Water Storage
Temporary Storage Cell (pit dewatering)
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
FIGURE 2-17
Water Management Plan
Construction / Pre-Production
Cowal Gold Project
ResourceStrategies
NDC-97-03_S2-022B.CDR


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
D1
D2
D3
D4
D5
D6
D7
D8
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Northern Tailings Storage
Southern Tailings Storage
Access Road
Stock Reserve
Travelling Stock Reserve
Wyalong West
Burcher
Railway
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
LEGEND
Up-catchment Diversion System (permanent)
Temporary Diversion Bund/Drain
Permanent Catchment Divide (Internal Catchment Drainage System)
Contained Water Flow Paths
Existing Drainage Line
Contained Water Storage
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
FIGURE 2-18
Water Management Plan
Operations Phase
Year 3
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-0238.CDR

Integrated Erosion, Sediment and Salinity Control System
Within the area contained by the Internal Catchment Containment System water management would involve the construction of a series of temporary bunds, drainage channels, runoff collection and sedimentation ponds. These structures have been designed to direct runoff to central locations from where it would be transferred to the process water pond for use as raw water. The Integrated Erosion, Sediment and Salinity Control System would incorporate the following components:

- Construction of sediment retention storages to reduce the non-colloidal fraction of sediment carried in runoff from large disturbed areas. These storages would be sized to provide flow detention and effective settlement during small to medium sized flood events (1 in 20 year 1 hour event).
- Use of small-scale runoff controls comprising hay bales and rockfill bunds to control sediment loads in runoff from small areas.
- Rapid stabilisation of disturbed areas using contour banks and furrows, erosion-stable drainage paths and early revegetation or armouring of disturbed areas.

Bunding and sediment control works would be constructed and stabilised prior to the initiation of any bulk stripping or clearing activities. Upon completion of earthworks, batter stabilisation, lining and revegetation of disturbed areas would be undertaken (including revegetation of topsoil stockpiles).

A temporary continuous silt curtain (construction phase only) would be erected around the outside of the temporary isolation bund prior to commencement of earthworks, to trap fines and prevent sediment entering the Lake. Any water trapped in between the pit and the bunds during construction would be allowed to settle in contained water storage D3 (Figure 2-17) until its suspended solids and turbidity levels are equivalent to or less than levels existing in the Lake, before being discharged back into the Lake. Once operations commence, water collected in this storage would be pumped to the process water pond.

Pit Dewatering
The operation of the pit dewatering programme during the Project is described in Section 2.4.2.

2.9.3 Operations Phase

The major components of the water management system during the operational phase are shown on Figures 2-18 and 2-19 and include the following:

(i) Water Supply (described in Section 2.8);

(ii) Pit Dewatering System (described in Section 2.4.2); and

(iii) Integrated Erosion, Sediment and Salinity Control System.

Integrated Erosion, Sediment and Salinity Control System
During operations the Integrated Erosion, Sediment and Salinity Control System would involve management of contained waters generated from major infrastructure components of the site. The water management strategy for key areas is provided in Appendix F and summarised below:

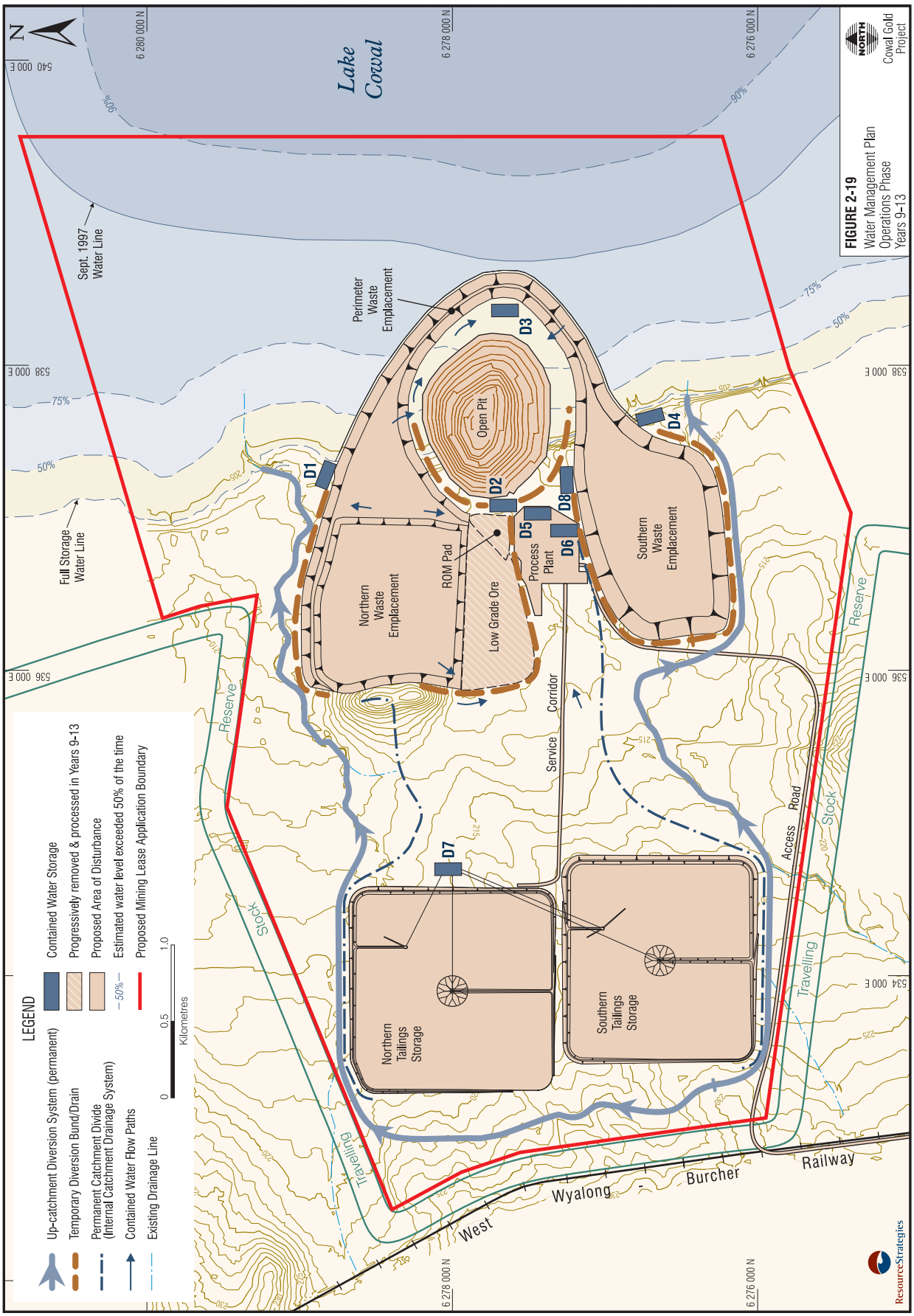
- *Waste Rock Emplacements.* Toe drains and storages (contained water storages D1, D4 and D8) (sized to contain runoff from a 1 in 100 year ARI rainfall event) would be constructed in stages around the Main Waste Emplacement (Figure 2-18) and the Southern Waste Emplacement (Figures 2-18 and 2-19). These structures would be temporary over the life of mine. Seepage and runoff intercepted by this system would be pumped to the process water dam (contained water storage D6) for use in the plant.
- *Lake Isolation System.* As described previously, the outer batters of the Lake isolation embankments would be rehabilitated as soon as possible. Any contained water generated on the top surface and internal batters would be directed to a contained water storage located adjacent to the eastern edge of the open pit (contained water storage D3).
- *ROM Area.* Runoff from the ROM area and the low grade ore stockpile would be collected in contained water storage D2 (Figure 2-18). Surface runoff from the top and southern batters of the Main Waste Rock Emplacement would also report to D2. As described in Section 2.5.3 the Main Waste Emplacement would involve the removal of basement soils and placement of compacted oxide waste to direct potential seepage in a southerly direction towards the open pit (Figure 2-9). During operations any seepage generated would be contained in the D2 storage.
- *Processing Plant.* This area would be bunded and graded such that runoff and any accidental spills (processing water, oils, fuel or reagents) would report to a process plant runoff storage (contained water storage D5).
- *Tailings Storage.* As discussed in Section 2.7.7, supernatant water liberated by settling and consolidation of the tailings would be decanted under gravity to an external decant pond (reclaim pond/contained water storage D7) and from there returned for re-use in the plant. A toe drain would be constructed around the embankment to collect runoff from the batters and any accidental spills. Any water collected in these drains would be pumped to the process water pond.

2.10 Infrastructure

2.10.1 Electric Power

Power Supply
The electrical power demand is estimated to be 23 mega-watts (MW), requiring a 132 kV supply system. A new medium sized high voltage electricity transmission line (132 kV) would be constructed from Temora to the Project area. Figure 1-2 shows the proposed electricity transmission line route. The route follows an existing 66 kV line towards Wyalong. It then heads north-east direct to the Project area.

The electricity transmission line would consist of three conductor wires and one overhead earthwire erected on concrete or timber poles.


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Access Road
Northern Tailings Storage
Southern Tailings Storage
Reserve
Stock
Travelling
Wyalong West
Burcher
Railway
D1
D2
D3
D4
D5
D6
D7
D8
75%
50%
90%
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
LEGEND
Up-catchment Diversion System (permanent)
Temporary Diversion Bund/Drain
Permanent Catchment Divide (Internal Catchment Drainage System)
Contained Water Flow Paths
Existing Drainage Line
Contained Water Storage
Progressively removed & processed in Years 9–13
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
FIGURE 2-19
Water Management Plan
Operations Phase
Years 9–13
Cowal Gold Project
ResourceStrategies
NOC-97-03_S2-024B.CDR

Appendix D provides a more detailed description of the electricity transmission line as well as its construction, operation and design.

Power Distribution

A 132 kV/11 kV/415 V substation would be constructed to distribute power within the proposed MLA. The power distribution design is standardised with all motors either 11 kV or 415 V.

Power requirements for the administrative offices, workshops, contractor areas, warehouse areas, car park lighting would be distributed from a switchboard located adjacent to the workshops. Power from this switchboard would be transferred either by overhead cable or underground cable where necessary. Power to the water return pumps located at the tailings reclaim dam would be distributed by an 11 kV electricity transmission line which would be established within the bunded tailings pipeline corridor. Standard electrical safety laws and practices (including vehicle clearance considerations) would apply.

2.10.2 Roadworks

Regional and Local Network

The Project site is favourably located in terms of regional transport network. It is located 38 km from West Wyalong which is the confluence of the Newell Highway (State Highway No. 17) and the Mid Western Highway (State Highway No. 6). These two highways, in addition to Main Roads 57 and 78, provide the main access routes to the site from neighbouring townships.

Several potential routes using the existing local road network have been investigated. The preferred route and proposed upgrade programme from the Project to West Wyalong is as follows:

- Internal access (within the proposed MLA) to the administrative area and processing plant would be via a new main access road. This road would be 7 m wide, sealed and located within a 20 m easement.
- Access outside the proposed MLA would be via an existing road reserve which is parallel to the West Wyalong-Burcher Railway on its western side. This road would run from the proposed MLA entrance to the Lake Cowal station silo and would require widening and sealing of the existing dirt road.
- From this point access proceeds west along Billys Lookout Road for a distance of 10.5 km to its intersection with Wamboyne Road at Blow Clear. Roadworks along this section would include sealing the existing gravel road and adjustment of the alignment on some bends.
- The route then proceeds south along Wamboyne Road for a distance of 18.7 km to its intersection with Ungarie Road. Roadworks in this section would involve intersection improvements.
- From the Ungarie Road junction, the route travels south to the junction with the Mid Western Highway, thence south to West Wyalong.

The preferred access route is shown on Figure 2-20.

In addition to sealing and widening sections of the proposed access route, major intersections would be upgraded where necessary in order to accommodate the increased traffic numbers and improve the safety and/or operational efficiency. Upgrading and maintenance would be performed in consultation with the Bland Shire Council.

Relocation of Stock Reserve

Travelling Stock Reserve No. 17085 currently runs in a north-south direction through the centre of the proposed MLA area and would be diverted around the mining lease prior to the commencement of the construction phase (Figure 2-1).

The proposed diversion of the stock route would run parallel to the western side of the proposed MLA boundary. The stock route would be relocated in consultation with the Condobolin Rural Lands Protection Board. North would fence the new route, develop an access road and would provide alternative stock watering points where necessary.

Internal Mine Roads

Internal mine roads would be built to provide construction and operational access to infrastructure components such as the tailings storages, dewatering bores, water supply, pipelines, and waste rock emplacement areas.

During construction, the internal access roads to major infrastructure components such as the tailings storages and temporary isolation bund would be sized to carry two-way traffic of large earthmoving machinery such as dump trucks (30 m easement). After construction is completed, these roads would be predominantly used by conventional light vehicles and only a road width of approximately 7 m would be maintained. All internal mine roads would be formed gravel.

2.10.3 Sewage Treatment and Disposal

A council and/or EPA approved sewage treatment plant would be installed on site to accommodate company and contractor workforces. Treated effluent would be disposed in the tailings storages.

2.10.4 Communications

Two communications systems would be established to service Project requirements. These are:

- conventional telephone system with external call and internal intercom facilities; and
- two way radios (portable and vehicle mounted) and/or mobile phones for communication within the Project area.

2.10.5 Security

A security station (including boom gate) would be installed on the main access road at the proposed MLA boundary to ensure only staff and authorised visitors enter the Project area. The proposed MLA boundary and plant site would be fenced and signposted.

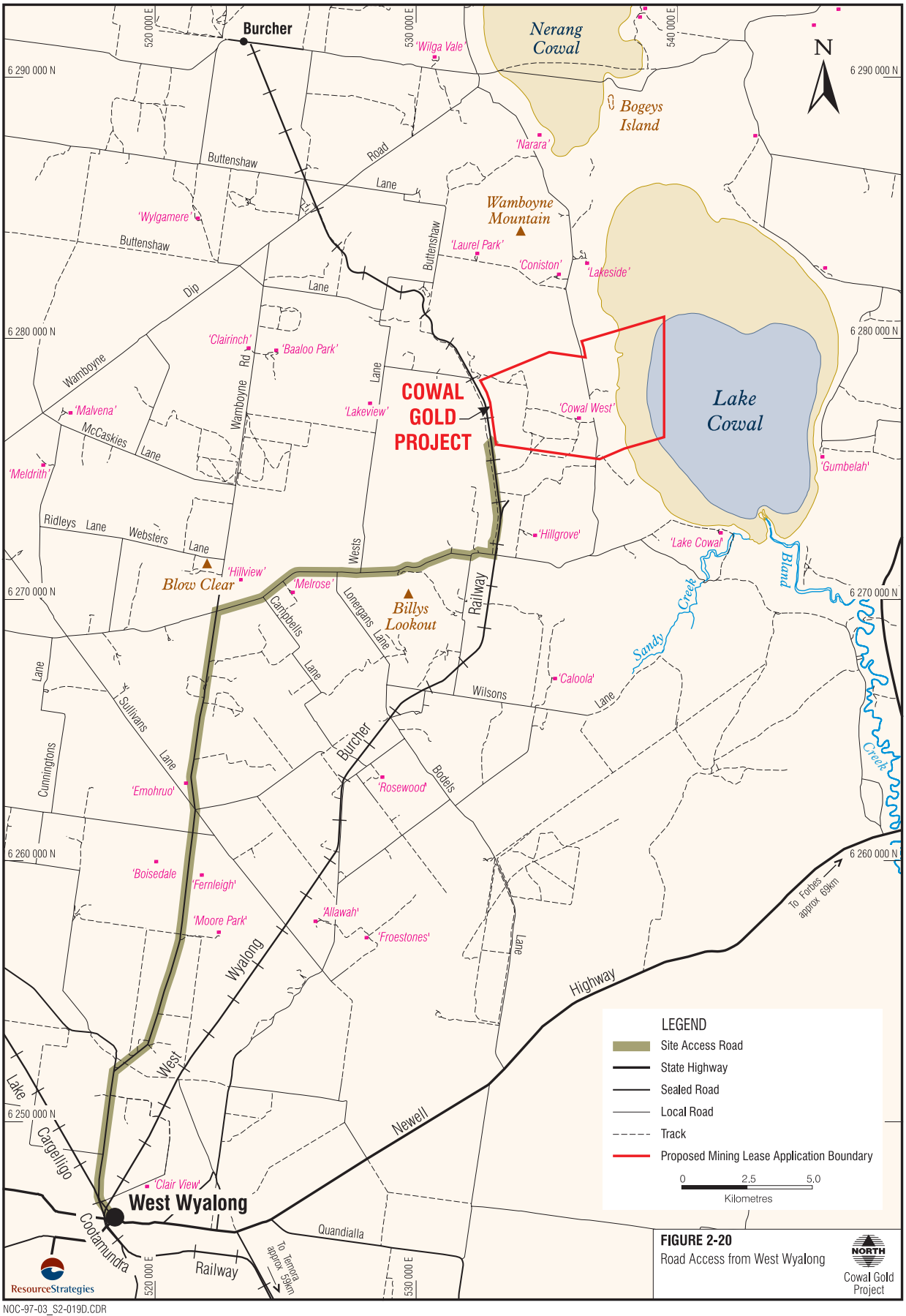


FIGURE 2-20
Road Access from West Wyalong

NORTH Cowal Gold Project

2.10.6 Domestic Waste

A recycling system for domestic waste would be implemented on site whereby bottles, aluminium cans, paper and boxes would be collected separately and recycled. Recyclable and non-recyclable domestic waste would be collected daily from the administration offices and work areas for transfer to specific storage containers. These containers would store an estimated average of 17 m^3 of recyclable waste and would be removed approximately once a week by truck to the West Wyalong tip.

2.11 Transport and Storage of Dangerous Goods

2.11.1 Transport

Hazardous reagents and explosives would be transported in accordance with the appropriate State regulations for the transport of dangerous goods. These regulations apply versions of the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (1995).

All chemical materials brought on-site for use at the operation would be recorded in an inventory register that would be updated and available at all times for inspection by appropriate authorities.

Transport risk issues are identified in Appendix L.

2.11.2 Fuel Storage

The main diesel fuel storage tank would have a total capacity of 500,000 litres. The tank would be surrounded by bund walls of suitable size to contain 120% of the capacity volume of the tank or as required by the appropriate authorities. The containment bunds would be designed and constructed in accordance with the requirements of Australian Standard (AS) 1940 – *The Storage and Handling of Flammable and Combustible Liquids*. The fuel storage facility would be located adjacent to the truck parking and workshop/warehouse areas.

Design, construction and operation of fuel and other flammable substance installations would be in accordance with AS 1940.

2.11.3 Explosive Storage

Approximately 150 t of Ammonium Nitrate per week would be transported to site in semi-trailers. Once at site it would be combined with diesel and used for blasting in the open pit. Blast hole loading is likely to be conducted using a twin-steer, bogie-drive truck equipped to deliver both Ammonium Nitrate and Fuel Oil (AnFo) as well as emulsion mixes. Explosive constituents such as AnFo are commonly transported substances that, with the proper handling and use procedures, pose no more of a hazard than other common fertilisers and liquid hydrocarbons.

All explosive material to be used at the Project site (*viz.* AnFo and/or similar products such as "Energon" emulsion explosive would be stored on-site.

Storage facilities would consist of separate emulsion tanks (approximately 25 m^3 capacity) and a steel portal frame shed constructed of aluminium cladding on a concrete slab base approximately 300 m2. The storage shed would be 15 m in height and would have a storage capacity of approximately 300 t.

As per the requirements and guidelines of the AS 1940, all explosive storage facilities and structures would be bunded to 120% vessel capacity.

Storage of the high explosives (accessories, primers and detonators) would be in a purpose-built building with concrete brick cladding, concrete roof and timber floor, in accordance with AS 2187 Explosives – *Storage, Transport and Use*. AS 2187 details the requirements for the safe storage, handling and land transport of explosives as well as safe storage distances from other activities and bunding requirements. The facility would have a storage capacity of up to 20 t and would be earth bunded.

It is proposed to locate the bulk mixing facilities and explosive magazines at a point that would be the furthest away from any public road, residence or work place as is practicable. Lightning protection for the magazine would also be provided.

2.11.4 Gas Storage

Liquid Petroleum Gas (LPG) and compressed oxygen (O_2) would both be stored separately, in isolation, and located near the process plant. Tank facilities would be installed and operated in accordance with relevant Australian Standards and State Safety Regulations.

2.11.5 Risk Assessment

As a component of the impact assessment process, and in order to address the requirements of State Environmental Planning Policy (SEPP) 33 (Hazardous Development), a risk assessment of the activities to be undertaken at the Project has been conducted (Appendix L).

2.12 Workforce

2.12.1 Construction Phase

The construction phase of the Project would require an average workforce of around 200 people with a maximum of approximately 300 at the peak of construction activity. The construction teams would normally be working one 12-hour shift, six days a week.

The nature of the positions suggests that the employees would reside in the shire during their employment period. It is anticipated that additional temporary and part time work would be created during the construction period

The construction phase workforce includes workers who would go on to form part of the operational phase workforce. These employees would be involved with works such as management, mine development, plant operation and other service categories.

2.12.2 Operational Phase

Of the estimated 200 positions to be created during the first eight years of the operational phase, it is anticipated that 110 of these jobs would be provided by the mining contractor, with North Limited providing the remaining 90. It is expected that 35 to 40% of the North Limited positions would be filled by existing staff or skilled workers from outside the region. These positions would be mainly managerial or professional. It is expected that the majority of the remaining North Limited positions would be available to local residents.

At the completion of mining (year 8) employee numbers would decline to about 90.

During operations the Cowal Project would operate continuously, seven days a week.

Details of the proposed workforce during operational phase are presented in Table 2-10.

Mining operations are subject to tender with stipulation that the contractor maximise local employment. It is expected that the contractor would bring in senior operators and maintenance personnel from other projects.

2.12.3 Workforce Recruitment and Training

It is anticipated that recruitment of staff for the Cowal Project would be primarily from the Central West region with the remainder being sourced from around Australia. The Contractors' employees would be recruited at the discretion of each contractor.

Table 2-10 Operations Workforce (Approximate)

Category	North Employees	Contractor Employees
Processing Plant		
Department Manager	1	-
Senior Supervisors	10	-
Professional	6	-
Trades	10	-
Apprentices	2	-
Other	27	-
Mining Operations		
Department Manager	1	-
Senior Supervisor	-	2
Professional	7	10
Other	8	98
Administration		
General Manager	1	-
Department Manager	1	-
Senior Supervisor	1	-
Professional	4	-
Other	6	-
Environmental Management		
Advisor	1	-
Technical Support	4	-
Total	**90**	**110**

All personnel would be required to attend a comprehensive on-site induction that includes issues such as environmental awareness and management, occupational health and safety. On-going training would be provided to employees as necessary to gain and update the necessary skills to work in their relevant areas.

2.12.4 Workforce Accommodation

Both local and non-local workers would be employed during the construction and operational phases. North employees would arrange their own accommodation based on individual preference. Contractors would be responsible for housing their own employees.

West Wyalong has ample capacity to cater for the temporary accommodation requirements of the Project. The town has 14 motels and two caravan parks and is currently experiencing low occupancy rates. The motels alone have the capacity, taking into account existing occupancy, to provide individual rooms for approximately 158 of the construction employees.

Section 3

Section 3
Description of the Existing Environment

3.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 Scope

The following section describes the existing local and regional environment for the Cowal Gold Project area. This description includes specific reference to the Project area not including the proposed electricity transmission line. Description of the existing environment for the proposed electricity transmission line between the Project site and Temora is presented in Appendix D.

3.2 Land Resources

3.2.1 Physiographic Setting

Location and Physiography

The proposed Cowal Gold Project area is located on the western side of Lake Cowal in Central New South Wales approximately 60 km south-west of Forbes and 38 km north-east of West Wyalong (Figure 1-1). The proposed Project Mining Lease Application (MLA) area falls within the Bland Creek Valley and covers approximately 2,650 ha (Plate 3-1). The region supports mainly dryland agriculture with irrigation farming in the Jemalong/Wyldes Plains Irrigation Districts located to the north-east of the Project area.

The general landscape of the area is flat to very gently undulating land with occasional rocky outcrops and low hills such as Wamboyne Mountain (Plate 3-1).

The majority of the vegetation of the area has been heavily cleared with remnant and regrowth vegetation restricted to elevated rocky areas.

All of the proposed mining operations area is located within the Bland Creek catchment which falls steadily from west to east and drains into Lake Cowal. Lake Cowal is part of a 400,000 ha area within the Lachlan Basin recognised as "wetland" by the Department of Land and Water Conservation (DLWC) (Figure 3-1).

The Lake overflows to Nerang Cowal to the north with evaporative losses reducing the size of the Lake between rainfall/inflow events. The hydrology of the Project area is described in Appendix F and summarised in Section 3.3.

Visual Features

A visual impact assessment of the regional and local landscape characteristics of the proposed gold mine has been undertaken by EDAW Australia Pty Ltd (1997) (Appendix M).

The region currently supports mainly dryland agriculture with irrigation farming in the Jemalong/Wyldes Plains Irrigation Districts adjoining the north-east edge of Lake Cowal. Remnant tree and shrub vegetation in the Lake Cowal region occurs primarily on rocky elevated ground, areas of impeded drainage, patches of sandy soils and road verges. Most of the lower slopes and relatively flat land has been cleared for grazing and/or cultivation.

The Project area is located on a gently sloping alluvial plain. Within the proposed MLA area, the land elevation ranges from about RL 205 m to RL 223 m with a slope of around 1% falling to the east. The major topographic features in the general vicinity of the Project area include Wamboyne Mountain, approximately 7 km north of the Project area (RL 412 m) and Billys Lookout, approximately 7 km south-west of the Project area (RL 368 m). A north-south oriented ridgeline system runs approximately 3.5 km west of Wamboyne Mountain and approximately parallel to the edge of Lake Cowal 8 km to the west. The gentle eastern slopes of this ridgeline drain east into the Lake.

The ridgeline system reaches a maximum elevation of RL 368 m at Billys Lookout, to the south-west of the Project area.

In addition to Billys Lookout and Wamboyne Mountain, a small tree covered hill known as Cowal West Hill, reaching an elevation of RL 223 m, lies approximately 1.7 km to the west of the Lake.

The visual catchment of the Project area is presented on Plate 3-1.

3.2.2 Meteorology

Climate

The Cowal region is located on the boundaries of the south-eastern semi-arid and the south-eastern temperate regions of Australia (Austin & Nix, 1978).

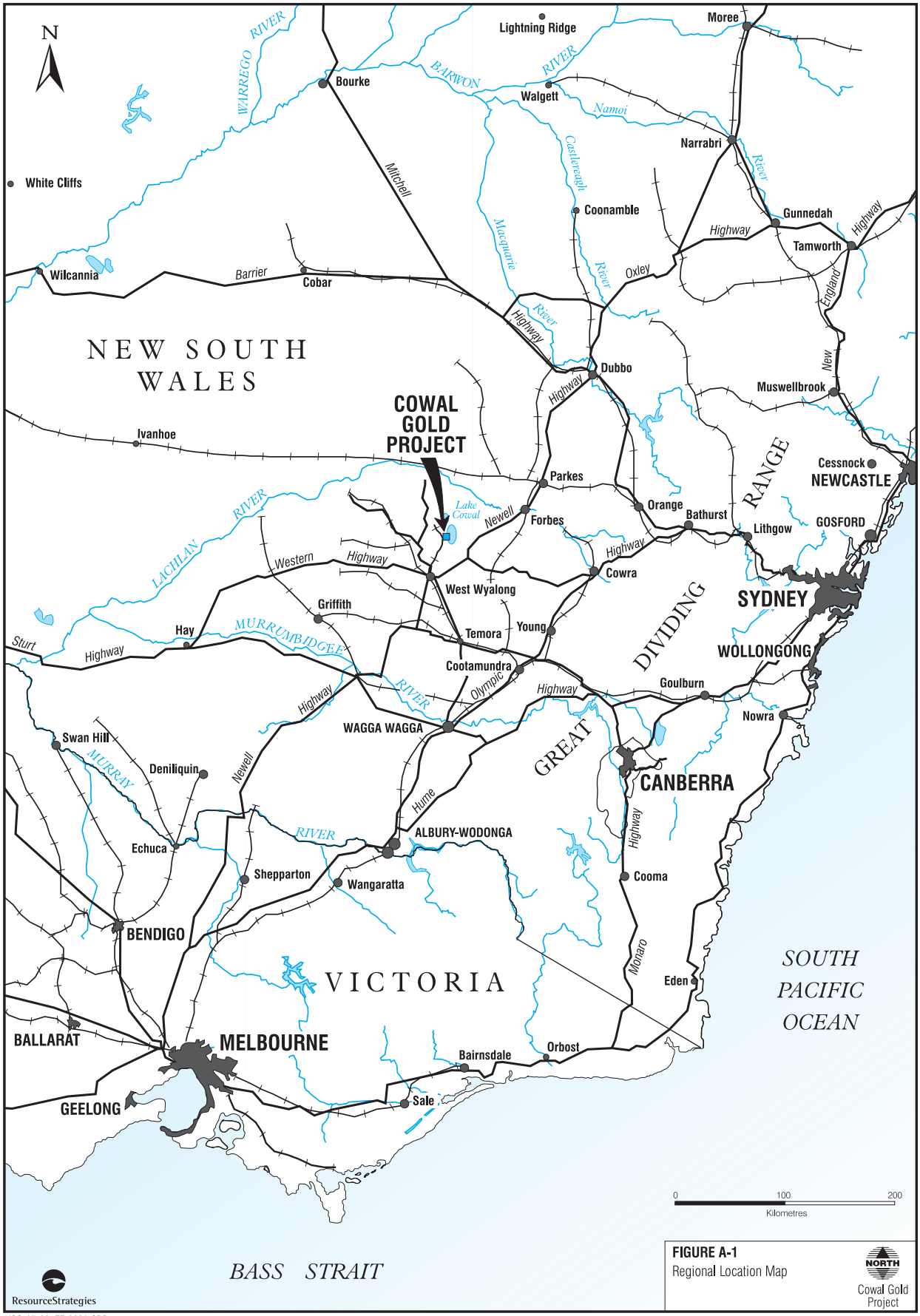
The regional climatic description has been collated from the following Bureau of Meteorology stations: Forbes (Station No. 065016); Condobolin Post Office (Station No. 050052); Condobolin Agricultural Research Station (Station No 050102); and Wyalong Post Office (Station No 073054).

Table 3-1 Bureau of Meteorology Station Locations and Recording Period

Bureau of Meteorology Station	Location	Elevation (m)	Period of Record	Distance and Direction from Cowal Project Area (approx. km)
Forbes	Latitude: 33° 23'S Longitude: 148° 00'E	240	1873 - 1996	55 km north-east
Condobolin Post Office	Latitude: 33° 04'S Longitude: 147° 14'E	195	1881 - 1997	66 km north-west
Condobolin Agricultural Research Station	Latitude: 33° 05'S Longitude: 147° 09'E	199	1973 - 1996	66 km north-west
Wyalong Post Office	Latitude: 33° 95'S Longitude: 147° 25'E	245	1895 - 1997	38 km south west



NOC-97-03_S3-025D.CDR



NOC-97-03_FF-023A.CDR

Details of the locations of the stations and their recording period are presented in Table 3-1.

A meteorological station has been installed at the Project area recording temperature, wind speed and direction, relative humidity and rainfall. The location of the on-site meteorological station is shown on Figure 3-2.

A summary of meteorological data collected from the various regional stations is presented below:

Temperature

Historical data show the warmest months within the region are November through to March, with the coolest temperatures falling from May through to August/ September.

Mean monthly temperature for the Project area are presented in Table 3-3.

The highest average monthly temperatures for Forbes (32.7°C) and Cowal Project area (31.3°C) have been recorded in January. The Forbes meteorology site recorded the average lowest monthly temperature in July (2.8°C) and the on-site meteorology station recorded the average lowest monthly temperature in July (5.1°C).

Relative Humidity

Relative humidity has been recorded at Forbes (Station No. 065016) and West Wyalong Station (Table 3-2). Relative humidity at West Wyalong for 9 am ranges from 21% in October and November to 39% in June and July. Afternoon (3 pm) levels range from 31% in December to 59% in June.

Wind Speed and Direction

Wind roses for the Project area are presented in Figure 3-3. The wind roses indicate that the Project area is strongly influenced by winds from the south-west. Wind speeds during the year are generally moderate and usually range between 6 and 10 km/hr, increasing up to 20 km/hr in summer during the afternoons.

Rainfall

Rainfall records in the vicinity of Lake Cowal date from 1873 (Forbes, Station No. 065016), 1881 (Condobolin Post Office, Station No. 050052) and 1895 (Wyalong, Station No 073054) and are presented in Table 3-2. The sum of the mean annual rainfall for Forbes, Condobolin and Wyalong is 527 mm, 448 mm and 483 mm respectively.

Table 3-3 On-site Meteorological Station Data Summary

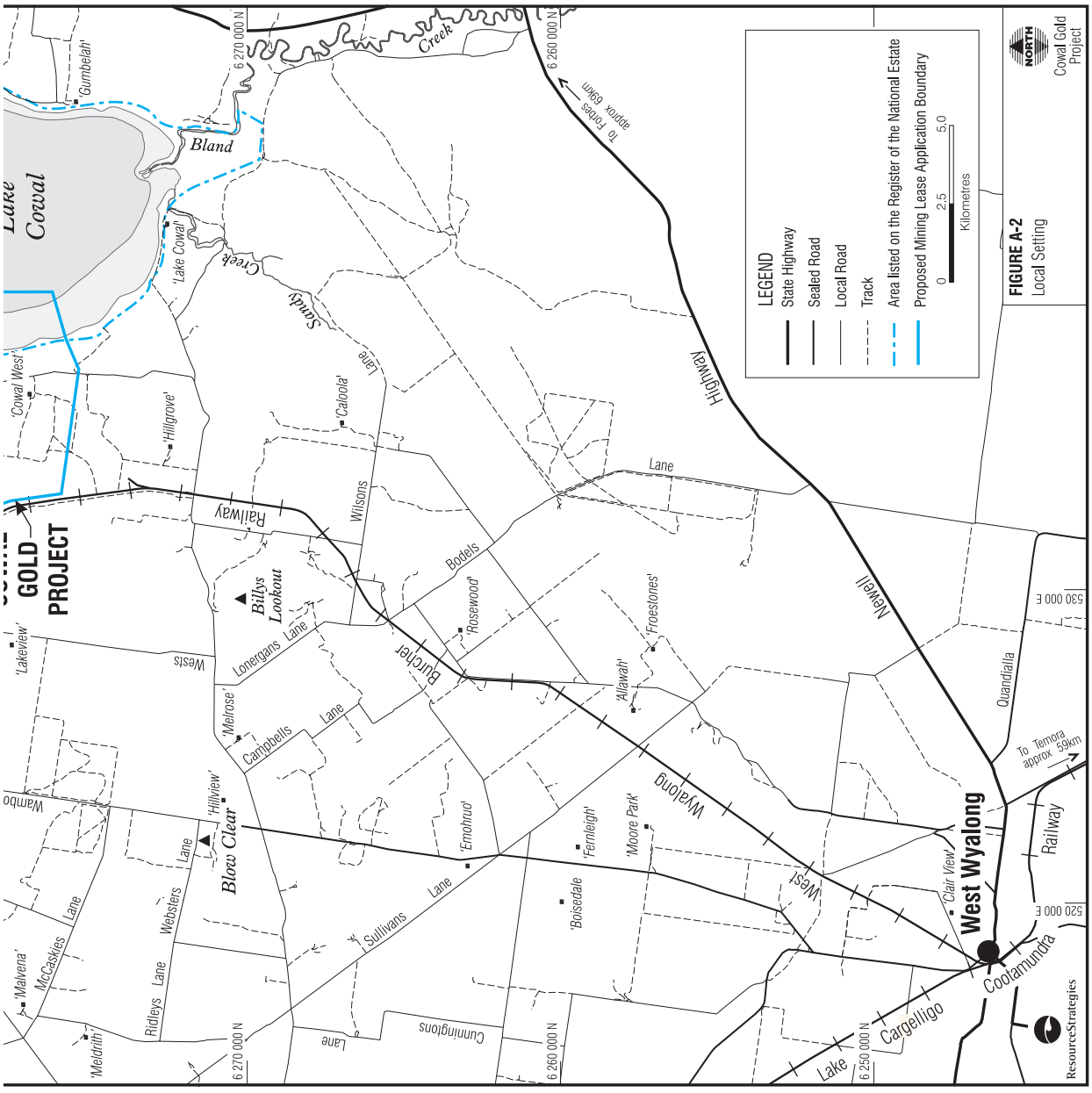
Month	Average Daily Air Temperature (Project Area) Maximum °C	Minimum °C
June 1995	13.2	6.5
July 1995	11.3	5.1
August 1995	17.8	6.1
September 1995	18.6	7.4
October 1995	23.3	11.1
November 1995	25.8	14.5
December 1995	27.9	15.6
January 1996	31.3	18.5
February 1996	N/A	N/A
March 1996	27.3	15.7
April 1996	21	10.1
May 1996	18.4	8.7
June 1996	N/A	N/A

N/A = data not available

Table 3-2 Regional Meteorology Stations Data Summary

Month	Relative Humidity				Air Temperature Daily Average (Forbes)		Average Rainfall			Evaporation*
	Daily Average (West Wyalong)		Daily Average (Forbes)							
	9.00 am (%)	3.00 pm (%)	9.00 am (%)	3.00 pm (%)	Max. (°C)	Min. (°C)	Forbes (mm)	Condobolin Post Office (mm)	Wyalong Post Office (mm)	Condobolin Agricultural Station (mm)
January	28	34	51	33	32.7	17.4	50.2	45.8	44.8	310.1
February	26	34	57	36	32.1	17.1	44.1	38.8	36.6	262.2
March	24	35	60	38	29.1	14.3	43.1	38.3	36.5	226.5
April	28	41	68	44	23.9	9.8	40.4	32.6	37.6	134.5
May	37	53	79	54	19.0	6.1	44.2	36.6	42.6	74.3
June	39	59	85	63	15.1	4.1	43.3	36.1	42.9	49.3
July	39	57	85	62	14.2	2.8	42.7	34.4	42.5	52.5
August	34	51	80	55	16.3	3.9	42.8	36.4	40.1	79.8
September	31	47	69	46	19.8	6.3	41.8	30.9	35.1	115.7
October	21	42	59	41	24.1	9.5	48.9	42.7	45.9	181.6
November	21	34	52	35	28.2	12.8	40.6	35.4	35.3	239.7
December	25	31	50	32	31.2	15.6	45.5	40.7	43.4	318.9
Annual Total							**527.6**	**448.7**	**483.3**	**2045.1**

* Refer to Appendix F for an evaluation of evaporation data.


Lake Cowal
Bland
Creek
Gumbelah
'Lake Cowal'
'Cowal West'
'Hillgrove'
Sandy Creek
'Caloola'
Lane
Wilsons
Railway
Billys Lookout
Bodels
'Rosewood'
Burcher
'Lakeview'
Wests
Lonergans Lane
'Melrose'
Campbells Lane
'Hillview'
Blow Clear
Warnbo
Lane
Websters
Ridleys Lane
'Malvena'
McCaskies Lane
'Melorith'
Sullivans Lane
'Emohruo'
'Boisedale'
'Fernleigh'
'Moore Park'
'Allawah'
'Froestones'
Wyalong
West
Highway
Nenmell
Lane
Quandialla
To Temora approx 59km
Railway
'Clair View'
West Wyalong
Cootamundra
Cargelligo
Lake
Cunningtons
Lane
To Forbes approx 69km
6 270 000 N
6 260 000 N
6 250 000 N
530 000 E
520 000 E
LEGEND
State Highway
Sealed Road
Local Road
Track
Area listed on the Register of the National Estate
Proposed Mining Lease Application Boundary
0
2.5
5.0
Kilometres
FIGURE A-2
Local Setting
Cowal Gold Project
ResourceStrategies
NOC-97-03_FF-007C.CDR

The water management system for the Project (Appendix F and Section 2.9) has been modelled on composite daily rainfall data recorded from the above meteorological stations.

Storm rainfall intensity data for Lake Cowal (33°66'S 147°40'E) was determined from methods outlined in *Australian Rainfall and Runoff* (IEA, 1987) manual, using the Intensity – Frequency – Duration Design Rainfall Program, for annual exceedance probabilities of 1:10, 1:50 and 1:100.

Rainfall event data is presented in Table 3-4 and shows a range of design storm events of varying probability and intensity for the Lake Cowal region.

Table 3-4 Rainfall Intensity Data

Annual Exceedance Probability	Intensity 1 hr (mm/hr)	12 hr (mm/hr)	72 hr (mm/hr)
1:10	35.80	5.52	1.43
1:50	51.05	7.50	1.92
1:100	58.07	8.38	2.14

Evaporation

The sum of the mean annual evaporation based on the Condobolin Agricultural Research Station records is 2,045 mm per year* (Class "A" pan). The regional average monthly rainfall and evaporation data presented in Table 3-2 shows that rain falls uniformly throughout the year while evaporation fluctuates between summer and winter and on average exceeds rainfall by more than four-fold.

Monthly trends in evaporation show January and December as having the highest rates of evaporation (310 mm and 318 mm respectively), while June and July record the lowest rates (49 mm and 53 mm respectively).

When considering average annual rainfall, a strong moisture deficit (net difference between evaporation and rainfall) is evident for an average year. This moisture deficit is most pronounced during summer months, coinciding with periods of higher evaporation.

3.2.3 Geology

Regional Geology

The Cowal Gold Project is located in the Lachlan Fold Belt in Central Western New South Wales (Figure 3-4). The Lachlan Fold Belt has historically been the source of many mineral discoveries of local, regional and national importance.

Geophysical exploration and drilling in the vicinity of Lake Cowal indicates that Cowal style mineralisation occurs within a regionally significant 0.1 parts per million (ppm) gold anomaly. The anomaly is believed to be part of a porphyry copper-gold system, with dimensions of 6 km x 2 km, located within the Girilambone Zone.

* Refer to Appendix F for an evaluation of evaporation data.

The southern end of the porphyry copper-gold system occurs at relatively shallow depths suggesting that the original meso- and epithermal upper levels have been eroded. Towards the north, the system dips below an overlaying volcanic sequence. This volcanic sequence hosts Cowal style mineralisation and is overlain by alluvial sediments of the Jemalong Plain to depths of 1 m to greater than 50 m, depending on the underlying palaeo-topography.

Local Geology

The Cowal orebody is hosted in an Ordovician-aged volcaniclastic sequence informally referred to as the Lake Cowal Volcanic Complex. These host rocks do not outcrop in the Lake Cowal area and are only understood from geophysical interpretation and exploration drilling (Figure 3-4). As a result, the Cowal orebody does not outcrop at the surface.

Miles (1993) has informally subdivided the stratigraphic sequence of the complex into three units, which are from youngest to oldest:

- The Great Flood Unit (massive, stratified non-welded pyroclastic debris);
- The Golden Lava Unit (partly brecciated lava sequence); and
- Cowal Conglomerate Unit (volcanic conglomerate interbedded with siltstone and mudstone).

Figure 3-4 shows the local geology of the deposit.

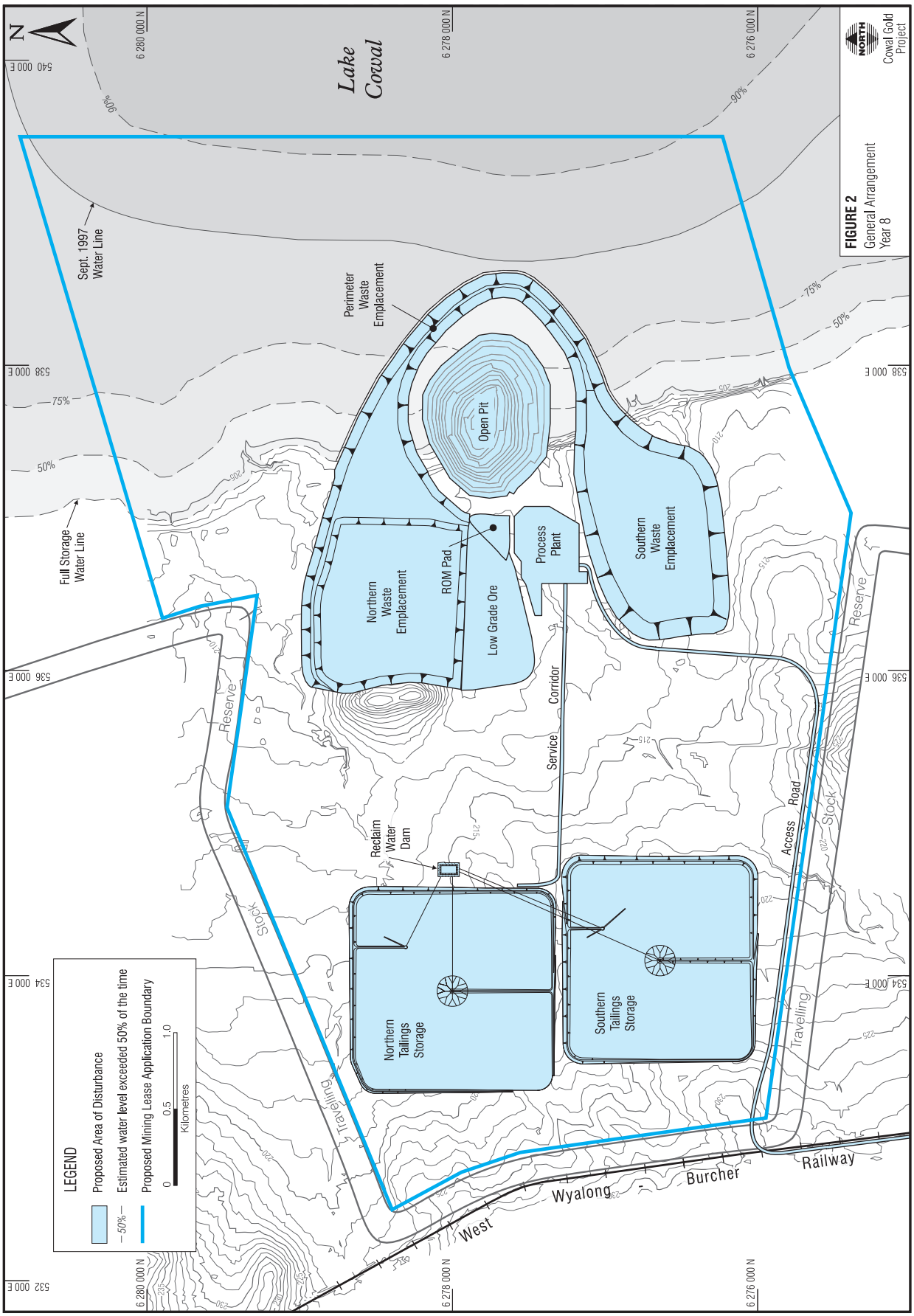
Within the Lake Cowal Volcanic Complex several roughly circular to distinctly elongated diorite/gabbro intrusions have been identified. The Cowal open pit intersects the Late Ordovician Muddy Lake Gabbro. In addition, several mafic to intermediate dykes also intersect the volcaniclastic sequence. The dykes range in size from 20 mm to greater than 20 m, but most are 1 m to 3 m thick.

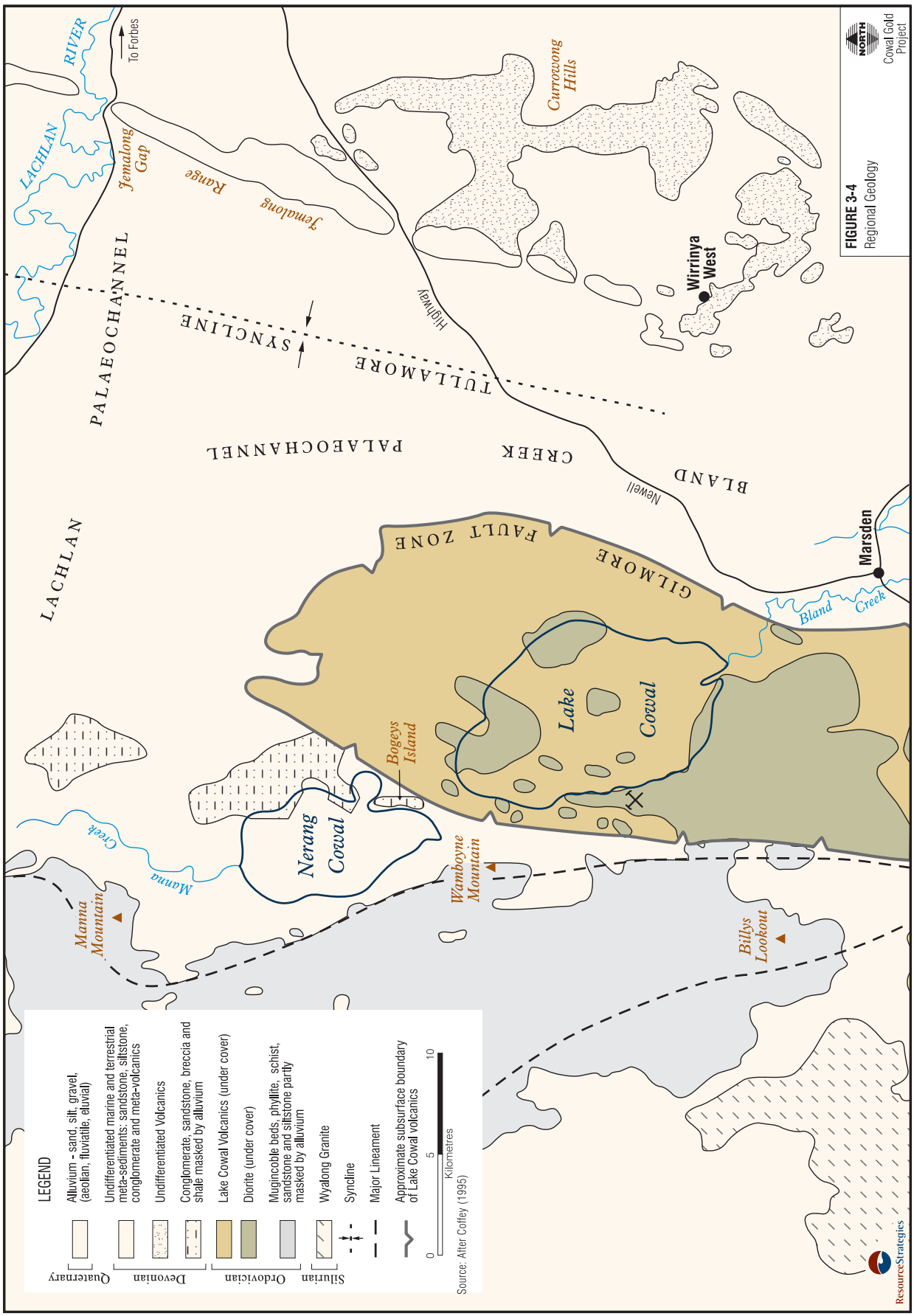
Overlying the Ordovician host rocks is a Tertiary laterite profile. The profile is often incomplete but may consist of a thin ferruginous caprock (less than 1 m thick), variable thickness mottled-zone horizon and underlying weakly ferruginous saprolite (both of which average 10 m thick, ranging from 2 m to 100 m thick).

Quaternary sediments (lacustrine clay) characteristically cover the Tertiary laterite to depths of 1 m to 3 m in the central parts of the deposit, increasing to thicknesses of 20 m to 30 m on the flanks of the deposit and locally exceeds 60 m in the surrounding area.

The stratigraphy of the host rocks of the Cowal orebody have a consistent strike of 215° and an approximate dip of 50° to the north-west. Several major fault and shear zones appear throughout the sequence.

Gold mineralisation primarily occurs in dilational quartz-carbonate-sulfide and carbonate ± quartz-sulfide veins. The veins occur throughout the deposit, however observations during the 1995 feasibility study indicate that the proximity to faults and shear zones controls occurrence of gold-bearing veins. The veins have a strike of 305-310° and


N
Lake Cowal
Cowal Gold Project
FIGURE 2
General Arrangement
Year 8
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Reclaim Water Dam
Northern Tailings Storage
Southern Tailings Storage
Access Road
Stock Reserve
Travelling Stock
Wyalong - West
Burcher Railway
LEGEND
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
Kilometres
6 280 000 N
6 278 000 N
6 276 000 N
532 000 E
534 000 E
536 000 E
538 000 E
540 000 E
NOC-97-03_LT-002B.CDR


FIGURE 3-4
Regional Geology
Cowal Gold Project
NORTH
LEGEND
Alluvium - sand, silt, gravel, (aeolian, fluviatile, eluvial)
Undifferentiated marine and terrestrial meta-sediments: sandstone, siltstone, conglomerate and meta-volcanics
Undifferentiated Volcanics
Conglomerate, sandstone, breccia and shale masked by alluvium
Lake Cowal Volcanics (under cover)
Diorite (under cover)
Muginoble beds, phyllite, schist, sandstone and siltstone partly masked by alluvium
Wyalong Granite
Syncline
Major Lineament
Approximate subsurface boundary of Lake Cowal volcanics
Quaternary
Devonian
Ordovician
Silurian
0
5
10
Kilometres
Source: After Coffey (1995)
To Forbes
LACHLAN RIVER
Jemalong Gap
Jemalong Range
Currawong Hills
Wirrinya West
Highway
SYNCLINE
TULLAMORE
PALAEOCHANNEL
PALAEOCHANNEL
CREEK
BLAND
Newell
Marsden
Bland Creek
GILMORE FAULT ZONE
LACHLAN
Lake Cowal
Bogeys Island
Nerang Cowal
Wamboyne Mountain
Billys Lookout
Manna Mountain
Manna Creek
ResourceStrategies
NOC-97-03_S3-009E.CDR

dip 30°-35° to the south-west. They are parallel-sided and range in thickness from less than 1 mm to 10 mm. The highest gold grades have been recorded in a series of vein sets (pods) that are vertically elongated and trending north-south. These pods are disrupted by west-northwest trending faults near the centre of the mineralisation zone.

Sulfide mineralisation in the veins consists of pyrite, sphalerite, chalcopyrite, pyrrhotite and galena. Adularia is a common auxiliary mineral.

The central area of the deposit is characterised by relatively shallow oxidation due to the high degree of silicification, while the poorly mineralised periphery has deep oxidation.

The weathered sequence has been sub-divided into three categories:

- Transported cover (Holocene and Quaternary sequence);
- Soft oxide (totally weathered upper lateritic profile); and
- Hard oxide (strongly altered volcaniclastics).

Geomorphology

The Project area is situated on the western shore of Lake Cowal which in turn lies on the western margin of the Jemalong Plain. Jemalong Plain is bounded to the east by the Jemalong Range, to the west by the Manna anticline and its associated ridge, to the north by the Lachlan River and to the south by the catchment of Bland Creek (Figure 3-5). The plain has been formed by the alluvial infilling of the Lachlan and Bland Creek palaeochannels with sediments of the Lachlan and Cowra Formations (Figure 3-6). The depth of these sediments is over 100 m above the Bland Creek palaeochannel and decreases to the east and west as the bedrock ridges are approached. Gravel and sand lenses within the Lachlan and Cowra Formations, as well as gravels at the base of the Bland Creek palaeochannel, are important groundwater stores and conduits and play a major role in the regional groundwater hydrology.

The ages of the Lachlan and Cowra Formations are uncertain. However, pollen samples and correlations with other sedimentary sequences indicate that the Lachlan Formation is of Pliocene age (1.8 to 5 million years before present, Ma), though its lower sections may be as old as Mid-Miocene (12 Ma). The Cowra Formation is probably of Pleistocene age (up to 1.8 Ma) (Martin, 1987 in Goldrick, 1997; Williamson, 1986 in Goldrick, 1997).

The surface geomorphology of Jemalong Plain is dominated by:

- the Lachlan-Lake Cowal floodway
- elevated relic channels; and
- the Lake Cowal-Nerang Cowal complex.

Figure 3-5 shows dominant geomorphological components of the Jemalong Plains.

Lachlan-Lake Cowal Floodway

The Lachlan-Lake Cowal floodway is a modified, partly-leveed, breakout channel of the Lachlan River. The floodway leaves the main channel downstream of Jemalong Gap and flows south-west across the plain and into the north-east section of Lake Cowal.

Elevated Relic Channels

The main elevated relic channels are Warroo Prior Stream and the Cadow Prior Stream (Kelly, 1971 in Goldrick, 1997). Warroo Prior Stream has its junction with the Lachlan River about 10 km west of Jemalong Gap and can be traced south-west before bifurcating around the bedrock high of Dog Kennel Hill. Cadow Prior Stream lies further north between the Warroo Prior Stream and the present Lachlan River. Smaller and less well defined prior streams are also evident on Jemalong Plain.

Lake Cowal-Nerang Cowal Complex

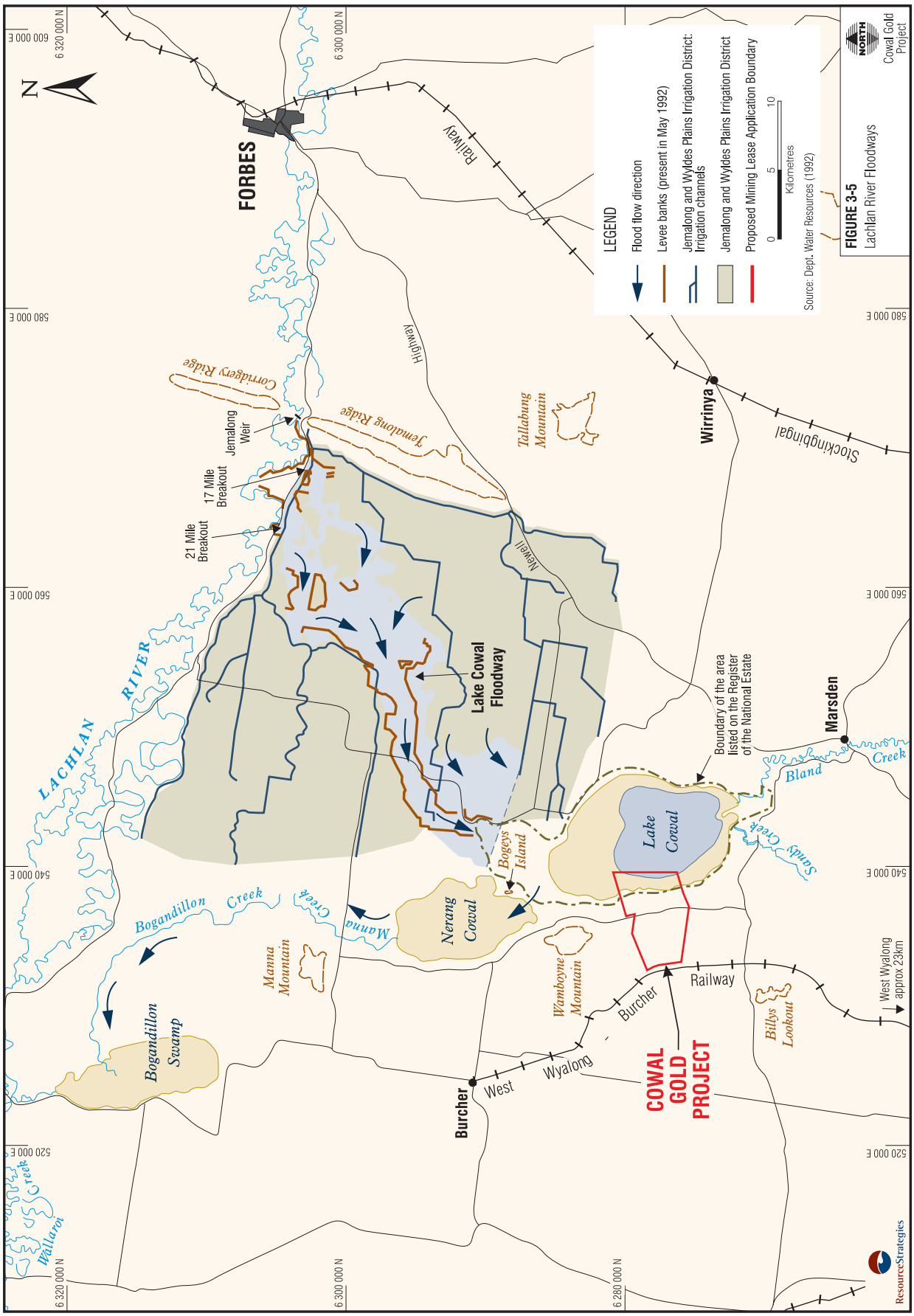
Surface water inflow to Lake Cowal comes from the Lachlan-Lake Cowal floodway and Bland Creek located to the south of the Lake. In flood conditions the Lake drains in a northerly direction through Nerang Cowal, Manna Creek, Manna Swamp, Bogandillon Creek then into Bogandillon Swamp and ultimately the Lachlan River (Section 3.3.1). Lake Cowal is underlain by sediments which vary in thickness from 1 m to more than 50 m, which in turn overlie bedrock of the Lake Cowal Volcanic complex (Section 3.2.3). In contrast to other sediments of Jemalong Plain, those beneath Lake Cowal are dominated by dark grey clays suggesting a strong lacustrine influence. These clays extend to significant depth (70 to 80 m) in the area.

Water levels within Lake Cowal and Nerang Cowal varied considerably during the Quaternary. The highest visible shoreline features indicate that Lake Cowal and Nerang Cowal were previously joined.

The north-eastern shore of this feature is well defined on air photos and forms at least two levels of a low sandy beach ridge which is probably associated with an aeolian sand sheet downwind. This feature is a form of lunette but differs from the more typical examples described on lakes further west and south. No dates have been established for these features but comparison with other lakes would suggest that they were active at the peak of the last glaciation (circa 18-20,000 years ago) and that their initial formation was substantially earlier.

On the western shore of the Lake high level shorelines are less easy to recognise however Culture and Heritage (1995) refers to "raised, almost stepped, ground along the western margin" which apparently is composed of alternating bands of gravel and clay. The proximity to the ridge means that shorelines in this vicinity are likely to be expressed as narrow steps in the hillslope profiles with a thin drape of beach sediments. The features described by Culture and Heritage (1995) fit this description and are almost certainly high level shorelines and their sequence and stratigraphy could provide insights to Quaternary or older lake history.

Bland Creek has previously entered the Lake at a number of points on the southern shore. The present channel appears to have been diverted to the east probably by beach deposits formed at high lake levels. This stream now


LEGEND
Flood flow direction
Levee banks (present in May 1992)
Jemalong and Wyldes Plains Irrigation District: Irrigation channels
Jemalong and Wyldes Plains Irrigation District
Proposed Mining Lease Application Boundary
0 5 10 Kilometres
Source: Dept. Water Resources (1992)
FIGURE 3-5
Lachlan River Floodways
Cowal Gold Project
NORTH
N
FORBES
Railway
Highway
Wirrinya
Stockinbingal
Jemalong Weir
17 Mile Breakout
21 Mile Breakout
Corntdgery Ridge
Jemalong Ridge
Tallabung Mountain
Newell
Lake Cowal Floodway
LACHLAN RIVER
Boundary of the area listed on the Register of the National Estate
Marsden
Bland Creek
Sandy Creek
Lake Cowal
Bogeys Island
Nerang Cowal
Bogandillon Creek
Manna Creek
Manna Mountain
Wamboyne Mountain
Bogandillon Swamp
Burcher
West Wyalong
Railway
Billys Lookout
West Wyalong approx 23km
COWAL GOLD PROJECT
Wallaroi Creek
600 000 E
580 000 E
560 000 E
540 000 E
520 000 E
6 320 000 N
6 300 000 N
6 280 000 N
ResourceStrategies
NOC-97-03_S3-016G.CDR

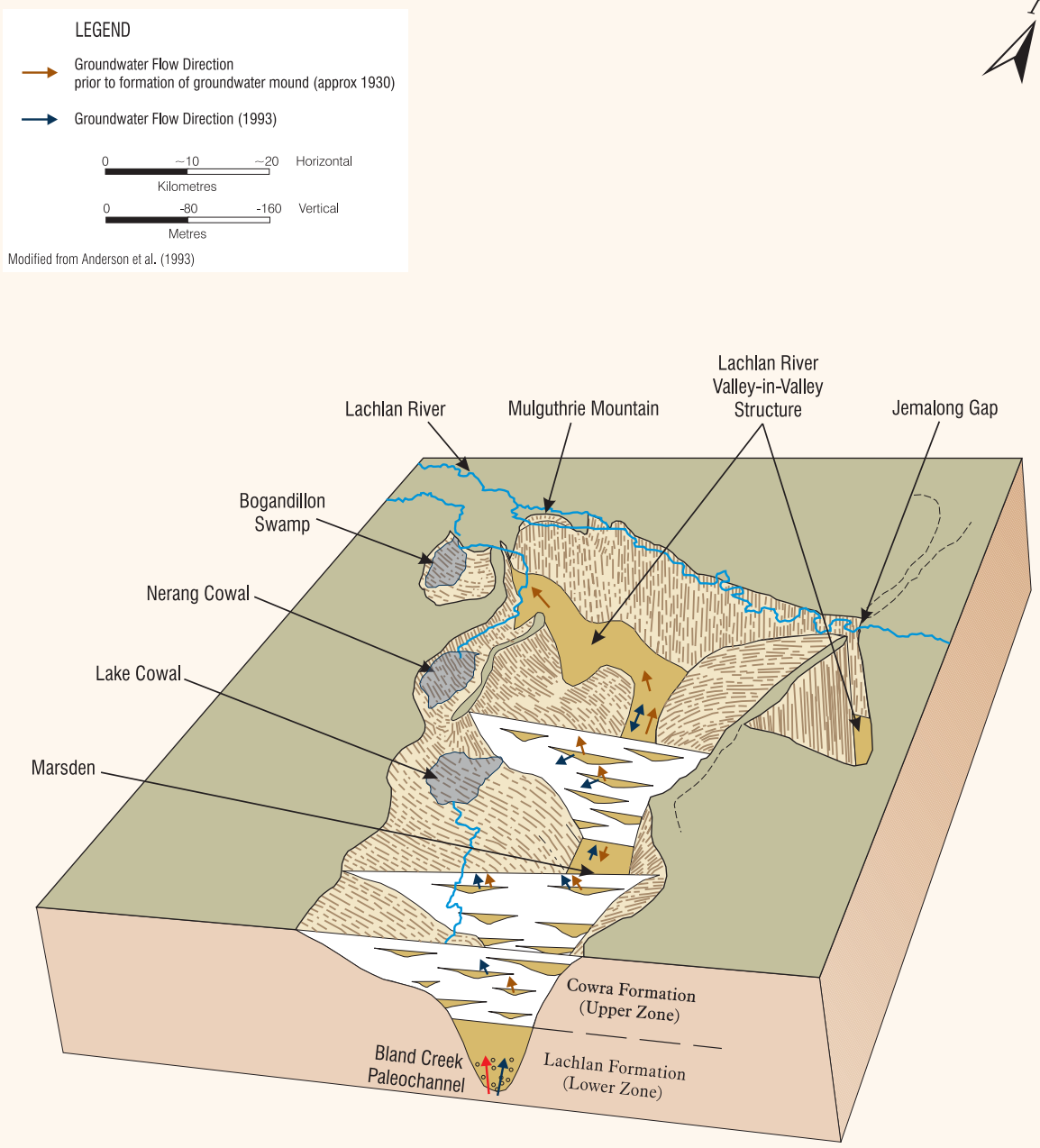


FIGURE 3-6
Groundwater Movement Schematic

ResourceStrategies

NOC-97-03_S3-017E.CDR

NORTH Cowal Gold Project

discharges into deeper water via a silt jetty (drowned channel levees) nearly 2 km long.

Seismicity of the Project Area

Lake Cowal is situated in the Lachlan Fold Belt geologic province, where earthquake activity has historically been moderate (Australian Geological Survey Organisation [AGSO], 1997). The most recent earthquake experienced by West Wyalong residents occurred on the 24 September 1997 and measured 2.3 on the Richter scale with the centre being located approximately 20 km to the north-west.

An estimate of the characteristic earthquakes for the Lake Cowal area for a range of recurrence expectancies was provided by the AGSO and is presented in Table 3-5.

Table 3-5 Lake Cowal Seismic Analysis

Analysis Event Parameter	Event Recurrence Expectancy (years)		
	500	5,000	>10,000
Peak horizontal ground acceleration	0.08 g	0.13 g	0.3 g
RMS horizontal ground acceleration	0.03 g	0.05 g	0.12 g
Duration of strong motion(s)	3	3	4
Predominant frequency of strong motion (Hz)	5	5	4
Earthquake magnitude (Richter ML)	5.5	5.5	6
Earthquake epicentral distance (km)	25	15	<10

3.2.4 Soils

In 1994 North Mining Limited commissioned the Department of Conservation and Land Management (now the Department of Land and Water Conservation [DLWC]) to conduct comprehensive soil surveys. The soil survey report provides information and data for the characterisation of overburden as well as baseline data necessary for the identification of soils resources for the planning and implementation of rehabilitation programmes associated with the Project. The methodologies and results of the survey are presented in Appendix B.

The DLWC survey (1994) identified three mapping units, which consist of the following major soil types:

- Hard pedal red duplex soils;
- Grey, brown and red cracking clays; and
- Hill soils.

Soil type distribution is shown on Figure 3-7. Physical and chemical characteristics of those main soil types identified are discussed in Appendix B.

Assessment of the suitability of these soils for revegetation purposes is also included in Appendix B and is summarised below in Section 3.2.5.

3.2.5 Agricultural Suitability and Land Capability

As a component of land resource assessment, agricultural suitability and land capability were addressed. Detail of the agricultural suitability and rural land capability is presented as an attachment to Appendix B, which is summarised below.

The suitability and capability assessments draw on existing mapping information from the NSW Department of Agriculture (NSW Ag) (agricultural suitability assessment at a scale of 1:100,000 completed in 1990) and the DLWC (land capability assessment at a scale of 1:100,000 completed in 1983). To allow meaningful assessment of the Project area, the site has been remapped at a scale of 1:16,000 (approx.) in consultation with the NSW Ag.

Agricultural Suitability

The agricultural suitability assessment has been conducted in accordance with the five class system which allows for rapid assessment and identification of land worth retaining for agricultural purposes (Riddler, 1996). Agricultural suitability classes for the Project area are shown on Figure 3-8 and consist of Classes 3, 4 and 5.

The majority of the site is Class 3 suitability which is defined as suitable for fodder crop cultivation or pasture establishment. Agricultural production is limited by erosion hazard, the breakdown of soil structure and climate.

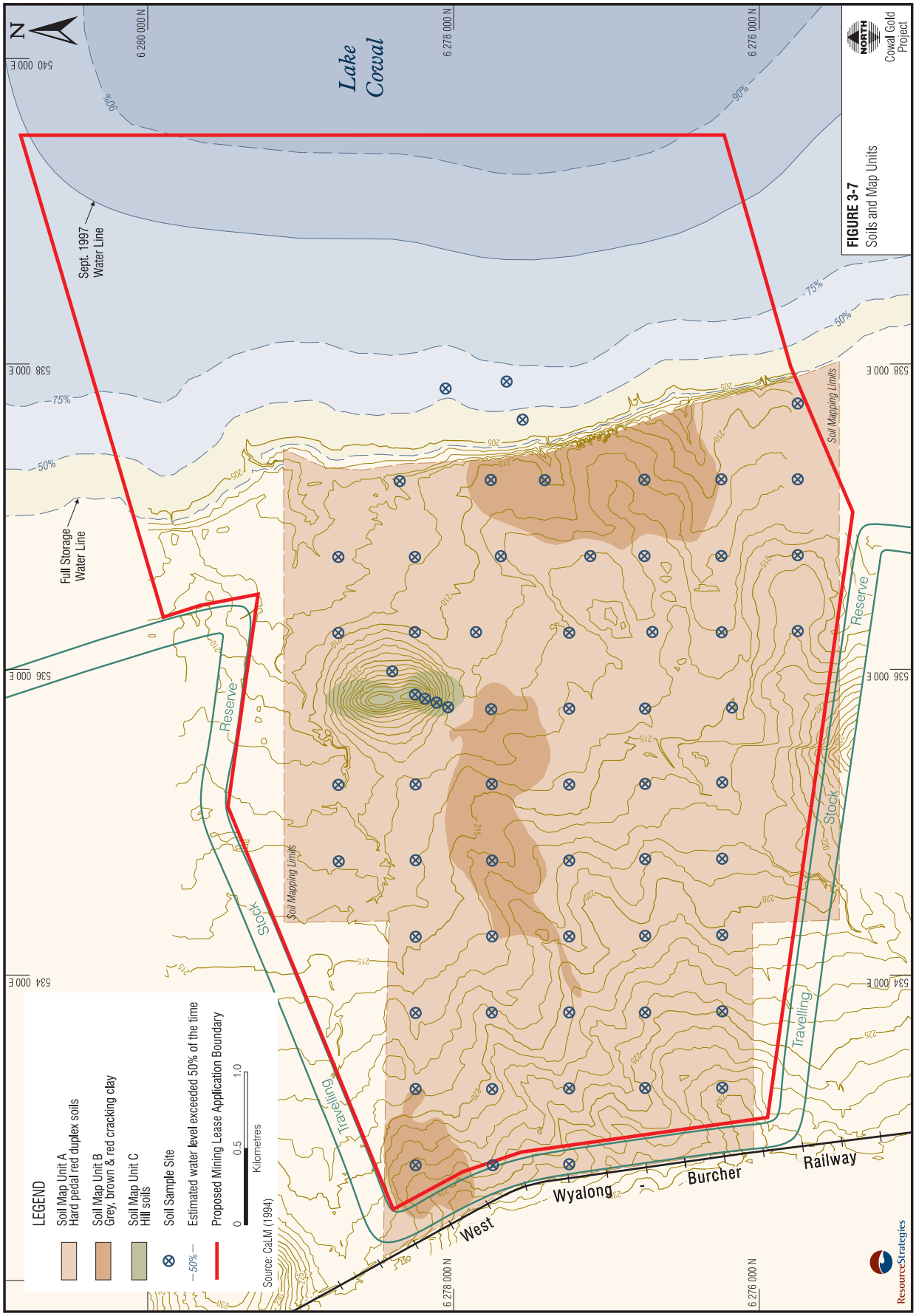
Class 4 land is restricted to the upper slopes of Cowal West Hill (approximately 45 hectares). Class 4 land is suitable for grazing but not cultivation and agriculture within this class is based on native pastures or improved pastures established using minimum tillage techniques. Ground truthing indicates that the suitability of Cowal West Hill is limited by the increased slope, thin soils, rockiness and soil type each of which require high levels of various inputs to ensure sustainability of the grazing activity.

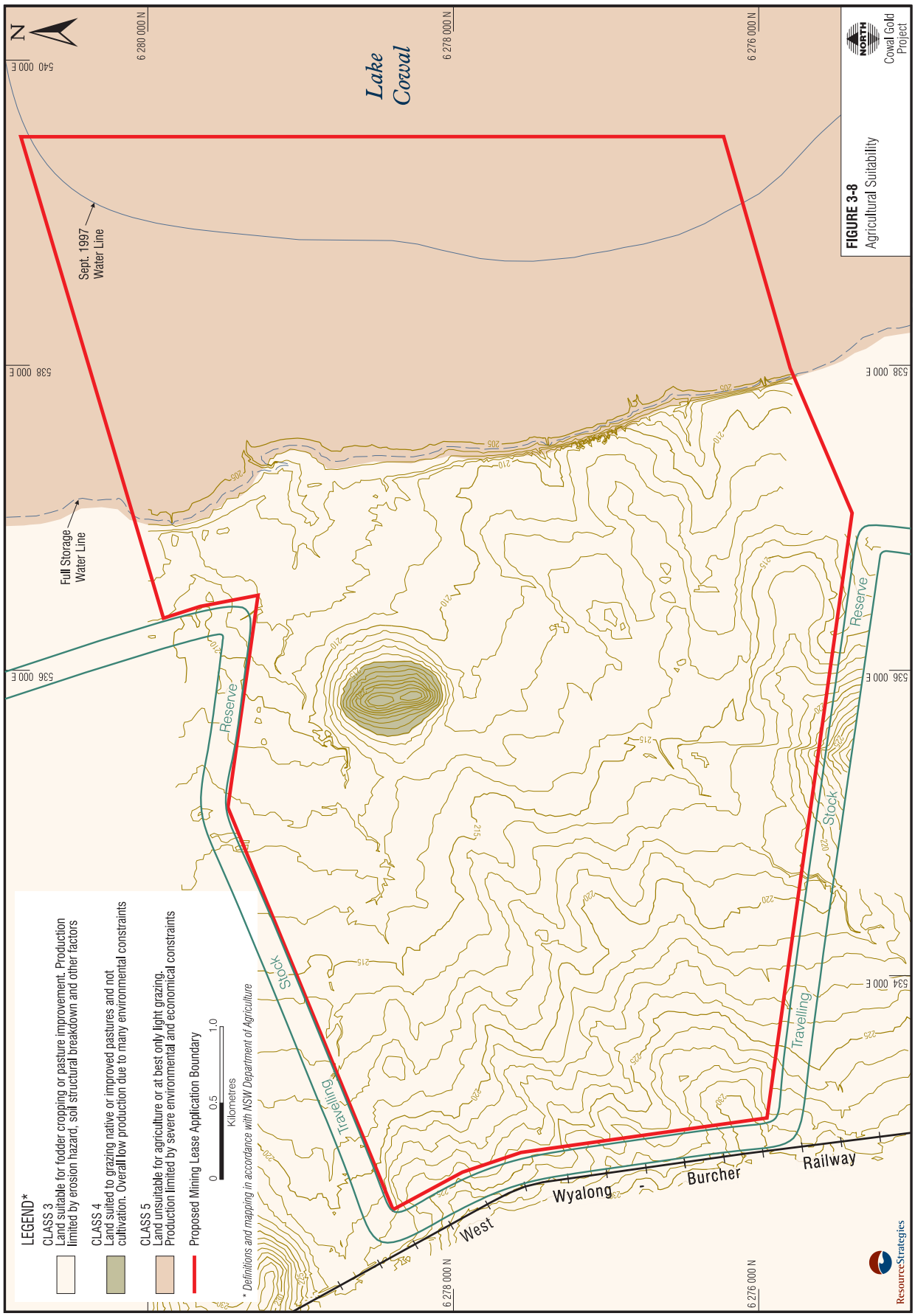
Class 5 land is unsuitable for cultivation but suitable for grazing with the adoption of intensive management practices. The area below Lake Cowal's full storage water line is Suitability Class 5 Land. The suitability is limited by the seasonal change in the water level in the Lake and the incidence of inundation. The presence of gilgai microrelief which occurs with variable frequency along the foreshore, also demands active management of grazing practices to ensure sustainability. This land is, however, cultivated and grazed when water levels allow.

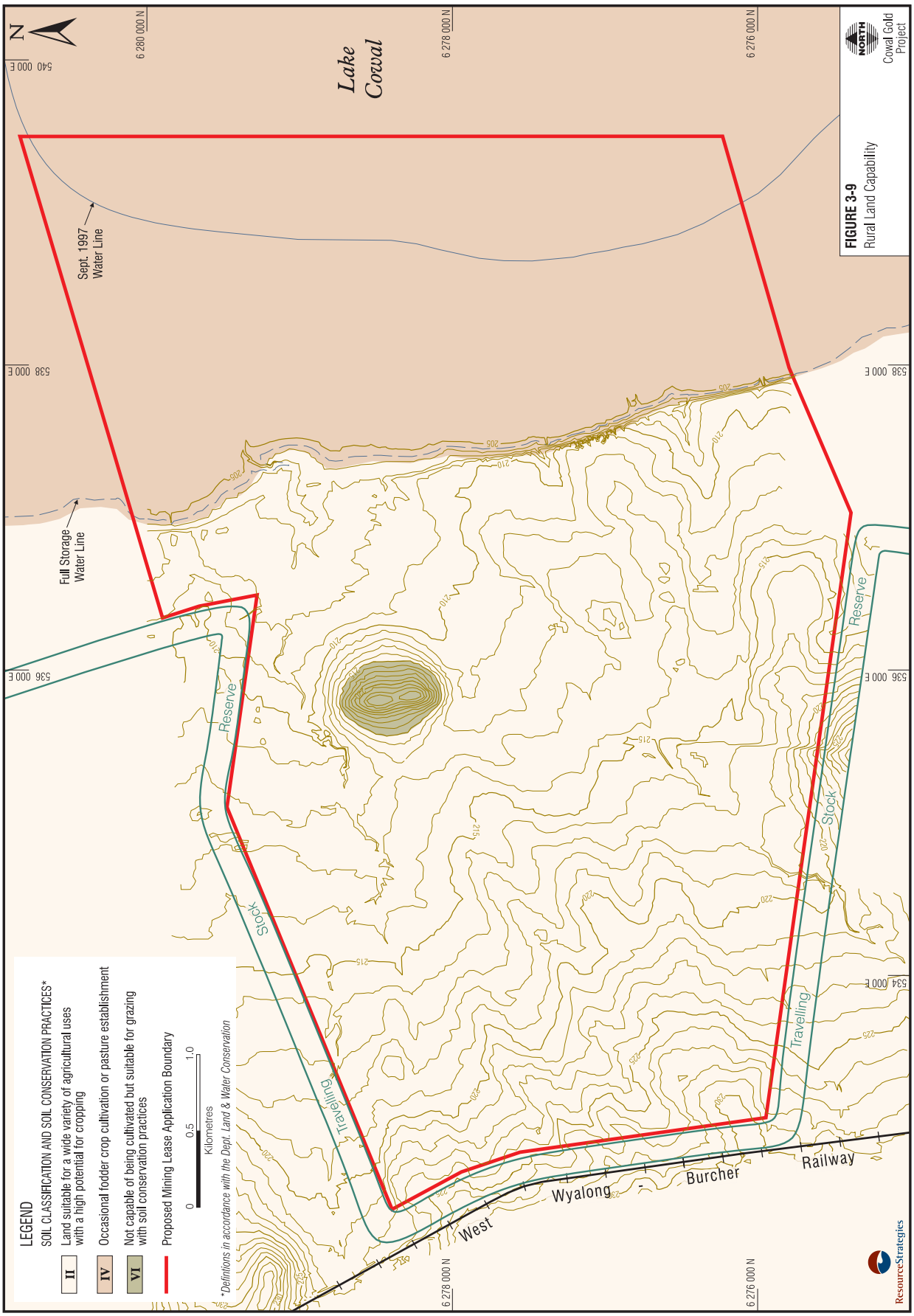
Rural Land Capability

The rural land capability assessment has been conducted in accordance with the standard NSW eight class system. This system is based on the assessment of biophysical characteristics, categorising land in terms of its general limitations such as erosion hazard, climate and slope. Land is classed based on the limitations to a particular type of land use (Emery, 1985). Rural land capability classes are shown on Figure 3-9. Rural land capability classes II, IV and VI were recorded at the site.

Class II land dominates the site and is defined as that with the potential to be cropped using soil conservation practices such as strip cropping, conservation tillage and adequate crop rotation. Agricultural productivity on this area is potentially high. Soil erosion risks arise due to the length of slope on 1% to 2% sloping land with thin surface soils


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Soil Mapping Limits
Reserve
Stock
Travelling
Wyalong - West
Burcher
Railway
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
LEGEND
Soil Map Unit A
Hard pedal red duplex soils
Soil Map Unit B
Grey, brown & red cracking clay
Soil Map Unit C
Hill soils
Soil Sample Site
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
Source: CaLM (1994)
Cowal Gold Project
FIGURE 3-7
Soils and Map Units
ResourceStrategies
NOC-97-03_S3-005H.CDR


N
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Reserve
Stock
Travelling
Wyalong West
Burcher
Railway
LEGEND*
CLASS 3
Land suitable for fodder cropping or pasture improvement. Production limited by erosion hazard, soil structural breakdown and other factors
CLASS 4
Land suited to grazing native or improved pastures and not cultivation. Overall low production due to many environmental constraints
CLASS 5
Land unsuitable for agriculture or at best only light grazing. Production limited by severe environmental and economical constraints
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
* Definitions and mapping in accordance with NSW Department of Agriculture
FIGURE 3-8
Agricultural Suitability
NORTH
Cowal Gold Project
ResourceStrategies
NDC-97-03_S3-007G.CDR


N
540 000 E
538 000 E
536 000 E
534 000 E
6 280 000 N
6 278 000 N
6 276 000 N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Reserve
Stock
Travelling
Wyalong West
Burcher
Railway
LEGEND
SOIL CLASSIFICATION AND SOIL CONSERVATION PRACTICES*
II Land suitable for a wide variety of agricultural uses with a high potential for cropping
IV Occasional fodder crop cultivation or pasture establishment
VI Not capable of being cultivated but suitable for grazing with soil conservation practices
Proposed Mining Lease Application Boundary
0 0.5 1.0 Kilometres
*Definitions in accordance with the Dept. Land & Water Conservation
FIGURE 3-9
Rural Land Capability
Cowal Gold Project
ResourceStrategies
NOC-97-03_S3-006G.CDR

being about 10 cm thick. Field inspection indicated textures and soil types on Class II land in the study area have a high degree of erodibility.

Class IV is land which has the potential to be occasionally cultivated for fodder crops or for pasture establishment. Within the proposed MLA the small area at the top of Cowal West Hill is Class IV land. The main limitations for this area are moderate to high soil erodibility, rock outcrop and slope.

The area below Lake Cowal's full storage water line is defined as Class VI land due primarily to its susceptibility to periodic inundation. Class VI is land considered suitable for grazing with soil conservation practices including limitation of stock. Although this area is cropped periodically when Lake levels permit, the rural capability of the area is graded as VI due to the frequency of inundation. This land is, however, cultivated and grazed when lake levels allow.

3.2.6 Landuse

Landuse surrounding the Project area is dominated by sheep and to a lesser extent, cattle grazing on both native and improved pastures and grain cropping (mainly wheat and barley). The Project area has been predominantly cleared for grazing and grain cropping. A small number of intensive livestock operations (eg. small scale piggery) are also located within the vicinity of the Project area. Grazing and occasional cropping below the Lake's full storage water line occurs when moisture and market conditions are suitable. Pasture has been proven to be more valuable and reliable when grown on recently flooded land as opposed to adjacent lands, particularly in times of drought.

A number of State Forests are proximal to the Project area including Euglo and Nerang Cowal State Forests to the north, Lake View and Corringle State Forests to the west, The Clear Ridge, Wirra, Boxall and Back Creek State Forests to the south and Little Blow Clear, Blow Clear and Hiawatha State Forests to the south-west.

A Game Reserve presently situated in the northern portion of the proposed MLA (to be relocated further north of the Project area) provides public access to Lake Cowal and was used primarily for camping during the duck hunting season.

A Travelling Stock Reserve (No. 17085) currently runs in a north-south direction through the centre of the proposed MLA area and will be diverted around the mining lease.

There are a number of unformed crown roads on the proposed MLA (Figure 1-4).

Commercial and Recreational Fishing

Historically the Lake was a significant inland commercial fishery in New South Wales, ranking in the top five producers of fish for fourteen of the past twenty-three years prior to 1980 (Rankine & Hill, 1980 in NSR Environmental Consultants, 1995). Recent comparable information for the Lake is unavailable (pers. comm., NSW Fisheries Research Institute [FRI]).

Several methods of commercial fishing are employed at the Lake including gill, drum, and loop netting and yabby trapping (FRI, 1997), with Golden Perch, Redfin, European Carp and the Freshwater Yabby the main species caught. The average annual value of the Lake Cowal fishery, based on catch statistics, is approximately $120,500 consisting of $93,650 of finfish and $26,850 of crustacea.

In addition to commercial fishing activities, limited local recreational fishing occurs at Lake Cowal, particularly in the summer months. Carp species are currently thought to dominate the Lake.

3.2.7 Bushfire Hazard

The potential bushfire hazard within the vicinity of the Project area is dependent on weather conditions, accumulation of fuel (dry vegetation matter), extent and density of remnant woodland and intensity of surrounding landuses, primarily grazing.

The proposed MLA and surrounding areas have generally low tree density resulting in scattered leaf litter accumulation and low ground fuel loads. The grass areas have the potential to act as a moderate fire hazards under certain growth and climatic conditions.

Dense lignum areas to the north of the Project area could present a potential fire hazard during dry periods as would the deciduous trees along creeks and drainage lines.

The Project area and its surrounds are mainly high intensity grazing land with a low risk of grass fires due to the continual grazing. The construction of roads and infrastructure associated with the Cowal Project will provide fire breaks within the site and improved access for fire fighting.

All bushfire management procedures and initiatives at the Project area are to be in accordance with Bland Shire Council's Bushfire Management Plan prepared under the *Rural Fire Services Act, 1997*. The closest fire brigades to the Project area are Wambeena and Clear Ridge.

3.3 Water Resources

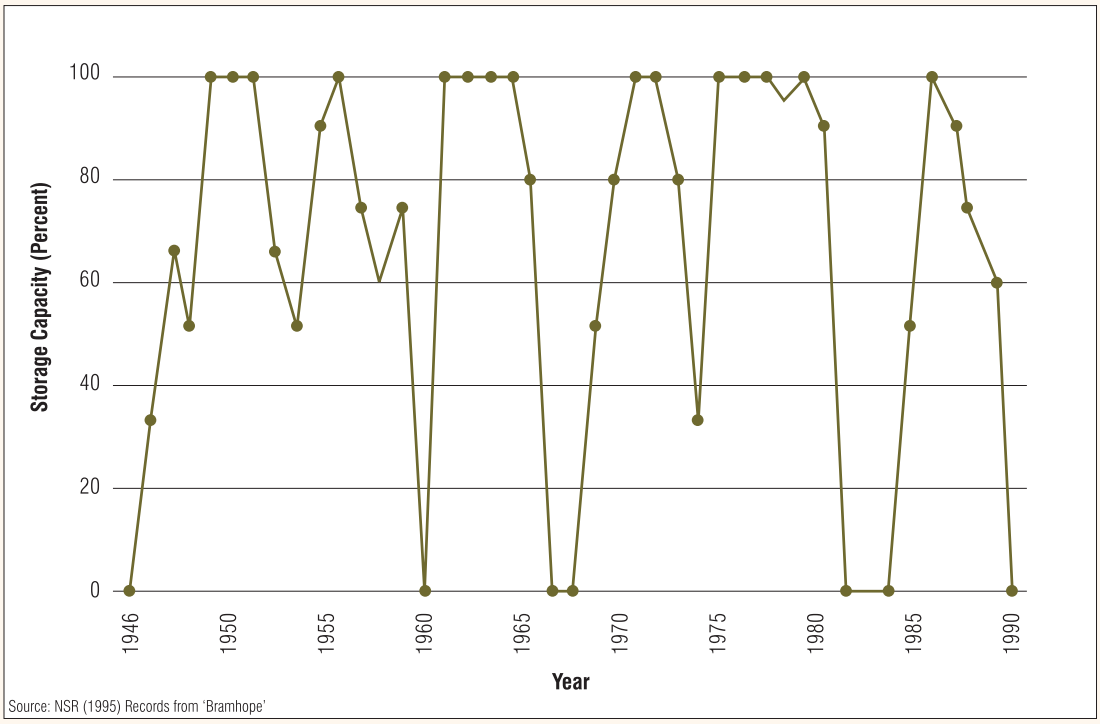
3.3.1 Surface Water

Regional Hydrology

The Lachlan River Valley has a catchment area of some 84,700 km^2 and incorporates around 400,000 ha of recognised wetlands (DWR, 1989) of which Lake Cowal is a part. The Lachlan River has an estimated mean annual flow of 1,270,000 ML at Forbes.

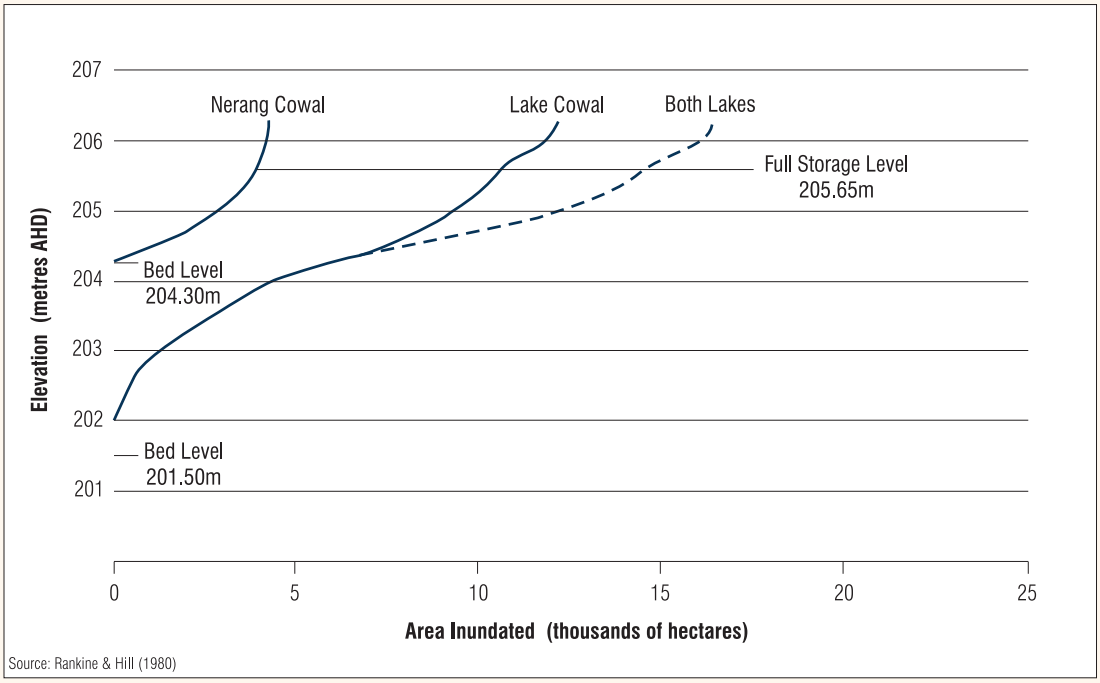
The Project area occurs on the western shore of Lake Cowal within the Lachlan River Valley and is situated on a fluvial feature of the Jemalong Plain. The Jemalong Ridge (east), Manna Range (west), Lachlan River (north) and tributaries of the Bland Creek system (south) bound the plain. The plain is 20-30 km in width and elevations range from 203-220 m. Landform features include relict stream ridges, stream beds, levees and floodplains. Figure 3-5 shows the drainage and flooding for the region.

Lake Cowal forms part of the Wilbertroy-Cowal wetlands located on the Jemalong plain which is a fluvial landform formed in the lower reaches of Bland Creek. The plain extends to the Lachlan River in the north and is bounded by



Source: NSR (1995) Records from 'Bramhope'

LAKE COWAL FILLING AND DRYING CYCLE



Source: Rankine & Hill (1980)

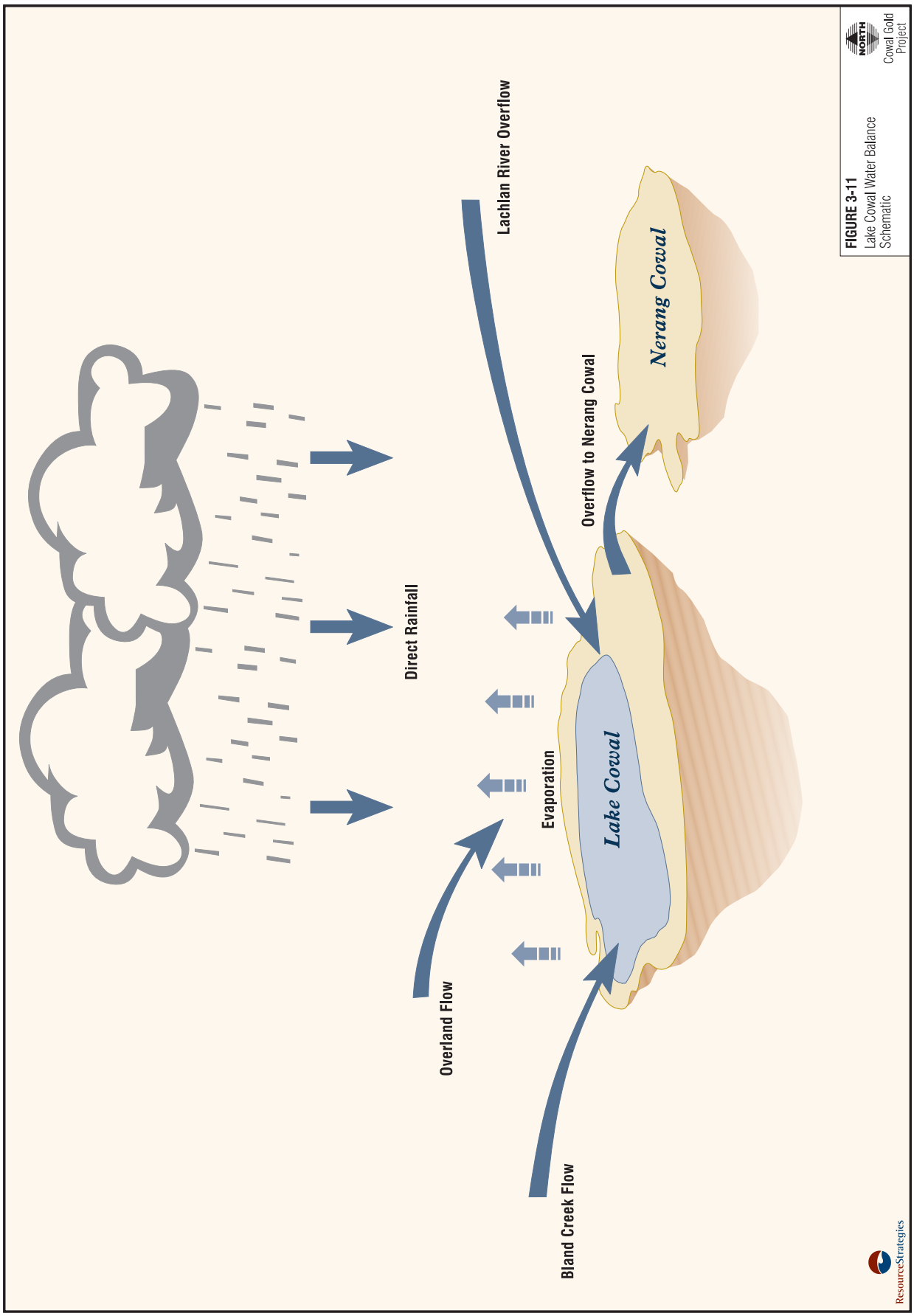
LAKE COWAL/NERANG COWAL STORAGE CHARACTERISTICS CURVE

FIGURE 3-10
Lake Cowal Hydrology

ResourceStrategies

Cowal Gold Project

NOC-97-03_S3-020D.CDR


Lachlan River Overflow
Overflow to Nerang Cowal
Nerang Cowal
Direct Rainfall
Evaporation
Lake Cowal
Overland Flow
Bland Creek Flow
NORTH
Cowal Gold Project
FIGURE 3-11
Lake Cowal Water Balance Schematic
ResourceStrategies
NOC-97-03_S3-0210.CDR

ridgelines to the east and west. Lake Cowal receives inflow from Bland Creek, which drains into the Lake at its southern end. Bland Creek commands a catchment area of some 9,500 km^2 upstream of the Lake. Inflows also occur from the Lachlan River via break-out flows that occur during major flood events in the Lachlan causing back-flooding to Lake Cowal. The break-out flows enter the Lake via modified floodways at the north-eastern side of the Lake as shown in Figure 3-5. The Lake also receives inflow from incident rainfall.

When full (RL 205.65 m) Lake Cowal overflows into Nerang Cowal to the north which in turn overflows to Manna Creek, Bogandillon Creek and ultimately into the Lachlan River (Figure 3-1). The Lake is substantially inundated approximately seven years out of ten, with relatively small increases in Lake water depth leading to significant increases in the area of inundation due to the flat, shallow nature of the Lake (Figure 3-10). Without inflows, drying of the Lake is driven predominantly by evaporative losses with a period of approximately three years taken to reduce the Lake from a full storage to minimal storage levels.

Outflows comprise evaporation from the Lake, as well as overflow and spill to Nerang Cowal.

A schematic of the Lake Cowal water balance showing the main inflows and outflows is shown in Figure 3-11.

Net inflow or outflow over any period of time results in a corresponding increase or decrease in storage volume (ie. rise or fall in Lake level). The historical changes in storage volume and occurrences of spill have not been officially monitored, and inflows to the Lake from Bland Creek or breakout flows from the Lachlan River have not been recorded. There is however an "unofficial record" available from evidence and anecdotal information provided by local landowners. This information is shown in Figure 3-10 and indicates the basic filling and drying patterns for the Lake since 1946.

Approximately 75% of the Lachlan River Valley has slopes of less than 3%. Runoff is extremely low and variability of flows is high (DWR, 1989). Surface water storages have been constructed throughout the region primarily for irrigation purposes and to a lesser extent flood mitigation measures. Flood protection works are common in the Bland Creek catchment and some 70 km of levees have been constructed along the Lachlan-Lake Cowal Floodway to protect adjacent land. "Silt jetties" within Bland Creek have been dammed at some stage and as a consequence low flows in Bland Creek are generally stored within these structures and no longer inflow to Lake Cowal.

The Project area is generally flat and falls to the east at a slope of approximately 1%, with a rise to approximately 12 metres above the surrounding paddocks in the centre of the area. Three main drainage lines occur within and adjacent to the Project area with catchment areas extending west and south.

Surface Water Quality

A baseline surface water quality monitoring programme was been undertaken by North between 1991 and 1992. The sampling programme which included both water and sediment sampling was conducted at 34 monitoring sites along 4 transects over the period March 1991 to June 1992. Over this period, the Lake volume varied from approximately 40% to 100% full. Conductivity was sampled from 1991 to 1995 and monthly since 1996. Interpretation of the water chemistry analysis (NSR Environmental Consultants, 1995) indicates:

- pH is relatively steady and slightly alkaline (pH 8.27 to 8.67).
- Mean water temperature ranged from 25.7°C (maximum) during the summer months to 7.3°C (minimum) during winter months.
- Measured dissolved oxygen concentrations were high-ranging from 7.3 mg/L to 11.5 mg/L.
- Suspended solids concentrations varied between 24 mg/L and 224 mg/L.
- Conductivity was shown to be related to Lake volume - increasing at times of reducing Lake volume (as a result of evapo-concentration) and decreasing as a result of dilution as the Lake refilled and as a result of spill events[1]. Mean conductivity values (ie. mean of values measured at various locations within the Lake) varied from 222 µS/cm to 1557 µS/cm over the monitoring period.
- Metals (cadmium, arsenic, lead, mercury and zinc) were all low. Levels of copper exceeded the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines for aquatic ecosystems and were shown to be largely associated with the suspended solids fraction.

Water quality parameters are compared to ANZECC Water Quality Guidelines in Table 3-6.

[1] Salt outflow occurs from the lake during spill events to Manna Creek. Without spill from the lake and the associated outflow of salt, Lake Cowal would tend towards becoming a salt pan due to the effects of evapo-concentration.

3.3.2 Groundwater

Regional and Local Hydrogeology

Groundwater resources within the region occur in two distinct forms, associated with differing geological formations. These are shown schematically in Figure 3-6 and consist of:

1. Lachlan Formation (Bland Creek Palaeochannel): comprising an aquifer of quartz gravel fractured bedrock.
2. Cowra Formation: comprising aquifers of isolated sand and gravel lenses in the silt and clay alluvial deposits associated with the formation. Groundwater associated with these perched aquifers generally exhibits higher salinity and lower yields than the fractured bedrock aquifer of the Lachlan Formation.

Groundwater movement within the region is thought to have been significantly modified since the initiation of surface water irrigation in the Jemalong/Wyldes Plain irrigation district. Prior to irrigation, groundwater flow would have followed a northerly direction along the Bland Creek Palaeochannel towards the confluence with the Lachlan River. A significant groundwater mound in the

shallow alluvial sequences has developed around the Warroo Prior Stream along which has been constructed a major irrigation supply channel. As a result, groundwater flow from Bland Creek no longer discharges to the Lachlan System.

Groundwater flow patterns within the Bland Creek system since the development of the mound are effectively divided into northward and southward flow directions with a hydraulic boundary at the centre of the mound defining the boundary between these two flows. Figure 3-6 shows schematically the basic flow patterns of groundwater in the Bland Creek system both prior to and since the formation of the groundwater mound.

It has been postulated that the groundwater mound is extending southwards toward Lake Cowal (Anderson *et al.*, 1993) with the hydraulic boundary to the north preventing outflow of groundwater from the Bland Creek system and causing the gradual "filling" of the system and increase in water table levels.

Studies by Coffey Partners International (1995a) have indicated that groundwater within the Project area is associated with fractured volcanic bedrock and transported cover. These aquifers are generally low yielding and saline with conductivities ranging from 16,400 to 47,900 µS/cm. Depth to groundwater over the Project area varies, 9 m (approximately) below ground level, being the shallowest water table level encountered.

A series of 20 boreholes have been constructed within the Lake Cowal and Nerang Cowal area (locations are shown in Figure 3-12) with measurements of salinity undertaken approximately every 3 months between July 1994 and April 1996. In addition, 18 boreholes have been constructed within the proposed open pit area, with water quality measurements undertaken for a range of parameters between January and March 1994. The results of the analyses associated with both sets of boreholes are included in Appendix F.

Test results of groundwater within the general vicinity of the Bland Palaeochannel are presented in Table 3-7. Locations of the sample points are shown on Figure 3-12.

3.4 Flora

3.4.1 Vegetation Patterns of the Region

Since European settlement, native vegetation in the Central Western Slopes region has undergone far-reaching changes (Goldney and Bowie, 1990), due primarily to its importance for agricultural production. This change is evident also in the wider New South Wales wheat-belt area where up to 95% of the original native vegetation has been removed for cropping and grazing purposes (Murray-Darling Basin Ministerial Council, 1987).

Table 3-7 Bland Palaeochannel Groundwater Analysis

Parameter	Sample Number	
	2	3
pH	6.9	6.8
Conductivity ((S/cm)	1,350	1,500
Total Dissolved Solids (mg/L)	900	970
Hardness (mg/L)	225	225
Sodium (mg/L)	255	295
Potassium (mg/L)	2.8	2.9
Calcium (mg/L)	44	44
Magnesium (mg/L)	28	28
Chlorine (mg/L)	390	460
Carbonate (mg/L)	<1	<1
Bicarbonate (mg/L)	210	220
Sulphate (mg/L)	59	63
Iron (mg/L)	0.08	0.09
Manganese (mg/L)	0.08	0.08
Silicate (mg/L)	15	14

Source: Coffey (1994)

Table 3-6 ANZECC Water Quality Guidelines for Aquatic Ecosystems and Livestock Watering

Parameter#	Aquatic Ecosystems	Livestock Watering	Lake Cowal Water Quality
pH	6.5 - 9.0	–	8.27 to 8.67
EC (µs/cm)	<1,500	5,882 (1) 8,824 (2)	222 µs/cm to 1557 µs/cm
SS (mg/L)	<10% change seasonal mean con.	–	22 mg/L to 224 mg/L
Hg (mg/L)	0.0001	0.002	*
As (mg/L)	0.05	0.5	2.6 (3)
Cd (mg/L)	0.0002 - 0.002	0.01	0.055 (3)
Cu (mg/L)	0.002 - 0.005	5.0 (1) 0.5 (2)	6.0 (3)
Pb (mg/L)	0.001 - 0.005	0.1	2.9 (3)
Zn (mg/L)	0.005 - 0.050	20.0	12.0 (3)

Additional parameters measured which have no ANZECC recommended water quality guidelines (1992): Sodium, Potassium, Chloride, Manganese, Alkalinity and Bicarbonate.
* >50% of samples less than Method Detection Limit (MDL) 1 Beef Cattle 2 Sheep 3 Average Value

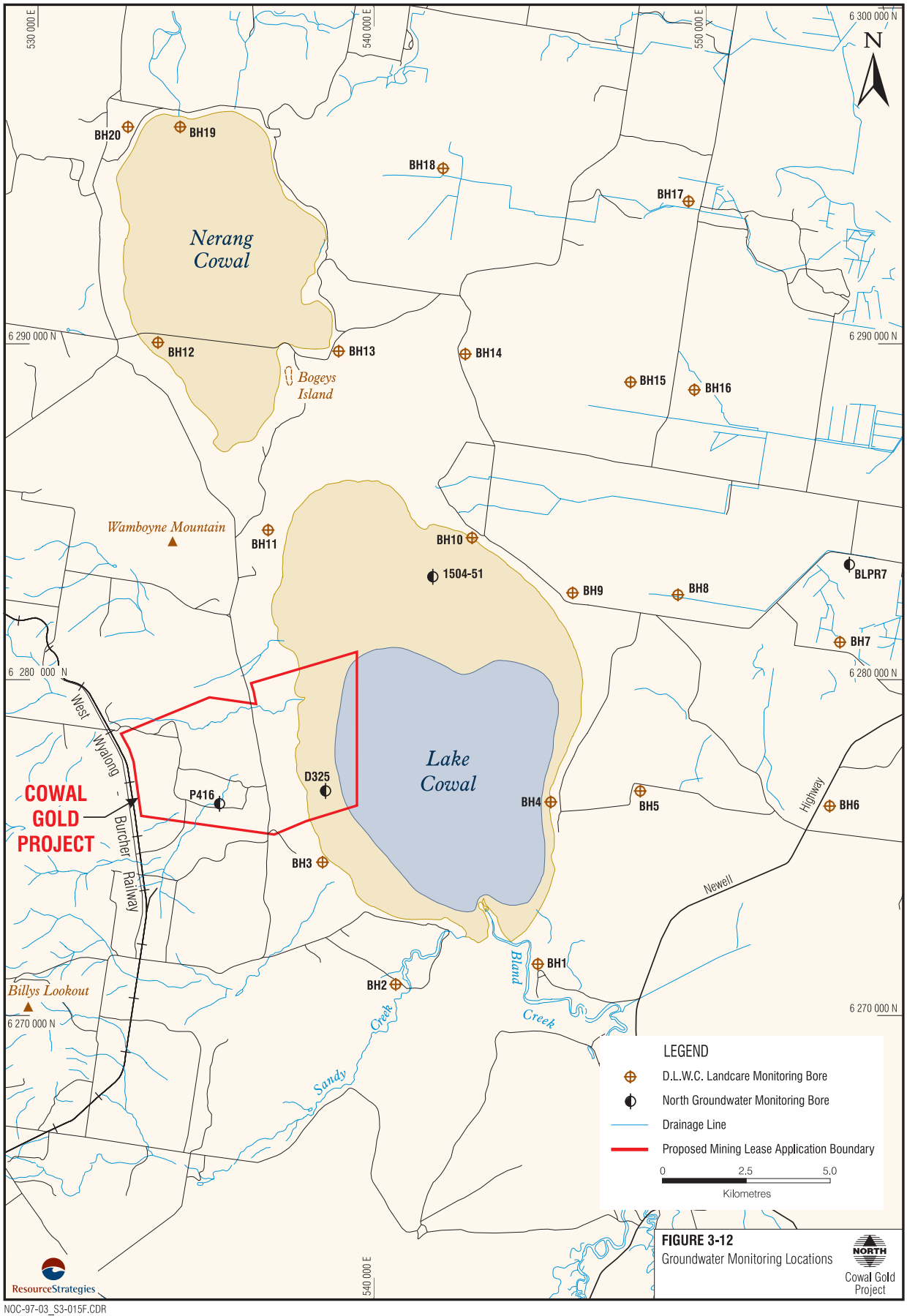


FIGURE 3-12
Groundwater Monitoring Locations
Cowal Gold Project


LEGEND
1 Remnant Woodland (E. dwyeri - Acacia doratoxylon - Callitris sp.)
2 Eucalypt Woodland (E. dwyeri - E. populnea - E. microcarpa - Callitris glaucophylla - Casuarina cristata)
3 Predominantly cleared agricultural land with scattered Bimble Box Woodland (E. populnea)
4 Fringing River Red Gum (Eucalyptus camaldulensis)
5 Lignum (Muehlenbeckia florulenta)
6 Lake Bed - Scattered areas of Medicago polymorpha and Canegrass (Eragrostis australasica)
7 Mixed Woodland (A. pendula - Casuarina cristata)
8 Wilga Woodland (Geijera parviflora - C. crist
9 Belah Woodland
Proposed Mining Lease Application Boundary

Clearing has been the most obvious change to native vegetation in the region however several other processes have had effects on the vegetation assemblages. These processes include grazing of native shrub and grass species by domestic stock and feral grazers; weed incursion and introduction of exotic species; alterations to pre-settlement fire regimes; modification and pollution of waterways; increased use of pesticides and fertilisers; and isolation of portions of remnant vegetation (Adamson and Fox, 1982; Goldney and Bowie, 1990; Sivertsen and Metcalfe, 1995). Mining, rural settlement and forestry have also contributed to vegetation change in the region (Adamson and Fox, 1982). Similarly, a number of State Forests and private woodlots in the region were actively managed to encourage growth of some species (eg. *Callitris glaucophylla*) thus necessitating the need for clearance of other native species (eg. *Eucalyptus populnea* subsp. *bimbil*) (Sivertsen and Metcalfe, 1995).

These processes and modifications that have been operating in the region have contributed to the existing vegetative structure which reflect a decline in native species diversity (after Adamson and Fox, 1982; Hobbs, 1987; Benson, 1991; Saunders *et al*., 1991).

3.4.2 Vegetation of the Project Area

Flora survey and reporting of the mining operations area (including the proposed water supply borefield and pipeline) has been undertaken by Anne Clements and Associates (1995 and 1996) and the Charles Sturt University (1997).

The 1995 survey report presented the results of spot location and transect/quadrat surveys carried out during October and December 1993. The 1993 survey recorded 411 species comprising approximately 21% weeds. Five weed species recorded are listed as noxious within the Bland Shire, although only one of these (*Lycium ferocissimum*) was recorded from within the MLA.

No rare or threatened Australian plants (ROTAP) were recorded during this survey however a single species listed as endangered in the *Threatened Species Conservation Act 1995*, Austral pilwort (*Pilularia novae-hollandiae*), was identified from gilgai south of the proposed plant and from the Bland Creek floodplain approximately 12 km south-east of the mining operations area.

To increase the botanical database, an additional flora survey and assessment of the Project area was undertaken in September and October 1997 (Appendix A, Attachment A-3). This study employed quadrat-based cover/abundance assessments of specific areas of the Project area including the tailings storages, waste emplacement zones and the mine infrastructure and pit area. Target searches were also undertaken for a list of ROTAP and threatened plant species, compiled in consultation with the NSW National Parks and Wildlife Service (NPWS). None of these species were identified during the 1997 survey period.

Based on the flora survey and mapping, nine main plant communities were identified from the Project area and surrounds (Figure 3-13) (after Bower, 1997; Charles Sturt University, 1997). These communities have been defined by the largest and most numerically dominant plant species and are as follows:

Community 1 – Remnant Woodland (*Eucalyptus dwyeri – Acacia doratoxylon – Callitris endlicheri*)

This community occurs only on the high exposed ridges with shallow soils. Given the isolated occurrence of rocky outcrops and ridges in the generally flat landscape of the Lake Cowal region, this community occurs as scattered unconnected islands amongst other communities. The shallow soils on which this community occurs are unsuitable for farming or grazing and most of it has been relatively free from clearance or disturbance although some areas have been affected by quarrying for gravel or harvesting of timber for fencing. This community type does not occur in the proposed MLA area and no examples of it are likely to be affected by the proposal (Bower, 1997).

Community 2 – Eucalypt Woodland (*E. dwyeri – E. populnea – E. microcarpa – Callitris glaucophylla – Casuarina cristata*)

This community occurs mainly on well-drained sloping country and low ridges. Within the proposed MLA area it is prominent on the Cowal West Hill, where it has been considerably thinned from natural densities. The most common associate is Bimble Box (*Eucalyptus populnea*) which would have occurred naturally as disconnected islands around the base of isolated ranges and on low hills and ridges in the area, but to a lesser extent than the former community.

White Cypress Pine (*C. glaucophylla*) is a component of many communities in which it is not necessarily dominant. Areas of this community have been largely cleared for farming and grazing and *C. glaucophylla* itself is a valued timber tree and in former times was used extensively for fencing and building.

Community 3 – Predominantly Cleared Agricultural Land with Scattered Bimble Box (*Eucalyptus populnea*) Woodland

This is the major plant community of the region. It dominates the upper strata of the flatter landscapes that have largely been cleared for farming and grazing. Bimble Box frequently associates with White Cypress Pine and other boxes, particularly Grey Box (*E. microcarpa*). On wetter sites Belah (*Casuarina cristata*) is a common associate. A variety of large shrubs or small trees also occur in this community including Myall (*Acacia pendula*), River Cooba (*A. stenophylla*), Wilga (*Geijera parviflora*) and Rosewood (*Alectryon oleifolius*). Pre-white settlement, the Bimble Box community would have been continuously connected through the area.

Community 4 – Fringing River Red Gum (*Eucalyptus camaldulensis*)

River Red Gum (*E. camaldulensis*) occurs along the edges of Lake Cowal and lines the creeks which enter and leave it. Its upper limit is the high water mark of the Lake and it extends for a short distance into the areas that flood.

Acacia stenophylla is an occasional associate. Only a few River Red Gum trees occur within the proposed MLA area as most of the lakeshore has been severely thinned and in this section, only scattered remnant trees remain.

Community 5 – Lignum (*Muehlenbeckia florulenta*)

Dense thickets of Lignum occur in the northern sections of Lake Cowal and form the basis of the breeding habitat for many of the waterbirds. Open areas without Lignum tend to be covered in Nardoo (*Marsilea drummondii*) and Water Milfoil (*Myriophyllum verrucosum*) when the Lake is inundated. Scattered River Red Gums may occur amongst the Lignum. No significant amounts of Lignum occur within the proposed MLA area.

Community 6 – Lakebed (*Eragrostis australasica – Medicago polymorpha*)

Sections of the shallow waters of the Lake support a Swamp Canegrass (*Eragrostis australasica*) and Burr Medic (*Medicago polymorpha*) community, particularly in the southern sections. A band of Swamp Canegrass occurs within the proposed MLA area. The area of Swamp Canegrass communities alters with the flooding cycle of the Lake.

Community 7 – Mixed Woodland (*Acacia pendula – Casuarina cristata*)

This community occurs mainly on the alluvial flats. Isolated remnants of this community occur within the proposed MLA area and would be affected by the proposed development. On drainage impeded gilgai areas, Belah (*Casuarina cristata*) is commonly the dominant associate.

Community 8 – Wilga Woodland (*Geijera parviflora - Casuarina cristata*)

Wilga (*G. parviflora*) is widespread in the area, reaching its optimum density on alluvial gilgai soils and other heavy soils on flats or lower slopes. It is commonly associated with trees such as Alectryon oleifolius, *C. cristata* and *E. microcarpa*. Portions of this community would be affected by the proposed development *viz.* the tailings storages and drainage works.

Community 9 – Belah Woodland (*Casuarina cristata*)

This community occurs on drainage impeded gilgai areas on grey soils. It is a common associate in many other communities (eg. Community 2 and Community 3). *C. cristata* woodland occurs in the south of the proposed MLA area and would be traversed by the proposed access road.

In summary the 1997 flora survey and reporting found that the areas within the mining operations area that would be disturbed/modified as a result of the proposed development are either:

(i) dominated by weeds (*viz.* the lakebed, shoreline and understorey of the woodland areas); or

(ii) extensively cropped (eg. the southern tailings storage); or

(iii) contain areas of relatively high species diversity even after many decades of grazing and cultivation (eg. northern waste emplacement) however these species are common and not restricted to the Lake Cowal region.

3.4.3 Vegetation Community Conservation Status

The 1995 Atlas of Plant Communities in Australia (Specht *et al.*, 1995) describes the conservation status of the above listed communities with a summary presented in Table 3-8.

3.5 Fauna

3.5.1 Habitats of the Project Area and Surrounds

Based on previous habitat assessment (Vestjens, 1977), dominant vegetation types, density of hollow-bearing trees, occurrence of substratum (such as fallen tree limbs, logs, decorticated bark, leaf litter and suitably dense ground

Table 3-8 Conservation Status of Project Area and Surrounds Plant Communities

Community+		Conservation Status*
1	*Eucalyptus dwyeri* Open scrub/woodland	Adequate: the plant community is well conserved in several large reserves which represent the range of biogeographic regions in which it occurs, each reserve exhibiting ecological diversity.
2	*Callitris glaucophylla* Low woodland/open forest	Reasonable-Adequate: the plant community is conserved in a large reserve or a number of small reserves which represent a large part of the range of biogeographic regions in which the community occurs; ecological diversity is usually present in the reserves.
3	*Eucalyptus populnea* (±*E. melanophloia*, ± *E. orgadophila*) Open forest/woodland	Reasonable-Adequate: the plant community is conserved in a large reserve or a number of small reserves which represent a large part of the range of biogeographic regions in which the community occurs; ecological diversity is usually present in the reserves.
4	*Eucalyptus camaldulensis* Woodland	Reasonable: the plant community is conserved in a large reserve or a number of small reserves which represent a large part of the range of biogeographic regions in which the community occurs; ecological diversity is usually present in the reserves.
5	*Muehlenbeckia florulenta* Low/mid-height shrubland	Adequate: the plant community is well conserved in several large reserves which represent the range of biogeographic regions in which it occurs, each reserve exhibiting ecological diversity.
6	*Eragrostis australasica* Reedland	Reasonable: the plant community is conserved in a large reserve or a number of small reserves which represent a large part of the range of biogeographic regions in which the community occurs; ecological diversity is usually present in the reserves.

+ While the species composition described by Specht *et al.* (1995) to identify individual vegetation communities may not exactly mirror that of the communities present at the Project area, the dominant structural characteristics are considered analogous to the extent to enable meaningful comparison.

* The conservation of each plant community was assessed using the following criteria: conservation in a reserve, size and number of the reserves, diversity of plant communities in the reserve and representation in all biogeographic regions in which it occurs (Specht *et al.*, 1995).

cover), levels of disturbance (historic, current and on-going), fire regime and abundance of water, four primary habitat types were delineated at the Project area and surrounds (Figure 3-14). These habitats are discussed in Appendix A and are briefly summarised below.

Lakebed

Lake Cowal is a shallow, ephemeral lake which is significantly dry for about three years out of ten. Filling of the lake is episodic and variable. Without inflows, drying of the Lake consists predominantly of evaporative losses, with a period of approximately three years taken to reduce the Lake from full storage to minimal storage levels. Subsequently the amount of lakebed covered in water is variable.

The vegetation on the lakebed of Lake Cowal is adapted to the irregular wetting and drying cycle. When inundated, propagules of ephemeral aquatic plants germinate and grow rapidly providing a food source for similarly ephemeral invertebrates and nomadic waterbirds. When dry, the bare lakebed is colonised by the seeds of many grasses and herbs creating a temporary grassland. The shallower parts of the lakebed also feature permanent swamp vegetation (Lignum and Canegrass) which can tolerate the extremes of wetness and dryness.

Riparian Zone

The riparian zone of Lake Cowal and tributaries comprises mainly a fringing woodland of River Red Gums which has been substantially thinned as a result of past land uses. The transition between the riparian zone and the surrounding vegetation is sharp and corresponds to the high water level of the Lake.

Cleared Farming and Grazing Lands

Predominantly cleared, open land that has undergone cropping and grazing, scattered woodlands irregularly occur throughout the Project area. Scattered isolated woodlands dominated by Poplar or Bimble box (*E. populnea*) and associated species occur sporadically. The landform is generally flat to gently undulating and dissected by occasional shallow gullies. Scattered patches of gilgai soils occur throughout the area. These feature irregular mounds and depressions, which provide microhabitats for some plant species. The dominant tree cover on gilgai is also *E. populnea*, but Belah (*Casuarina cristata*) is also prominent.

Vegetated Slopes

To the west of Lake Cowal a series of north-south oriented ridges rises above the surrounding flatter terrain. The most prominent is Wamboyne Mountain in the north, which rises to RL 412 m, or 207 m above the high watermark of the Lake while Billys Lookout in the south, is a lower hill at RL 368 m. Within the proposed MLA area a small rise (RL 223 m) known as Cowal West Hill (Figure 3-13) occurs about 1.7 km from the Lake edge. The lower slopes of Mount Wamboyne and Billys Lookout and all of Cowal West Hill, are dominated by White Cypress Pine (*Callitris glaucophylla*). This grades into the ridgetop vegetation dominated by Spearwood (*Acacia doratoxylon*), Dwyer's Mallee Gum (*Eucalyptus dwyeri*) and *C. glaucophylla*.

3.5.2 Fauna Surveys

Numerous fauna surveys of the Lake Cowal area and surrounds have been undertaken since the early 1960's and have included surveys of terrestrial fauna and aquatic fauna with the focus primarily on waterfowl. Specific survey of the Project area and surrounds has been conducted by Gunninah Consultants (1995), Hawking (1991, 1995), Lane (1989, 1990, 1991a,b,c), Environmental and Educational Services (1992a,b,c, 1993a,b,c, 1994a,b,c, 1995a,b,c, 1996a,b,c, 1997a,b,c), Greg Richards and Associates (1997a) and Mount King Ecological Surveys (1997).

3.5.3 Significant Fauna Records

A list of the threatened fauna species recorded from the Lake Cowal region is presented in Table 3-9. Table 3-10 presents a list of fauna species recorded or considered possible occurrences in the Lake Cowal region including records compiled by the NPWS (1997), CSIRO (1997), Lane (1989, 1990, 1991a,b,c), EES (1992a,b,c, 1993a,b,c, 1994a,b,c, 1995a,b,c, 1996a,b,c, 1997a,b,c), Gunninah Consultants (1995), Vestjens (1977), Greg Richards & Associates (1997a), Lawler (1989), Hatton (1991) in Gunninah Consultants (1995), NSW Bird Atlassers (1995) in Gunninah Consultants (1995), RAOU (1995) in Gunninah Consultants (1995) and the Illawarra Bird Observers Club (date unknown) in Gunninah Consultants (1995).

A detailed assessment of the threatened fauna species known to occur or considered likely to occur in the Project area is presented in a Species Impact Statement and supporting documents in Appendix A.

Australia is signatory to the Bonn Convention (involving the conservation of migratory species) and has international agreements which relate to the conservation, preservation and protection of important habitat areas and migratory bird species.

Table 3-9 Threatened Fauna Species Recorded in the Lake Cowal Area

Common Names	Scientific Names
Amphibians and Reptiles	
South-eastern Lined Earless Dragon	*Tympanocryptis lineata pinguicolla*
Birds	
Magpie Goose	*Anseranas semipalmata*
Blue-billed Duck	*Oxyura australis*
Freckled Duck	*Stictonetta naevosa*
Australasian Bittern	*Botaurus poiciloptilus*
Osprey	*Pandion haliaetus*
Square-tailed Kite	*Lophoictinia isura*
Black-breasted Buzzard	*Hamirostra melanosternon*
Brolga	*Grus rubicunda*
Black-tailed Godwit	*Limosa limosa*
Painted Snipe	*Rostratula benghalensis*
Major Mitchell's Cockatoo	*Cacatua leadbeateri*
Superb Parrot	*Polytelis swainsonii*
Turquoise Parrot	*Neophema pulchella*
Painted Honeyeater	*Grantiella picta*
Mammals	
Greater Long-eared Bat	*Nyctophilus timoriensis*

Sources: Lane (1989-1991); EES (1992-1997); NSW Bird Atlassers Records in Gunninah (1995); NPWS NSW Wildlife Atlas Records in Gunninah (1995); Illawarra Bird Observers Club in Gunninah (1995); Dent (1990) in Gunninah (1995); Vestjens (1977); Lawler (1989) in Gunninah (1995); Hatton (1991) in Gunninah (1995); Greg Richards & Associates (1997).



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Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds[v]

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
Birds												
Emu	*Dromaius novaehollandiae*	•		•			•	•	•	•	•	•
Malleefowl*	*Leipoa ocellata*									•	•	
Stubble Quail	*Coturnix pectoralis*	•		•				•		•	•	•
Brown Quail	*Coturnix ypsilophora*	•						•	•	•	•	•
Magpie Goose*	*Anseranas semipalmata*		•	•		•		•		•	•	
Plumed Whistling-Duck	*Dendrocygna eytoni*			•			•	•		•	•	
Wandering Whistling-Duck	*Dendrocygna arcuata*		•			•		•		•	•	
Blue-billed Duck*	*Oxyura australis*		•	•		•		•		•	•	•
Musk Duck	*Biziura lobata*		•	•			•	•		•	•	•
Freckled Duck*	*Stictonetta naevosa*		•	•		•	•	•		•	•	•
Black Swan	*Cygnus atratus*	•	•	•		•		•		•	•	•
Australian Shelduck	*Tadorna tadornoides*	•	•	•			•	•		•	•	•
Australian Wood Duck	*Chenonetta jubata*	•	•	•			•	•	•	•	•	•
Mallard+	*Anas platyrhynchos*									•		
Pacific Black Duck	*Anas superciliosa*	•	•	•		•	•	•		•	•	•
Australasian Shoveler	*Anas rhynchotis*		•	•			•	•		•	•	•
Northern Shoveler[1]	*Anas clypeata*										•	
Grey Teal	*Anas gibberifrons*	•	•	•		•	•	•		•	•	•
Chestnut Teal	*Anas castanea*		•	•				•		•	•	•
Pink-eared Duck	*Malacorhynchus membranaceus*		•	•			•	•		•	•	•
Hardhead	*Aythya australis*		•	•		•	•	•		•	•	•
Australasian Grebe	*Tachybaptus novaehollandiae*	•	•	•		•	•	•	•	•	•	•
Hoary-headed Grebe	*Poliocephalus poliocephalus*		•	•		•	•	•	•	•	•	•
Great Crested Grebe	*Podiceps cristatus*		•	•		•	•	•		•	•	
Darter	*Anhinga melanogaster*	•	•	•		•	•	•		•	•	

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
Little Pied Cormorant	*Phalacrocorax melanoleucos*	•	•	•		•	•	•	•	•	•	•
Pied Cormorant	*Phalacrocorax varius*	•	•	•				•	•	•	•	•
Little Black Cormorant	*Phalacrocorax sulcirostris*	•	•	•		•	•	•	•	•	•	•
Great Cormorant	*Phalacrocorax carbo*	•	•	•		•	•	•	•	•	•	•
Australian Pelican	*Pelecanus conspicillatus*	•	•	•		•	•	•	•	•	•	
White-faced Heron	*Ardea novaehollandiae*	•	•	•			•	•		•	•	•
Little Egret	*Egretta garzetta*	•	•	•			•	•		•	•	•
White-necked Heron	*Ardea pacifica*		•	•			•	•	•	•	•	•
Pied Heron	*Ardea picata*			•								
Great Egret[1,2]	*Egretta alba*	•	•	•		•	•	•		•	•	•
Intermediate Egret	*Egretta intermedia*	•	•	•			•	•		•	•	•
Cattle Egret[1,2]	*Ardeola ibis*	•	•	•						•	•	
Nankeen Night Heron	*Nycticorax caledonicus*	•	•	•		•	•	•		•	•	•
Little Bittern	*Ixobrychus minutus*			•						•		
Australasian Bittern*	*Botaurus poiciloptilus*			•						•	•	
Glossy Ibis[1]	*Plegadis falcinellus*		•	•		•	•	•		•	•	•
Australian White Ibis	*Threskiornis molucca*	•	•	•		•	•	•		•	•	•
Straw-necked Ibis	*Threskiornis spinicollis*	•	•	•		•	•	•		•	•	•
Royal Spoonbill	*Platalea regia*	•	•	•		•	•	•		•	•	•
Yellow-billed Spoonbill	*Platalea flavipes*	•	•	•			•	•	•	•	•	•
Black-necked Stork*	*Ephippiorhynchus asiaticus*										•	
Osprey*	*Pandion haliaetus*							•		•	•	•
Black-shouldered Kite	*Elanus notatus*	•		•				•		•	•	•
Letter-winged Kite	*Elanus scriptus*			•								
Square-tailed Kite*	*Lophoictinia isura*									•	•	
Black-breasted Buzzard*	*Hamirostra melanosternon*							•		•	•	•

Black Kite	*Milvus migrans*				•				•			•	•	
Whistling Kite	*Haliastur sphenurus*	•			•			•	•			•	•	•
White-bellied Sea-Eagle[1]	*Haliaeetus leucogaster*		•		•				•			•	•	•
Spotted Harrier	*Circus assimilis*				•				•			•	•	
Swamp Harrier	*Circus approximans*	•			•				•			•	•	•
Brown Goshawk	*Accipiter fasciatus*				•			•	•			•	•	•
Collared Sparrowhawk	*Accipiter cirrocephalus*				•							•	•	
Wedge-tailed Eagle	*Aquila audax*	•			•			•	•	•		•	•	•
Little Eagle	*Hieraaetus morphnoides*				•				•			•	•	•
Brown Falcon	*Falco berigora*	•			•			•	•	•		•	•	•
Australian Hobby	*Falco longipennis*	•			•			•	•	•		•	•	•
Grey Falcon*	*Falco hypoleucos*											•	•	
Black Falcon	*Falco subniger*				•							•	•	
Peregrine Falcon	*Falco peregrinus*	•			•				•			•	•	
Nankeen Kestrel	*Falco cenchroides*	•			•			•	•	•		•	•	•
Brolga*	*Grus rubicundus*		•		•				•			•	•	
Buff-banded Rail	*Rallus philippensis*				•							•	•	
Baillon's Crake	*Porzana pusilla*				•				•			•	•	
Australian Spotted Crake	*Porzana fluminea*	•			•			•	•			•	•	•
Spotless Crake	*Porzana tabuensis*				•							•	•	
Purple Swamphen	*Porphyrio porphyrio*	•	•		•			•	•			•	•	•
Dusky Moorhen	*Gallinula tenebrosa*		•		•			•	•			•	•	•
Black-tailed Native-hen	*Gallinula ventralis*		•		•			•	•			•	•	•
Eurasian Coot	*Fulica atra*	•	•		•		•	•	•			•	•	•
Australian Bustard*	*Ardeotis australis*											•	•	
Little Button-quail	*Turnix velox*											•		
Red-chested Button-quail	*Turnix pyrrhothorax*											•	•	
Painted Button-quail	*Turnix varia*											•	•	
Plains-wanderer*	*Pedionomus torquatus*												•	
Latham's Snipe[1,2]	*Gallinago hardwickii*		•		•				•			•		•

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
Black-tailed Godwit*[1,2]	*Limosa limosa*			•				•		•	•	
Bar-tailed Godwit[1,2]	*Limosa lapponica*			•						•		
Little Whimbrel[1,2]	*Numenius phaeopus*		•									
Marsh Sandpiper[1,2]	*Tringa stagnatilis*		•							•	•	
Common Greenshank[1,2]	*Tringa nebularia*									•	•	
Wood Sandpiper[1,2]	*Tringa glareola*									•	•	
Common Sandpiper	*Actitis hypoleucos*		•	•				•		•		
Red-necked Stint[1,2]	*Calidris ruficollis*		•	•						•		
Pectoral Sandpiper[2]	*Calidris melanotos*		•							•		
Sharp-tailed Sandpiper[1,2]	*Calidris acuminata*		•	•				•		•	•	
Curlew Sandpiper[1,2]	*Calidris ferruginea*									•		
Painted Snipe*[,1]	*Rostratula benghalensis*			•				•		•	•	
Bush Stone-curlew*	*Burhinus grallarius*									•	•	
Black-winged Stilt	*Himantopus himantopus*		•	•			•	•		•	•	
Red-necked Avocet	*Recurvirostra novaehollandiae*	•	•					•		•	•	•
Pacific Golden Plover	*Pluvialis fulva*		•	•								
Red-capped Plover	*Charadrius ruficapillus*		•	•				•		•	•	
Black-fronted Dotterel	*Elseyornis melanops*		•	•			•	•		•	•	•
Red-kneed Dotterel	*Erythrogonys cinctus*		•	•			•	•		•	•	•
Banded Lapwing	*Vanellus tricolor*		•	•				•		•	•	
Masked Lapwing	*Vanellus miles*		•	•			•	•		•	•	•
Australian Pratincole	*Stiltia isabella*		•	•						•	•	
Silver Gull	*Larus novaehollandiae*	•	•	•			•	•		•	•	•
Franklin's Gull	*Larus pipixcan*		•								•	
Gull-billed Tern	*Sterna nilotica*		•	•			•	•		•	•	
Caspian Tern[1,2]	*Sterna caspia*		•	•				•		•	•	

Whiskered Tern	*Childonias hybridus*		•	•		•	•		•	•	•	
White-winged Black Tern[1]	*Childonias leucopterus*		•									
Grey Ternlet*	*Procelsterna cerulea*									•		
Rock Dove[+]	*Columba livia*			•			•		•	•		
Common Bronzewing	*Phaps chalcoptera*	•		•			•	•	•	•	•	
Crested Pigeon	*Ocyphaps lophotes*	•		•		•	•	•	•	•	•	
Diamond Dove	*Geopelia cuneata*			•			•		•	•		
Peaceful Dove	*Geopelia placida*	•		•			•	•	•	•	•	
Bar-shouldered Dove	*Geopelia humeralis*								•	•		
Glossy Black-cockatoo*	*Calyptorhynchus lathami*									•		
Galah	*Cacatua roseicapillus*	•	•	•		•	•	•	•	•	•	
Little Corella	*Cacatua sanguinea*								•			
Major Mitchell's Cockatoo*	*Cacatua leadbeateri*						•		•	•		
Sulphur-crested Cockatoo	*Cacatua galerita*			•					•	•		
Cockatiel	*Nymphicus hollandicus*	•	•	•		•	•	•	•	•	•	
Little Lorikeet	*Glossopsitta pusilla*								•	•		
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*									•		
Superb Parrot*	*Polytelis swainsonii*						•		•	•	•	
Crimson Rosella	*Platycerus elegans*								•	•		
Eastern Rosella	*Platycercus eximius*	•					•		•	•	•	
Australian Ringneck	*Barnardius zonarius*	•		•			•	•	•	•	•	
Blue Bonnet	*Northiella haematogaster*			•		•	•	•	•	•	•	
Swift Parrot*	*Lathamus discolor*								•	•		
Red-rumped Parrot	*Psephotus haematonotus*	•	•	•		•	•	•	•	•	•	
Mulga Parrot	*Psephotus varius*			•					•	•	•	
Budgerigar	*Melopsittacus undulatus*			•		•	•		•	•		
Turquoise Parrot*	*Neophema pulchella*								•	•		
Pallid Cuckoo	*Cuculus pallidus*	•		•			•	•	•	•		
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			•					•	•		
Black-eared Cuckoo	*Chrysococcyx osculans*								•	•		

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*									•	•	•
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*			•						•	•	•
Gould's Bronze-Cuckoo	*Chrysococcyx russatus*							•				
Barking Owl	*Ninox connivens*			•						•	•	
Southern Boobook	*Ninox noveseelandiae*	•	•	•				•		•	•	•
Masked Owl*	*Tyto novaehollandiae*										•	
Barn Owl	*Tyto alba*			•				•		•	•	•
Tawny Frogmouth	*Podargus strigoides*	•		•			•			•	•	
Spotted Nightjar	*Eurostopodus argus*									•	•	
Australian Owlet-nightjar	*Aegotheles cristatus*	•		•						•	•	
White-throated Needletail[1,2]	*Hirundapus caudacutus*									•	•	
Fork-tailed Swift[1,2]	*Apus pacificus*			•						•	•	
Azure Kingfisher	*Alcedo azurea*										•	
Laughing Kookaburra	*Dacelo novaeguineae*	•		•			•	•	•	•	•	•
Red-backed Kingfisher	*Halcyon pyrrhopygia*							•		•		
Sacred Kingfisher	*Todiramphus sanctus*		•	•			•	•		•	•	•
Rainbow Bee-eater[2]	*Merops ornatus*			•			•	•		•	•	•
Dollarbird	*Eurystomus orientalis*			•				•		•	•	
Noisy Pitta	*Pitta versicolor*										•	
White-throated Treecreeper	*Cormobates leucophaeus*							•		•	•	•
Brown Treecreeper	*Climacteris picumnus*	•		•				•	•	•	•	•
Superb Fairy-wren	*Malurus cyaneus*									•	•	
Splendid Fairy-wren	*Malurus splendens*										•	
Variegated Fairy-wren	*Malurus lamberti*	•		•			•	•	•	•	•	•
White-winged Fairy-wren	*Malurus leucopterus*			•						•	•	
Spotted Pardalote	*Pardalotus punctatus*									•	•	•

Striated Pardalote	*Pardalotus striatus*	•	•			•	•	•	•	•	
White-browed Scrubwren	*Sericornis frontalis*							•	•		
Chestnut-rumped Heathwren	*Hylacola pyrrhopygia*							•	•		
Shy Heathwren	*Hylacola cauta*							•	•		
Speckled Warbler	*Cthonicola sagittatus*					•		•	•	•	
Weebill	*Smicronis brevirostris*		•			•	•	•	•	•	
Western Gerygone	*Gerygone fusca*	•	•			•		•	•	•	
White-throated Gerygone	*Gerygone olivacea*							•	•		
Brown Thornbill	*Ancanthiza pusilla*	•				•		•	•		
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	•	•		•	•	•	•	•	•	
Buff-rumped Thornbill	*Acanthiza reguloides*					•		•	•	•	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	•	•		•	•	•	•	•	•	
Yellow Thornbill	*Acanthiza nana*	•	•			•	•	•	•	•	
Striated Thornbill	*Acanthiza lineata*							•	•		
Southern Whiteface	*Aphelocephala leucopsis*		•		•	•	•	•	•	•	
Red Wattlebird	*Anthochaera carunculata*							•	•		
Spiny-cheeked Honeyeater	*Acanthagenys rufogularis*	•	•			•	•	•	•	•	
Striped Honeyeater	*Plectorhyncha lanceolata*	•	•			•	•	•	•	•	
Noisy Friarbird	*Philemon corniculatus*		•			•		•	•		
Little Friarbird	*Philemon citreoqularis*	•	•		•	•		•	•	•	
Regent Honeyeater*	*Xanthomyza phrygia*							•	•		
Blue-faced Honeyeater	*Entomyzon cyanotis*	•	•			•		•	•	•	
Noisy Miner	*Manorina melanocephala*	•	•		•	•	•	•	•	•	
Yellow-throated Miner	*Manorina flavigula*	•	•					•	•		
Yellow-faced Honeyeater	*Lichenostomus chrysops*							•	•		
Singing Honeyeater	*Lichenostomus virescens*	•	•				•	•	•	•	
White-eared Honeyeater	*Lichenostomus leucotis*	•				•		•	•	•	
Yellow-tufted Honeyeater	*Lichenostomus melanops*							•	•		
Yellow-plumed Honeyeater	*Lichenostomus ornatus*							•	•		
Grey-fronted Honeyeater	*Lichenostomus plumulus*								•		

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
Fuscous Honeyeater	*Lichenostomus fuscus*									•	•	
White-plumed Honeyeater	*Lichenostomus penicillatus*	•	•	•			•	•	•	•	•	•
Black-chinned Honeyeater	*Melithreptus gularis*									•	•	
Brown-headed Honeyeater	*Melithreptus brevirostris*	•						•	•	•	•	•
White-naped Honeyeater	*Melithreptus lunatus*									•	•	
Painted Honeyeater*	*Grantiella picta*			•				•		•	•	•
Eastern Spinebill	*Acanthorhynchus temuirostris*									•		
Black Honeyeater	*Certhionyx niger*									•	•	
Pied Honeyeater	*Certhionyx variegatus*										•	
Crimson Chat	*Epthianura tricolor*									•	•	
Orange Chat	*Ephthianura aurifrons*							•		•		
White-fronted Chat	*Ephthianura albifrons*			•			•	•		•	•	•
Jacky Winter	*Microeca fascinans*	•						•	•	•	•	•
Scarlet Robin	*Petroica multicolor*									•	•	
Red-capped Robin	*Petroica goodenovii*	•		•			•	•	•	•	•	•
Flame Robin	*Petroica phoenicea*									•	•	
Rose Robin	*Petroica rosea*										•	
Hooded Robin	*Melanodryas cucullata*									•	•	
Eastern Yellow Robin	*Eopsaltria australis*	•						•	•	•	•	•
Southern Scrub-robin*	*Drymodes brunneopygia*									•	•	
Grey-crowned Babbler	*Pomatostomus temporalis*	•		•				•	•	•	•	•
White-browed Babbler	*Pomatostomus superciliosus*							•		•	•	•
Spotted Quail-thrush	*Cinclosoma punctatum*									•		
Chestnut Quail-thrush*	*Cinclosoma castanotus*									•	•	
Varied Sittella	*Daphoenositta chrysoptera*	•						•		•	•	•
Crested Shrike-tit	*Falcunculus frontatus*			•						•	•	

Crested Bellbird	*Oreoica gutturalis*									•	•	
Gilbert's Whistler*	*Pachycephala inornata*	•								•	•	
Golden Whistler	*Pachycephala pectoralis*			•			•	•		•	•	
Rufous Whistler	*Pachycephala rufiventris*	•		•		•	•	•		•	•	•
Grey Shrike-thrush	*Collurincicla harmonica*	•					•	•		•	•	•
Leaden Flycatcher	*Myiagra rubecula*									•		
Satin Flycatcher	*Myiagra cyanoleuca*			•								
Restless Flycatcher	*Myiagra inquieta*	•		•		•	•	•		•	•	
Magpie-lark	*Grallina cyanoleuca*	•	•	•		•	•	•		•	•	•
Rufous Fantail	*Rhipidura rufifrons*						•					
Grey Fantail	*Rhipidura fuliginosa*	•		•			•	•		•	•	•
Willie Wagtail	*Rhipidura leucophyrys*	•		•		•	•	•		•	•	•
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	•		•		•	•	•		•	•	•
White-bellied Cuckoo-shrike	*Coracina papuensis*									•	•	
Ground Cuckoo-shrike	*Coracina maxima*			•			•	•		•	•	•
White-winged Triller	*Lalage sueurii*			•			•			•	•	•
Olive-backed Oriole	*Oriolus sagittatus*						•			•	•	•
White-breasted Woodswallow	*Artamus leucorhynchus*			•			•			•	•	
Masked Woodswallow	*Artamus personatus*			•			•			•	•	
White-browed Woodswallow	*Artamus superciliosus*			•			•	•		•	•	•
Black-faced Woodswallow	*Artamus cinereus*			•			•	•		•	•	
Dusky Woodswallow	*Artamus cyanopterus*			•			•			•	•	
Grey Butcherbird	*Cracticus torquatus*	•		•			•	•		•	•	•
Pied Butcherbird	*Cracticus nigrogularis*	•		•			•	•		•	•	•
Australian Magpie	*Gymnorhina tibicen*	•		•		•	•	•		•	•	•
Pied Currawong	*Strepera graculina*									•	•	
Grey Currawong	*Strepera versicolor*										•	
Australian Raven	*Corvus coronoides*	•		•		•	•	•		•	•	•
Little Raven	*Corvus mellori*	•		•			•	•		•	•	
Little Crow	*Corvus bennetti*	•								•		•

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
White-winged Chough	*Corcorax melanorhamphos*	•		•			•	•	•	•	•	•
Apostlebird	*Struthidea cinerea*	•		•				•	•	•	•	•
Spotted Bowerbird	*Chlamydera maculata*									•		
Singing Bushlark	*Mirafra javanica*			•				•		•	•	
Richard's Pipit	*Anthus novaeseelandiae*			•				•		•	•	•
Citrine Wagtail[1]	*Motacilla citreola*										•	
House Sparrow[+]	*Passer domesticus*	•		•				•		•	•	•
Eurasian Tree Sparrow[+]	*Passer montanus*										•	
Zebra Finch	*Taeniopygia guttala*	•		•			•	•	•	•	•	
Double-barred Finch	*Taeniopygia bichenovii*							•	•	•	•	•
Plum-headed Finch	*Neochmia modesta*									•	•	
Red-browed Finch	*Neochmia temporalis*									•	•	
Diamond Firetail	*Stagonopleura guttata*							•		•	•	•
European Goldfinch[+]	*Carduelis carduelis*							•		•		
Mistletoebird	*Dicaeum hirundinaceum*	•		•				•	•	•	•	•
White-backed Swallow	*Cheramoeca leucosternus*									•	•	
Welcome Swallow	*Hirundo neoxena*	•		•				•		•	•	•
Tree Martin	*Hirundo nigricans*	•		•			•	•	•	•	•	•
Fairy Martin	*Hirundo ariel*			•				•		•	•	•
Clamorous Reed-warbler	*Accrocephalus stentoreus*			•			•	•		•	•	•
Little Grassbird	*Megalurus gramineus*			•			•	•		•	•	•
Rufous Songlark	*Cinclorhamphus mathewsi*	•		•				•		•	•	•
Brown Songlark	*Cinclorhamphus cruralis*			•				•	•	•	•	•
Golden-headed Cisticola	*Cisticola exilis*			•			•	•		•		•
Silvereye	*Zosterops lateralis*			•				•		•	•	
Common Blackbird[+]	*Turdus merula*							•		•	•	

Common Starling[+]	*Sturnus vulgaris*	•	•	•			•	•	•	•	•	•	
Mammals													
Platypus	*Ornithorhynchus anatinus*									•			
Short-beaked Echidna	*Tachyglossus aculeatus*	•		•						•	•		
Spotted-tailed Quoll*	*Dasyurus maculatus*									•	•		
Eastern Quoll	*Dasyurus viverrinus*										•		
Yellow-footed Antechinus	*Antechinus flavipes*	•								•	•		
Brush-tailed Phascogale*	*Phascogale tapoatafa*									•	•		
Fat-tailed Dunnart	*Sminthopsis crassicaudata*									•	•		
Striped-face Dunnart	*Sminthopsis macroura*										•		
Common Dunnart	*Sminthopsis murina*									•	•		
Koala*	*Phascolarctos cinereus*									•			
Eastern Pygmy-possum	*Cercarteus nanus*									•			
Sugar Glider	*Petaurus breviceps*	•								•	•		
Squirrel Glider*	*Petaurus norfolcensis*									•	•		
Greater Glider	*Petauroides volans*									•			
Common Ringtail Possum	*Pseudocheirus peregrinus*									•			
Feathertail Glider	*Acrobates pygmaeus*									•			
Common Brushtail Possum	*Trichosurus vulpecula*	•		•						•	•		
Eastern Grey Kangaroo	*Macropus giganteus*	•		•						•	•		
Common Wallaroo	*Macropus robustus*									•	•		
Red-necked Wallaby	*Macropus rufogriseus*										•		
Red Kangaroo	*Macropus rufus*			•						•			
Brush-tailed Rock-wallaby*	*Petrogale penicillata*										•		
Swamp Wallaby	*Wallabia bicolor*									•	•		
Grey-headed Flying-fox	*Pteropus poliocephalus*									•			
Little Red Flying-fox	*Pteropus scapulatus*									•	•		
Eastern Horseshoe-bat	*Rhinolophus megaphyllus*									•			
Yellow-bellied Sheathtail-bat*	*Saccolaimus flaviventris*				•					•	•		
Little Free-tail Bat	*Mormopterus planiceps*	•		•	•					•	•		

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
White-striped Freetail-bat	*Nyctinomus australis*	•		•	•					•	•	
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	•		•	•					•	•	
Greater Long-eared Bat*	*Nyctophilus timoriensis*									•	•	
Large-eared Pied Bat*	*Chalinolobus dwyeri*									•		
Gould's Wattled Bat	*Chalinolobus gouldii*	•		•	•					•	•	
Chocolate Wattled Bat	*Chalinolobus morio*				•					•		
Little Pied Bat*	*Chalinolobus picatus*	•									•	
Eastern False Pipistrelle*	*Falsistrellus tasmaniensis*									•		
Southern Myotis*	*Myotis macropus*									•		
Inland Broad-nosed Bat	*Scotorepens balstoni*	•								•	•	
Little Broad-nosed Bat	*Scotorepens greyii*	•			•						•	
Large Forest Bat	*Vespadelus darlingtoni*									•		
Southern Forest Bat	*Vespadelus regulus*	•			•					•		
Eastern Cave Bat*	*Vespadelus troughtoni*	•										
Little Forest Bat	*Vepadelus vulturnus*	•			•					•	•	
Unknown Forest Bat	*Vespadelus* sp.			•								
Water-rat	*Hydromys chrysogaster*			•						•	•	
House Mouse+	*Mus musculus*	•		•						•	•	
Black Rat+	*Rattus rattus*			•						•	•	
Dingo	*Canis lupus dingo*									•	•	
Dog+	*Canis familiaris*										•	
Fox+	*Vulpes vulpes*	•		•						•	•	
Cat+	*Felis catus*	•		•						•	•	
Brown Hare+	*Lepus capensis*	•								•	•	
Rabbit+	*Oryctolagus cuniculus*	•		•						•	•	
Pig+	*Sus scrofa*	•		•						•	•	

Cow+	*Bos taurus*	•				•
Goat+	*Capra hircus*				•	•
Sheep+	*Ovis aries*	•				•
Reptiles						
Eastern Snake-necked Turtle	*Chelodina longicollis*		•		•	•
Murray Turtle	*Emydura maquarii*		•		•	
Marbled Gecko	*Christinus marmoratus*				•	
Eastern Spiny-tailed Gecko	*Diplodactylus intermedius*		•		•	
Box-patterned Gecko	*Diplodactylus steindachneri*				•	
Tesellated Gecko	*Diplodactylus tessellatus*				•	
Wood Gecko	*Diplodactylus vittatus*				•	•
Tree Dtella	*Gehyra variegata*		•		•	•
Bynoe's Gecko	*Heteronotia binoei*				•	
Beaked Gecko	*Rhynchoedura ornata*				•	
Thick-tailed Gecko	*Underwoodisaurus milii*	•	•		•	•
Pink-tailed Legless Lizard*	*Aprasia parapulchella*				•	•
Unbanded Delma	*Delma butleri*				•	
Patternless Delma	*Delma inornata*		•		•	•
Burton's Snake-lizard	*Lialis burtonis*				•	
Common Scaly-foot	*Pygopus lepidopodus*				•	
Hooded Scaly-foot	*Pygopus nigriceps*				•	•
Jacky Lizard	*Amphibolurus muricatus*				•	
Nobbi	*Amphibolurus nobbi*				•	•
Painted Dragon	*Ctenophorus pictus*				•	
Bearded Dragon	*Pogona barbata*	•	•		•	•
Lined Earless Dragon*	*Tympanocryptis lineata pinguicolla*				•	
Lined Earless Dragon	*Tympanocryptis lineata*		•		•	
Gould's Goanna	*Varanus gouldii*		•		•	
Lace Monitor	*Varanus varius*	•	•		•	•
Bold-striped Cool-skink	*Bassiana duperreyi*		•		•	

Table 3-10 Fauna Species Recorded for Lake Cowal and Surrounds Continued

Common Name	Scientific Name	Gunninah Consult. (1995)	Lane (1989-1991) EES (1992-1997)	Vestjens (1977)	Greg Richards & Assoc. (1997)	Lawler (1989)	Hatton (1991)	NSW Bird Atlassers (1995)	RAOU Records (1995)	CSIRO (1997)	NPWS NSW Wildlife Atlas Records (1997)	Illawarra Bird Observers Club
Southern Rainbow-skink	*Carlia tetradactyla*									•		
Spiny-palmed Shinning-skink	*Cryptoblepharus carnabyi*	•		•						•	•	
Brown-blazed Wedgesnout Ctenotus	*Ctenotus allotropis*									•	•	
Robust Ctenotus	*Ctenotus robustus*			•						•	•	
Eastern Barred Wedgesnout Ctenotus	*Ctenotus strauchii*										•	
Copper-tailed Skink	*Ctenotus taeniolatus*									•	•	
Spotted Ctenotus	*Ctenotus uber*									•		
Tree Skink	*Egernia striolata*									•	•	
Eastern Water-skink	*Eulamprus quoyii*									•		
Three-toed Earless Skink	*Hemiergis decresiensis*									•		
South-eastern Slider	*Lerista bougainvillii*									•		
Wood Mulch-slider	*Lerista muelleri*	•								•		
Eastern Robust Slider	*Lerista punctatovittata*			•						•		
Common Dwarf Skink	*Menetia greyii*			•						•		
Southeastern Morethia Skink	*Morethia boulengeri*	•		•						•	•	
Eastern Blue-tongued Lizard	*Tiliqua scincoides*			•						•	•	
Shingle-back	*Trachydosaurus rugosus*			•						•	•	
Southern Blind Snake	*Ramphotyphlops australis*									•		
Prong-snouted Blind Snake	*Ramphotyphlops bituberculatus*									•	•	
Blackish Blind Snake	*Ramphotyphlops nigrescens*									•		
Proximus Blind Snake	*Ramphotyphlops proximus*									•	•	
Claw-snouted Blind Snake	*Ramphotyphlops unguirostris*			•						•		
Brown-snouted Blind Snake	*Ramphyotyphlops wiedii*									•		
Carpet & Diamond Python	*Morelia spilota*			•						•		
Common Death Adder	*Acanthophis antarcticus*									•		
Yellow-faced Whip Snake	*Demansia psammophis*			•						•		

White-lipped Snake	*Drysdalia coronoides*		•		•	
Red-naped Snake	*Furina diadema*		•		•	•
Eastern Tiger Snake	*Notechis scutatus*		•		•	•
King Brown Snake	*Pseudechis australis*		•		•	
Spotted Black Snake	*Pseudechis guttatus*		•		•	•
Red-bellied Black Snake	*Pseudechis porphyriacus*				•	
Eastern Brown Snake	*Pseudonaja textilis*	•	•		•	•
Spectacled Hooded Snake	*Suta spectabilis*		•		•	•
Curl Snake	*Suta suta*		•		•	
Bandy-bandy	*Vermicella annulata*		•		•	•
Amphibians						
Eastern Sign-bearing Froglet	*Crinia parinsignifera*		•		•	
Common Eastern Froglet	*Crinia signifera*				•	
Sloane's Froglet	*Crinia sloanei*	•	•		•	
Eastern Banjo Frog	*Limnodynastes dumerilii*					•
Long-thumbed Frog	*Limnodynastes fletcheri*	•	•		•	•
Giant Banjo Frog	*Limnodynastes interioris*		•		•	•
Salmon-striped Frog	*Limnodynastes salmini*		•		•	•
Spotted Grass Frog	*Limnodynastes tasmaniensis*	•	•		•	•
Sudell's Frog	*Neobatrachus sudelli*		•		•	•
Crucifix Toad	*Notaden bennettii*	•	•		•	•
Brown Toadlet	*Pseudophryne bibronii*				•	•
Wrinkled Toadlet	*Uperoleia rugosa*	•	•		•	
Water-holding Frog	*Cyclorana platycephala*				•	•
Green Tree-frog	*Litoria caerulea*		•		•	•
Peron's Tree-frog	*Litoria peronii*	•	•		•	•
Southern Bell Frog*	*Litoria raniformis*				•	•
Desert Tree Frog	*Litoria rubella*				•	•

* Listed on the *NSW Threatened Species Act, 1995* + Introduced Species ▼ Note that the list contains species considered to be possible occurrences in the region and unrealistic vagrant species (eg. Grey Ternlet, listed by the NPWS NSW Wildlife Atlas Records, 1997).

[1] Species listed on China – Australia Migratory Brids Agreement (CAMBA) 2 Species listed on Japan – Australia Migratory Brids Agreement (JAMBA)

Source:

Gunninah Consultants Pty Ltd (1995) Appendix A *Fauna Impact Statement* in NSR Environmental Consultants (1995) *Lake Cowal Project Environmental Impact Statement* Volume 2.

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Greg Richards & Associates Pty Ltd (1997). *Lake Cowal Gold Project: Results of a Bat Fauna Survey to Target Threatened Species.* Appendix A Attachment 7 Cowal Gold Project Environmental Impact Statement.

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Hatton, P.J. (1991). *Draft Water Management Plan for the Wilbertroy/Cowal Wetlands.* Department of Water Resources. In Gunninah Consultants as above.

NSW Bird Atlassers Records for 10 Minute Grids Centred on 33°35" x 147°25' and 33°45" x 147°25'. In Gunninah Consultants as above.

RAOU Records for 10 Minute Grids Bounded by 33°20'S to 33°50'S and 147°00' to 147°40'E. In Gunninah Consultants as above.

CSIRO (1997). Expert assessments of species that occur, or may occur, for the Lake Cowal area (33°15' to 34°00'S and 145°15' to 148°00'E).

NSW NPWS (1997). NSW Wildlife Atlas Records for the Lake Cowal Area (33°00' to 34°00'S and 147°00' to 148°00'E).

Illawarra Bird Observers Club – Avifauna Species List for the Lake Cowal Area. In Gunninah Consultants as above.

These agreements include:

- Agreement between the Government of Australia and the Government of Japan for the Protection of Migratory Birds and Birds in Danger of Extinction and their Environment (JAMBA); and
- Agreement between the Government of Australia and the Government of the People's Republic of China for the Protection of Migratory Birds and their Environment (CAMBA).

Species protected by the JAMBA and CAMBA agreements that are known to occur at Lake Cowal include the Cattle Egret (*Ardeola ibis*), Great Egret (*Egretta alba*), Glossy Ibis (*Plegadis falcinellus*), Painted Snipe (*Rostratula benghalensis*), Caspian Tern (Sterna caspia) and Red-necked Stint (*Calidris ruficollis*). (A full list of CAMBA/JAMBA listed bird species recorded or considered possible occurrences in the Lake Cowal region is presented in Table 3-10).

3.6 Air Quality

Pavel Zib and Associates (1997) have assessed the existing air quality in the Project area (Appendix I).

Ambient air quality in the Project area is determined by local land management activities (ie. farming activities, road and rail traffic, commercial and residential activities). There are no significant industrial installations near the Project area which emit large amounts of waste gases into the air. Typical industrial pollutants, such as the oxides of sulphur and nitrogen, ozone and carbon monoxide, are not expected in significant levels. As a result, particulate matter or atmospheric dust is expected to represent the majority of foreign material found in the ambient air.

The area within and surrounding the proposed MLA is predominantly well vegetated with a high proportion of the land surface covered with groundcover (primarily non-endemic grass species). There are relatively few farmhouses and roads in the immediate vicinity of the proposed MLA (Pavel Zib and Associates, 1997). As a result, the ambient dust levels in the Project area are likely to be relatively low except under adverse climatic conditions (drought conditions and/or high winds).

In 1992, a meteorological monitoring station was located at the Project site. The station was audited and upgraded in September 1997. Ambient dust levels have been measured on site (November 1993 to November 1994 and November 1995 to date) using a network of three dust deposition gauges (Figure 3-2). The results of this study are presented in Appendix I.

The mean deposition rates of atmospheric particulates at each of the 3 dust monitoring sites are summarised in Table 3-11.

The mean deposition rates of dust were generally low, ranging from 1.62 g/m^2/month at Site 51 to 1.00 g/m^2/month at Site 54.

Mean monthly deposition rates (Table 3-12) showed a degree of variation over the monitoring period. The highest deposition rates were recorded in the summer months (November to January).

The NSW Environmental Protection Authority (EPA) has adopted amenity based criteria for dust deposition. It uses a total annual average of 4.0 g/m^2/month as the level at

Table 3-11 Mean Dust Deposition Rates (November-93 to November-94)

Site	Mean Deposition Rate (g/m^2/month)	Number of Measurements
51	1.61	11
52	1.37	13
54	0.99	13

Table 3-12 Mean Dust Deposition Rates Monthly Intervals

Interval	Mean Deposition Rate (g/m^2/month)	Number of Days
Nov-93	1.83	27
Dec-93	1.88	33
Jan-94	3.19	31
Feb-94	1.42	30
Mar-94	0.85	34
Apr-94	0.85	28
May-94	1.20	31
Jun-94	0.74	31
Jul-94	0.52	26
Aug-94	0.20	29
Sep-94	0.91	34
Oct-94	1.67	31
Nov-94	0.96	31

which amenity is likely to be affected causing complaints of nuisance dust. Monitoring results for the Project indicate existing dust levels range from 0.20 g/m^2/month to 3.19 g/m^2/month. EPA criteria specify a maximum acceptable increase of 2.0 g/m^2/month (Appendix I). Based on these guidelines and the monitoring results, the mean existing air quality with regards to dust deposition at the Project site is within the expected background level (2 g/m^2/month) for a rural setting.

3.7 Noise

Acoustic studies have been conducted for the Project by Richard Heggie Associates (1995a and 1997) (Appendix H). A major component of the acoustic studies is the determination of the existing background or ambient noise levels of the Project area and surrounds.

To characterise and quantify the existing acoustical environment, ambient noise surveys using unattended loggers were initially conducted in July and August 1994. To supplement these measurements and to assist in identifying the character and duration of ambient noise sources, operator-attended surveys were also conducted throughout the measurement period. The location of the background noise monitoring sites is presented in Figure 3-15.

To quantify prevailing meteorological conditions throughout the ambient noise monitoring survey, an automatic weather station was installed at the Project area. The automatic weather monitor was configured to continuously record a number of parameters such as wind speed, wind direction, rainfall, air temperature and relative humidity.

The noise levels recorded during the surveys are expressed in A-weighted decibels (dBA). This system simulates the response of the human ear, which is more sensitive to high-frequency sounds and de-emphasises lower frequency sounds. The A-weighting also expresses noise levels on a consistent scale enabling the assessment of cumulative levels. Table 3-13 provides information on common noise sources for comparative reference.

Hearing "nuisance" begins at noise levels of about 70 dBA. This is equivalent to freeway traffic at 15 metres, while sustained noise levels of 85 dBA (ie. 8 hours) can cause hearing damage. An accepted critical level for continuous noise during sleep is within a range from 37 to 45 dBA. Continuous noise above this range may interrupt sleep and contribute to community annoyance.

Noise levels are presented as an L_{A90} (normal or background) or L_{A10} (maximum) level. L_{A90} refers to the noise level which is exceeded for 90% of the sampling period and is referred to as the average minimum, or background noise level. L_{A10} is the noise level which is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.

The accumulated background noise levels at the nearest residence (Figure 3-15) recorded during the winter survey period, are presented in Table 3-14.

Table 3-14 Accumulated Wintertime Background Noise Levels Monday to Sunday (dBA)

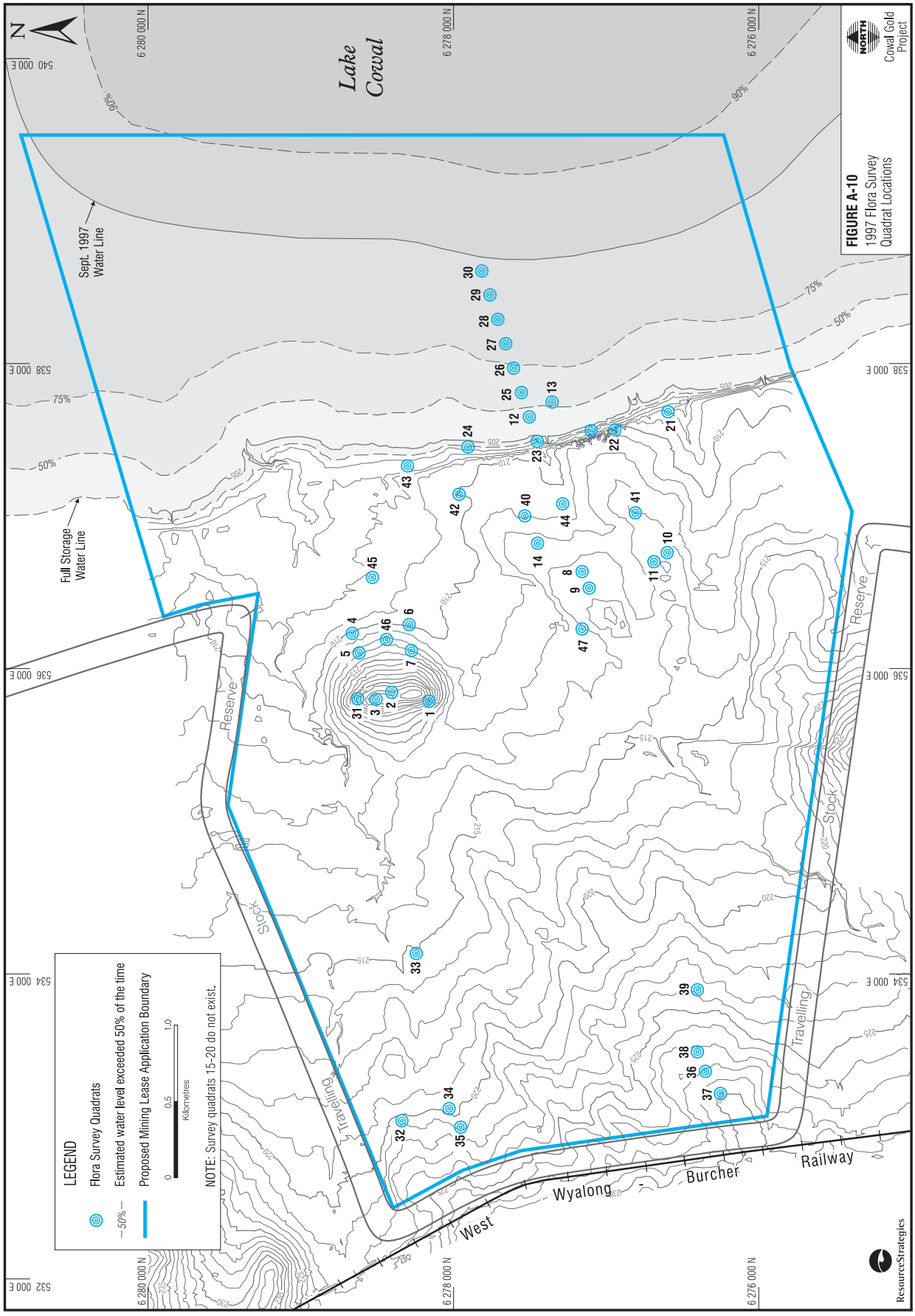
Residence Owner (Property Name)	Daytime (7 am - 6 pm)	Evening (6 pm - 10 pm)	Night-time (10 pm - 7 am)
C. Carnegie (Cowal West)	35	21	20
A. Buttenshaw (Coniston)	34	25	25
T. Bolte (Lake Side)	32	25	25
W. Buttenshaw (Lake Cowal)	34	25	25
B. Dent (Gumbelah)	31	25	25

Note: All evening and night-time levels are likely to have been determined by the noise logger's electronic noise floor.

Table 3-13 Relative Scale of Various Noise Sources and Effect on People

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 - 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Inside subway train	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
90	Loud	Garbage disposal at 1 m Shouting at 1 m	Urban daytime noise
70*	Loud	Vacuum cleaner at 3 m Normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	
50	Moderate to quiet	Dishwasher next room Wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background). Library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night Concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	
10-0	Silent	Threshold of hearing	

Source: Modified from US Dept. Interior, Robinson Project EA (1993) and Heggie and Associates (1995)
* Reference level – 70 dBA


Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
75%
50%
90%
Reserve
Stock
Travelling
Wyalong West
Burcher
Railway
6 280 000 N
6 278 000 N
6 276 000 N
532 000 E
534 000 E
536 000 E
538 000 E
540 000 E
LEGEND
Flora Survey Quadrats
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
NOTE: Survey quadrats 15-20 do not exist.
FIGURE A-10
1997 Flora Survey
Quadrat Locations
Cowal Gold Project
NORTH
ResourceStrategies
NOC-97-03_FF-002C.CDR

Analysis of the background noise data indicated that the noise levels fall abruptly at nightfall, ie. around 6 pm. It was recognised that this may not necessarily be the situation during other seasons of the year, particularly in summer. Consequently, further ambient noise surveys were conducted in December 1994 and January 1995. An unattended noise logger and weather station were positioned at Residence 3 with loggers also installed at Residences 2, 4 and 5.

The summertime accumulated background noise levels are presented in Table 3-15.

As expected, the evening (6 pm to 10 pm) ambient noise levels during the summer were significantly higher than those in the winter. Consequently, based on the "structure" of the noise level charts, the accumulated data for daytime (7 am to 10 pm) and night-time (10 pm to 7 am) were used to determine the respective design goals.

3.8 European Heritage

A study of the history of Lake Cowal was undertaken in 1993 by the Bland Historical Society (BHS, 1993) which addressed issues such as European settlement of the local area and mining's role in the development of the area.

European exploration of the Bland region occurred in 1817 under the direction of the then Surveyor General, John Oxley. Oxley described the area as unfavourable although based on the physiography of the area Oxley did note that the area was typical of gold-bearing country (BHS, 1993).

Pastoral settlement began in the area around 1842. By the early 1900s, wheat growing had become well-established with some 11,900 acres of land devoted to wheat production.

In addition to agricultural practices, gold mining was also a feature of the historic development of the region. Mining continued to around 1920 decreasing as deposits were discovered elsewhere in Australia.

Schedule 1 of the Bland Local Environment Plan 1993 (LEP) lists heritage items of local, regional or state significance within the shire. In accordance with this list, no items of local, regional or state European heritage significance have been recorded from the Project area.

Table 3-15 Accumulated Summertime Background Noise Levels Monday to Sunday (dBA)

Residence Owner (Property Name)	Daytime (7 am - 6 pm)	Evening (6 pm - 10 pm)	Night-time (10 pm - 7 am)
A. Buttenshaw (Coniston)	30	29	27
T. Bolte (Lake Side)	33	35	37
W. Buttenshaw (Lake Cowal)	33	33	26
B. Dent (Gumbelah)	31	32	33

3.9 Archaeology

3.9.1 Aboriginal Heritage

Previous studies on the ethnography and archaeology of the Project area and its surrounding environment have been conducted by Culture and Heritage (1995, 1997) and Australian Archaeological Survey Consultants (1995). These reports are summarised in Appendix E to this study and a summary of the main points is presented below.

In general, there is a dearth of historical information available on the first inhabitants of the region. However information gathered during the surveys indicates that given the relatively arid nature of the region, Lake Cowal is likely to have been important to Aboriginal people.

Lake Cowal itself is named after the Aboriginal word "*cowal*" meaning "*large water*" while "*nerang*" (as in Nerang Cowal) means "*little water*" and historical information suggests that Wiradjuri was the language group occupying the region surrounding Lake Cowal (White and Cane, 1986). This group consisted of a number of smaller groups who ranged widely through clearly defined territories (Read, 1983).

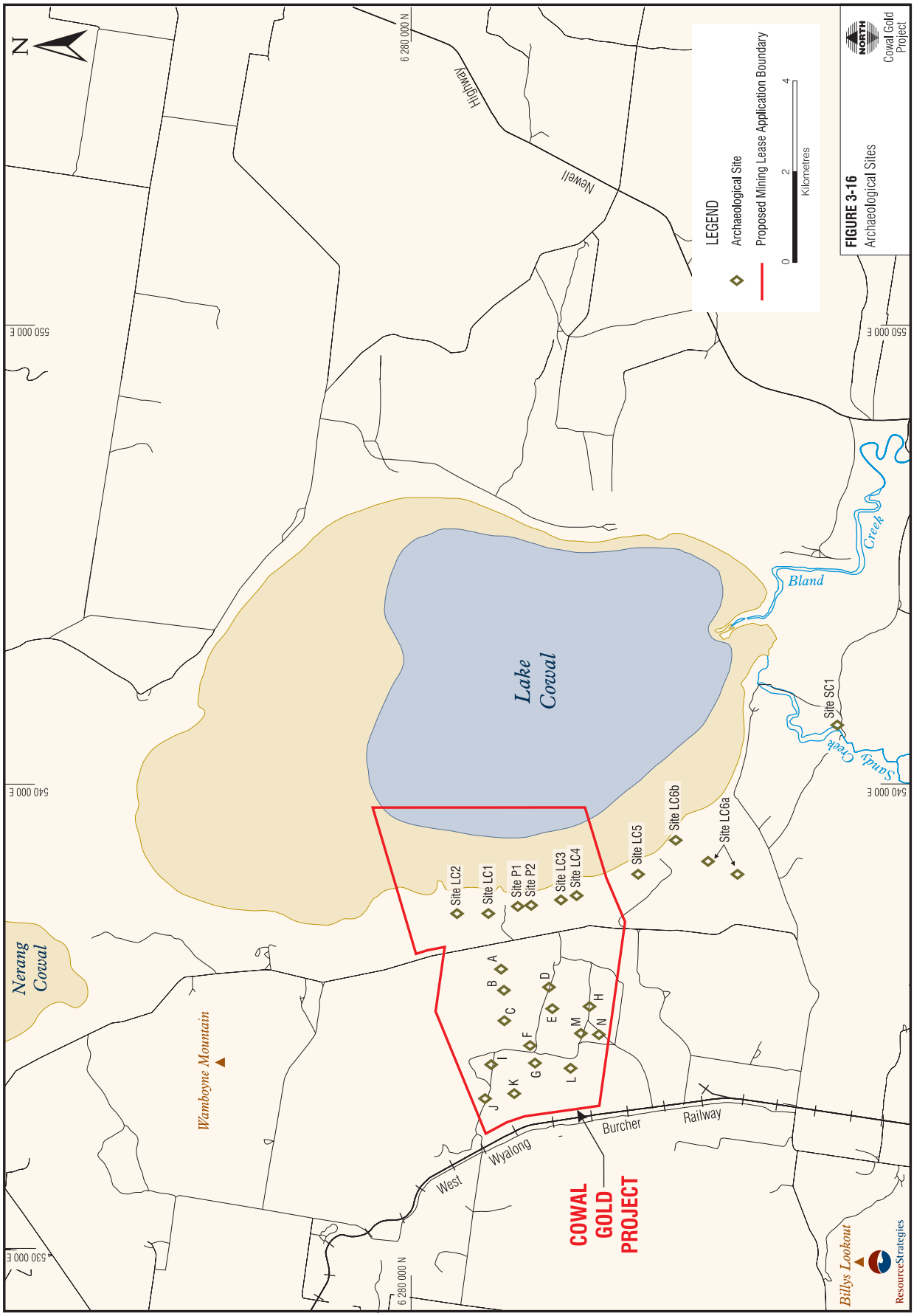
Historical reporting by Wilson (1923) and Musgrave (1979) refers to the use of the area now known as Wyalong by the Lachlan and Murrumbidgee tribe members during the initiation rituals. The initiations ceased when the area was accidentally discovered by John Reagan and the Aboriginal people believing that the ground had been desecrated apparently abandoned the area.

In other dry parts of Australia where waterbodies of similar magnitude are located, ethnographic indicators have been found suggesting past use as a focal point for settlement, economic activity, ceremonial gatherings and territorial conflict (Culture and Heritage, 1995). However, historical data suggests that Lake Cowal may not have been a reliable water source, as evidenced by Lake water level records (Figure 3-10).

Therefore in an attempt to determine the archaeological significance of the Project area and surrounds the archaeological surveys were carried out in consultation and with the assistance of the Wiradjuri Regional Land Council and the West Wyalong Local Aboriginal Land Council.

During the 1994 survey and assessment, the following archaeological sites were identified (Figure 3-16):

- Site P1 – continuous scatter of artefacts composed principally of unmodified flakes, cores, backed blades, blades, small blades and a burin;
- Site P2 – a scarred tree;
- Site LC1 – artefacts generally associated with male activities (viz. adze flakes, burins, cores, backed blades). Hearths with heat retainers were also located;
- Site LC2 – "basecamp" - type material such as flaked material, cores, modified flakes, backed blades, blades, hand axes, hammerstones, adze flakes and ground artefacts;


N
6 280 000 N
Newell Highway
550 000 E
540 000 E
530 000 E
LEGEND
Archaeological Site
Proposed Mining Lease Application Boundary
0
2
4
Kilometres
FIGURE 3-16
Archaeological Sites
NORTH
Cowal Gold Project
Lake Cowal
Bland Creek
Sandy Creek
Site SC1
Site LC6b
Site LC6a
Site LC5
Site LC2
Site LC1
Site P1
Site P2
Site LC3
Site LC4
A
B
C
D
E
F
G
H
I
J
K
L
M
N
Nerang Cowal
Wamboyne Mountain
West Wyalong
Burcher
Railway
COWAL GOLD PROJECT
Billys Lookout
ResourceStrategies
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- Site LC3 – small artefact scatter of flaked pieces, backed blades, blades, cores, hammerstones, a single ground piece of sandstone and one modified flake;
- Site LC4 – sparse, small scatter of flaked pieces, blades, backed blades, adze flakes and burins;
- Site LC5 – very small scatter of flakes, cores, hammers, grindstone fragments and an axe;
- Site LC6a – two distinct areas:
  (i) a continuous scatter of unmodified flakes, cores, flaked pieces, blades; and
  (ii) scatter of flakes, backed blades, cores, adzing tools and pieces of ground sandstone;
- Site LC6b – scatter of unmodified flakes, cores, flaked pieces and adze flakes.

Additional survey of the Project area was conducted in January 1996. Eight sites were identified during this survey (Figure 3-16). Descriptions of these sites are:

- Site A – one quartz core and one quartzite block.
- Site B – aretfact scatter consisting of flakes and a heat retainer.
- Site C – scatter consisting of quartz, chert, silcrete, quartzite and sandstone artefacts.
- Site D – exposure including quartz flakes, a hammer and hearths.
- Site E – scatter including heat retainers and quartz, chert and sandstone artefacts.
- Site F – scatter including mussel shells and quartz and chert artefacts.
- Site G – scatter including quartz, chert, sandstone and volcanic artefacts, one hammer and three heat retainers.
- Site H – scatter including quartz, chert, silcrete, volcanic and sandstone artefacts as well as ground sandstone.

Subsequent survey of the proposed tailings storage areas in 1997 identified six additional sites (Sites I to N (Figure 3-16). These sites are described as:

- Site I – artefact scatter consisting of quartz, chert and silcrete flakes, ground sandstone fragments, mussel shell fragments and broken pebbles as well as several hearth features.
- Site J – artefact scatter including a large number of broken pebbles and fragments of ground stone, quartz and chert flakes, a backed blade, ground edge axe, heat retainer and mussel shell fragments.
- Site K – artefact scatter consisting of flakes, cores, broken hammer stones, heat retainers and mussel shell fragments.
- Site L – small artefact scatter consisting of a broken hammer stone, quartz flakes and a chert flake.
- Site M – artefact scatter including chert, quartz and silcrete flakes, cores, broken quartzite pebbles and remains of a hearth.
- Site N – artefact scatter including quartz and chert flakes, cores, a broken quartzite pebble and a fragment of ground sandstone.

3.10 Socio-economics

A report on the social and economic significance of a resource development project for country NSW (Centre for International Economics [CIE], 1997) has been prepared for the Cowal Gold Project (Appendix K). A summary of the CIE report and existing socio-economic characteristics of the area is presented below.

3.10.1 Economic Base

Agriculture is the dominant industry in the region accounting for over 71% of business within the Bland Shire. Other important areas of economic activity include wholesale and retail trade, recreation, personal and other services.

Tourism is an important industry in Wyalong and West Wyalong and currently consists of catering for the needs of motorists travelling along the two major highways (*viz.* Newell and Mid Western) that pass through the town.

3.10.2 Employment Base

The Australian Bureau of Statistics (ABS) state that in 1991 there were 2,919 people employed in Bland Shire with 1,110 (38.1%) of these engaged in agriculture, forestry, fishing and hunting related industry. Other significant employers in the area are wholesale and retail trade (14.9%) and community services (12.1%).

Unemployment in Bland Shire is on average 5% which is considered low compared to other regional centres in NSW.

3.10.3 Demographic Profile

Current ABS estimates indicate the population of Bland Shire to be around 6,600.

Population declines have been experienced across the state in towns with populations under 10,000 and the Bland Shire 1981 and 1991 census data shows the population to be 8,033 and 7,053 respectively.

Since 1966, Bland Shire population has been declining at an average rate of 0.9% per year while NSW has been experiencing an average increase of 1.4%. The rate of decline in Bland Shire has increased over the past five years to 1.6%. If the rate of decline continues, the population of the shire could fall to 5,500 over the next decade.

3.10.4 Existing Housing and Accommodation

The 1991 census data recorded approximately 2,900 dwellings in Bland Shire with an occupancy rate of around 84%.

West Wyalong has a large capacity to provide temporary accommodation in the 14 motels and 2 caravan parks located in town. Occupancy rates are generally low with an average room occupancy of 42%.

Rental accommodation comprises in excess of 650 dwellings.

3.10.5 Journey-to-Work

The Project area is located approximately 38 km north-east of West Wyalong (Figure 3-17). The existing road system provides reasonable links with the surrounding towns (Figure 3-17) and the Project area.

The preferred access route to the Project area is via Ungarie Road, Wamboyne Road and Billys Lookout Road, connecting to the roadway parallel to the West Wyalong-Burcher railway line. This route will carry the vast majority of traffic associated with the mine and will be upgraded to provide a 7 m wide sealed carriageway over its entire length, with appropriate geometric and structural improvements and upgrades where required.

3.10.6 Commercial and Industrial Structure

West Wyalong/Wyalong has well-developed temporary accommodation facilities, food outlets, service stations and other shops and services including a post office, supermarket, licenced clubs, banks, churches and a variety of small retail outlets.

Competition for commercial service from outside the local area is strong with the regional centre of Wagga Wagga being located approximately 165 km by road to the south of West Wyalong.

3.10.7 Community Facilities Provision

Health Facilities

There are currently two full-time and one part-time doctors operating in West Wyalong and one full-time doctor in Ungarie. Dental services in West Wyalong presently operate 3 days a week.

The Wyalong Health Service currently operates a 39-bed hospital which includes 13 nursing home beds. Funding has been approved for the construction of a new 22-bed hospital to replace the existing facility with construction scheduled to commence in late 1998.

There are a number of specialist health and community services that service the area on a regular basis such as Speech Pathologist, Dietitian, Psychologist and Women's Health Nurse.

Educational Facilities

Child services in the Shire include the Mobile Resource Unit, Family Day Care, Playgroups and the Toy Library.

There are three primary schools servicing the area (West Wyalong and Wyalong Public Schools and St Mary's War Memorial School).

West Wyalong High School is the only public high school in Bland Shire and in May 1997, 383 students were enrolled with 34 full-time equivalent staff. St Mary's offers secondary eduction to Year 10.

The West Wyalong TAFE campus (The Riverina Institute of TAFE) has enrolments of around 580 students in both full and part-time courses. The TAFE offers courses such as computing, welding, wool classing, fashion and general education. The TAFE has the capacity to provide on-demand courses such as the joint co-operative training/ workplace course offered by Parkes TAFE and Northparkes Mines.

Recreational Facilities

Sporting clubs are strongly supported in West Wyalong/Wyalong and well maintained facilities for a variety of activities are available. Sporting facilities include:

- sports stadium
- swimming pool
- tennis courts
- golf course
- bowling green
- gymnasium
- speedway
- sports ovals
- showground/trotting track.

Social and Community Services

Organisations such as social security advisors and social workers service the area regularly. Augmenting these services are a diverse range of community groups and service clubs including Red Cross, RSL, Rotary, Apex, Lions, Aboriginal Land Council, Senior Citizens, Bushfire Brigade, Homecare, Meals-on-Wheels and Community Transport.

Cultural/Entertainment Facilities

West Wyalong/Wyalong contains a number of cultural/entertainment facilities including eight hotels and several restaurants. Cultural facilities include the Bland Historical Museum and the Art Gallery of the Bland. Eight major churches are represented in West Wyalong/Wyalong. Annual events include the West Wyalong Agricultural Society Show, Masonic Debutante Ball, Junior Presbyterian Eisteddfod and the Bland Avicultural Society Bird Show.

Generally the town is well serviced with infrastructure and most community facilities, with some spare capacity principally as a result of a declining population in the town.

3.11 Transport

A traffic impact assessment report prepared for the Project (Traffix, 1997) provides details of the existing road network and traffic volumes, the rail network and existing air transport (Appendix J). A summary of those components is provided below.

3.11.1 Road Network and Traffic

In a regional context, West Wyalong is located at the confluence of the Newell Highway (State Highway No. 17) and the Mid Western Highway (State Highway No. 6). Figure 3-17 shows the regional road network within about 150 km travel distance to the site by road.

The other major regional roads which provide access to the site are as follows:

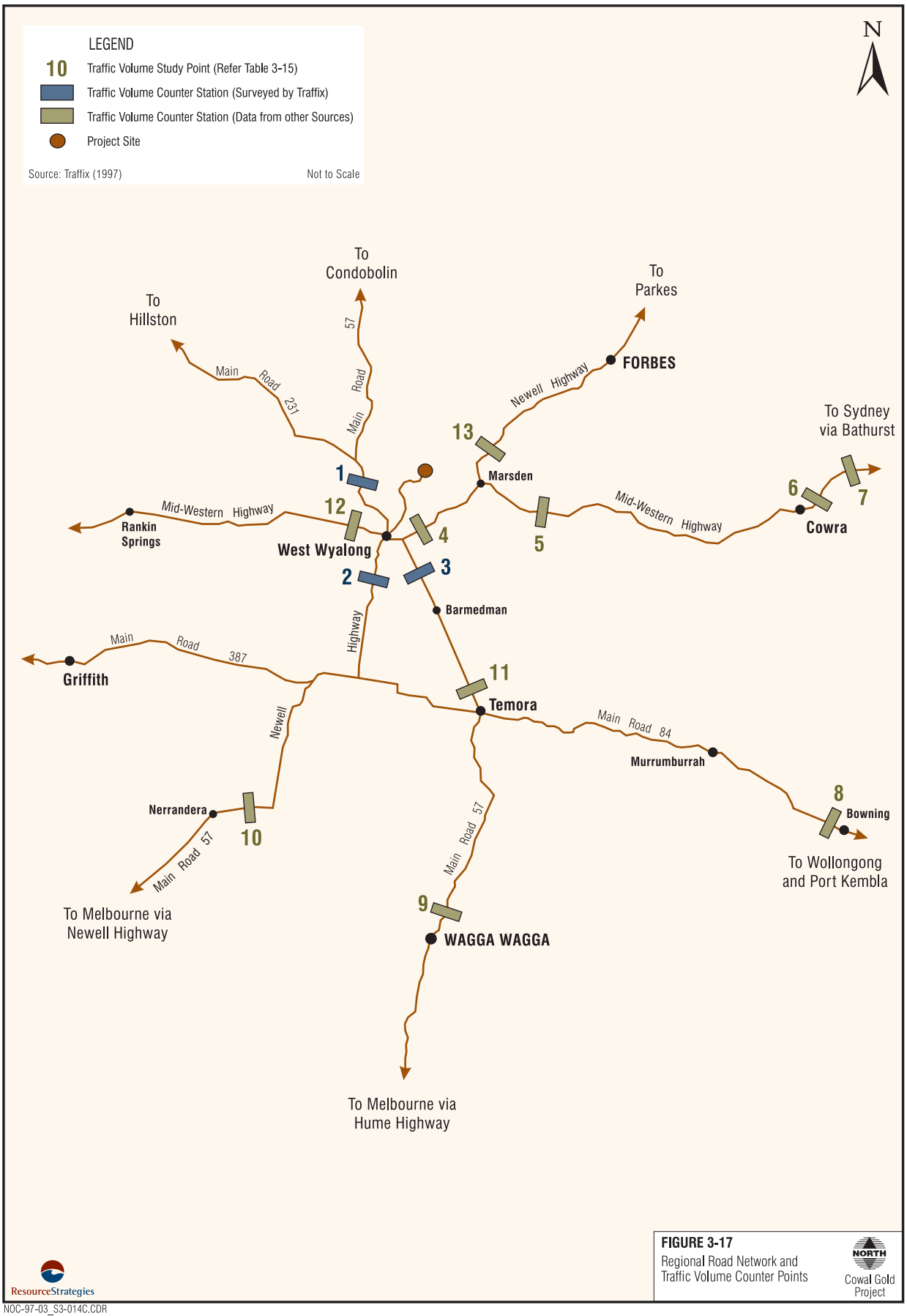


FIGURE 3-17
Regional Road Network and Traffic Volume Counter Points

Cowal Gold Project

ResourceStrategies

NOC-97-03_S3-014C.CDR

To the north:
Main Road 57 providing access to Condobolin.

Newell Highway (State Highway No. 17 providing access to Forbes and Parkes). The Newell Highway is part of the National Road Network and is funded by the Commonwealth.

To the east:
Mid Western Highway (State Highway No. 6) providing access to Sydney via Bathurst.

To the south-east:
Main Road 57 and Main Road 84, providing access to Wollongong via the Hume Highway.

To the south:
Main Road 57 and Main Road 78, providing access to the Hume Highway via Wagga Wagga.

To the south-west:
Newell Highway (State Highway No. 17), providing access to Melbourne via Narrandera.

To the west:
Mid Western Highway (State Highway No. 6), providing access to Rankin Springs and Griffith.

A number of Project area access routes were assessed and based on engineering and economic viability studies, access will be via Ungarie Road, Wamboyne Road and Billys Lookout Road.

Traffic volumes on roads in the region which are likely to be relied upon by traffic associated with the mine have been obtained from all available sources and have been supplemented by surveys as appropriate. The location of the traffic counts is presented in Figure 3-17. The results of the surveys, including the percentage of heavy vehicles in the total vehicle fleet, is shown in Table 3-16.

It is evident that flows on all routes examined are significantly less than their capacity, as demonstrated in Table 3-17.

The proportion of heavy vehicles varies between 14% and 20%, which is within the typical range for rural highways. These heavy vehicle proportions are averaged over both directions of flow.

3.11.2 Rail Transport

The Burcher-West Wyalong rail line is located approximately 5 km west of Lake Cowal and runs between Burcher and Wyalong. The line is used exclusively for grain transport during the harvest period and depending on requirements, approximately 50 trains per year utilise the line (Eric Hill, pers. comm., 1997).

The proposed development does not entail transport of goods or services by rail.

3.11.3 Air Transport

The closest airport to the Project area is at West Wyalong where Country Connection Airlines operate a twice daily shuttle service within the region (*viz.* Forbes, Cowra, Young and Cootamundra) and to Sydney.

Table 3-17 Volume Capacity Ratios of Key Roads

Road	Existing Daily Flow (vpd)	Capacity (vpd)	Vol./Capacity Ratio
Newell Highway			
– south of West Wyalong	1,860	4,800[1]	0.38
Mid Western Highway			
– west of West Wyalong	749	2,000[2]	0.37
– east of West Wyalong	3,786	4,800[1]	0.79
Ungarie Road	752	2,000[2]	0.79
Wamboyne Road	150	500[2]	0.30

Note: [1] Based on NAASRA Roadway Capacity Guide. Assumes Level of Service B and K factor of 0.10. [2] Based on RTA Road Design Guide

Table 3-16 Existing Regional Traffic Volumes and Heavy Vehicle Proportions

Map Identifier	RTA Station No.	Location	Daily Traffic Volume[1]	% Heavy Vehicles
1	N/A	Ungarie Road, South of Wamboyne Road	752	14
2	N/A	Newell Highway, South of West Wyalong (National Highway)	1,860	26
3	N/A	Barmedman Road, South of Mid Western Highway	916	29
4	95,377	Mid Western Highway, east of Barmedman Road	3,786	28[2]
5	93,114	Mid Western Highway, east of Marsden	324	28[3]
6	93,103	Mid Western Highway, east of Cowra	2,983	18[3]
7	99,001	Mid Western Highway (SH5), east of Evans Shire Boundary	5,445	21[3]
8	94,001	Hume Highway (SH2), east of Bowning (National Highway)	15,422	21
9	95,137	MR78 (Wagga Road), north of Wagga Wagga	4,268	29[2]
10	95,081	Newell Highway (SH17), east of Narrandera (National Highway)	2,568	28[4]
11	95,154	MR57 (Wagga Road), north of Temora	1,567	29[2]
12	N/A	Mid Western Highway, west of Ungarie Road	749	25
13	93,869	Newell Highway (SH17), south of Forbes (National Highway)	2,665[5]	N\/A

Note: 1 1997 Volumes 2 Estimated (Traffix, 1997) 3 1996 Data 4 1995 Data 5 1992 Data

Section 4

Section 4

Potential Impacts and Mitigation Measures

4.0 POTENTIAL IMPACTS AND MITIGATION MEASURES

4.1 Land Resources

4.1.1 Topography and Final Landform

Potential Impacts

The development of the Cowal Gold Project would require modification of the existing topography of the Project area. The open pit, waste rock emplacements, tailings storages and several water management structures are permanent features which, once rehabilitated, would form part of a new final landform.

The development of the open pit would require mining to occur below the full storage water line of Lake Cowal. A new permanent landform (lake protection bund) would be created between the Lake and the open pit to isolate the Lake from the open pit (Section 2.3.3). These new landforms would be rehabilitated as soon as possible after construction (Section 5). The final landform would form an arc around the open pit effectively creating a new Lake foreshore extending further into the Lake. The hydrological impacts of these activities are discussed in Section 4.2.

The northern and southern waste emplacements would be joined to the perimeter waste emplacement resulting in a final landform that encloses the open pit on three sides. Placement of the expected 128 Mt of waste rock in these emplacements would significantly change the existing topography within the Project area. The northern waste emplacement would abut Cowal West Hill and would have a final surface at RL 243 m (approximately 20 m above Cowal West Hill). The perimeter and southern waste emplacements would be lower (final surface RL 223 m), but their final top surfaces would still be up to 20 m above the existing ground surface.

Similarly, the tailings storages would change existing topography through the construction of embankments ranging from approximately 10 m (in the south-west corner of the northern tailings storage) to a maximum height of 20 m (north-east corner of the northern tailings storage) above the existing topography. At the cessation of mining the tailings storages would cover a rehabilitated area of about 350 ha.

As described in Section 2.9, the water management strategy for the Project would require the development of a permanent Up-catchment Diversion System and Internal Catchment Drainage System. The development of these features would modify the size of certain catchments and surface water flow paths.

Mitigation Measures

All topsoil and selected subsoils in the areas of disturbance would be prestripped and either stockpiled for later use or used directly in progressive rehabilitation.

The open pit would remain post-closure as a void enclosed on three sides by waste rock emplacements. The isolation function of the lake protection bund and perimeter waste emplacement is designed to provide a permanent barrier between Lake Cowal and the open pit. Surface and groundwater management strategies (during mining and post-closure) are discussed in Section 4.2.

The rehabilitation of these permanent landforms surrounding the open pit would result in a new Lake foreshore with features designed to enhance wildlife habitat and ecotonal characteristics (eg. small-scale topographic variations, shallow water areas, vegetation associations). Section 5 describes the rehabilitation strategy of the proposed new Lake foreshore.

The location and final shape of the waste emplacements and tailings storages are designed to integrate with local topographical features. All landforms have been restricted in height to lie below local topographic highs (ie. the ridgeline located immediately west of the Project area). Revegetated outer batter slopes would be reprofiled to an overall gradient of 1(V): 5(H).

4.1.2 Soils and Erosion Potential

Potential Impacts

The potential soil and erosion-related impacts of the Cowal Gold Project are:

- loss of in-situ soil resources from beneath mine landforms (ie material not stripped);
- alteration of physical and chemical soil properties during stripping and stockpiling operations;
- reduced soil quality (structure, fertility and microbial activity) of long-term stockpiles;
- contamination of soil with saline water/subsoil, process reagents and chemicals;
- erosion of soil from the outer batters of waste emplacements and tailings storages, the verges of access and haul roads and areas in which vegetation has been cleared or water is concentrated;
- instability of earthen containment structures due to inherent dispersive characteristics of Project area soils;
- erosion of stockpiled soil;
- soil erosion and sediment movement during construction of the water supply pipeline to the Project area; and
- increased erosion rates due to the exposure of dispersive soils.

Mitigation Measures

An integrated Erosion, Sediment and Salinity Control Plan would be developed for the construction and operational phases of the mine. The plan would describe how erosion, sedimentation and any saline waters would be controlled in disturbed areas by applying methodologies to be developed in consultation with the relevant Government agencies in the pre-construction phase.

The overall control strategy involves sequencing construction works so as to minimise the area of disturbance at any one time and the implementation of a

progressive rehabilitation programme. Specific sedimentation control works (to retain sediment on site) would be installed prior to any surface disturbance. A detailed water management system for the Project has been developed and is contained in Appendix F and summarised in Sections 2.9 and 4.2.

Investigations into the dispersivity/stability of Project soil types (Knight Piesold, 1995), indicated moderate dispersion potential. Further tests conducted using Lake water and saline groundwater indicated stability of all water containment structures (including tailings embankments and the temporary isolation bund) would not be compromised by soil dispersion. Gilgai areas in the north-western corner of the tailings storage area would be excavated during construction. Any potential erosional or stability impacts created by such areas would therefore be negated.

Furthermore, all water containment structures would be designed and constructed in accordance with Dam Safety Committee requirements.

Control of erosion through the stabilisation and revegetation of disturbed areas would occur as part of the progressive rehabilitation strategy (Section 5). Additional measures to be adopted to mitigate potential impacts on soils include:

- minimising the area disturbed by the Project and restricting access to non-disturbed areas;
- ripping and rehabilitation of hard-stand areas and roads no longer required for access;
- avoidance of soil stripping operations during particularly wet or dry periods, minimising compaction during soil excavation and movement and the use of ameliorants where required (eg. gypsum application to dispersive soils);
- use of silt fences and temporary sediment traps to minimise sediment movement;
- use of diversion banks, channels and rip-rap structures to divert surface water around disturbed areas and to control runoff velocity;
- maintaining soil stockpile slopes at a maximum acceptable angle to resist erosion;
- constructing all access roads at an appropriate slope along the contour;
- the use of spoon drains, table drains and concrete culverts to control surface runoff from access roads; and
- leaving the more saline and dispersive soil horizons *in-situ* beneath mine landforms, where possible.

A detailed Soil Stripping and Management Plan (including designs for soil and water management features) would be prepared in consultation with the Department of Land and Water Conservation (DLWC), prior to the commencement of mine construction activities.

4.1.3 Land Use

Potential Impacts

Section 3.2.6 describes existing landuse in the Project area. There are no known existing or planned projects adjacent to the Project that have potential to create common impacts. The Project area has been predominantly cleared and is currently used for grazing and cropping purposes. Some land degradation associated with agricultural practices is evident within the proposed MLA (eg. overgrazing by stock, development of gullies and rills within drainage lines). During construction and operation of the mine, areas disturbed by mining activities would be unavailable for agricultural purposes. Grazing of areas within the proposed MLA which would be undisturbed by mining activities would be progressively phased out during the operational phase of the Project.

A DLWC Game Reserve is currently located in the centre-left portion of the proposed MLA (Figure 1-4). It has historically been used to provide public access to Lake Cowal. Development of the project would require the relocation of the Reserve to an area north of the proposed MLA.

A Travelling Stock Reserve runs in a north-south direction through the centre of the proposed MLA. Mining activities within the Project area would disrupt that section of the Travelling Stock Reserve traversing the site. The affected section of the Reserve would be closed and re-routed around the western boundary of the proposed MLA.

Historically Lake Cowal has been used as an inland fishing area, both for commercial and recreational anglers. Potential impacts of the Cowal Gold Project on fishing primarily relate to possible changes in Lake water quality and the potential impacts on Lake water levels. The water management strategy and proposed mitigation strategies to minimise potential impacts are described in Section 4.2.

Principle six of the *NSW Management Wetlands Policy* (DLWC, 1996) requires rehabilitation of wetland disturbed by the development or the construction, ongoing maintenance and monitoring of a compensatory wetland.

In the Policy wetlands are defined as *"areas that are wet for a long enough period such that the plants and animals living in them are adapted to, and often dependent on, living in wet conditions for at least part of their life cycle".* that is, wetlands are areas:

- inundated with water on a temporary or permanent basis;
- inundated with water that is usually slow moving or stationary;
- inundated with water that is shallow; and
- inundated with water that may be fresh, brackish or saline (DLWC, 1996).

Based on the definitions given in the *NSW Wetland Management Policy* the proposed development would entail modification of approximately 120 ha (ie. 20 ha of fringing River Red Gum and 100 ha of lakebed) of "wetland" habitat.

In order to minimise the size of the area from which agricultural production will be excluded (in accordance with rehabilitation strategies), a compact Project layout is proposed.

Mitigation Measures

The progressive rehabilitation strategy proposed for areas disturbed by mining activities with the proposed MLA involves a change in landuse from agricultural production to native ecosystem. The post-closure landform would include successional vegetation communities endemic to the Lake Cowal/South Western Slopes region and features to enhance wildlife habitat. Strategies for the management of weeds and feral species would be addressed in a proposed Land Management Plan as detailed in Sections 4.1.4 and 6. Areas within the proposed MLA where land degradation has been identified would be progressively restored as part of the overall rehabilitation programme. Section 5 describes the rehabilitation strategies and long term compatibility goals for the Project.

The Game Reserve would be relocated to an equivalent area to the north of the MLA on land optioned by North. The exact location and dimensions of the new Reserve would be determined in consultation with DLWC, National Parks & Wildlife Service (NPWS), landowners, other relevant authorities and stakeholders. In siting the new reserve the intention would be to:

- maintain public access to the Lake;
- include in the reserve a sample of remnant vegetation and lake habitat;
- locate the reserve at a suitable distance from both the Project area and main bird breeding areas;
- provide access tracks to the reserve; and
- provide appropriate signage and fencing.

The possible location of the relocated Game Reserve to the north of the MLA would be limited to within three blocks of land as shown on Figure 4-1.

In order to maintain the function of the existing Travelling Stock Reserve, an equivalent route would be formed around the western edge of the proposed MLA. Mining operations would be managed to ensure the free and uninterrupted passage of stock along the relocated reserve. Appropriate fencing would be provided.

In accordance with Principle six of the *NSW Wetlands Management Policy* (DLWC, 1996), the proposed rehabilitation plan focuses on the enhancement of existing wetland resources through the creation of the new lake foreshore habitat area. This area would equate to approximately 15 ha of wetland.

In addition to the new lake foreshore wetland, an area of approximately 1,350 ha of North-owned land (to the north of the proposed MLA) is potentially available for wetland enhancement via land management practices and specific rehabilitation initiatives.

4.1.4 Agricultural Suitability and Rural Land Capability

Section 3.2.5 and Appendix B describe the agricultural suitability and rural land capability classifications for the Project area. Agricultural suitability classes for the Project area consist of Classes 3, 4 and 5. Rural land capability classes II, IV and VI were recorded at the site.

Potential Impacts

As discussed in Section 4.1.3, the post-closure landuse objective for disturbed areas is to provide stable landforms that are revegetated to enhance wildlife habitat opportunities. As a consequence, changes would occur to the existing agricultural suitability and rural land capability classes of land disturbed by mining activities (ie waste emplacements, open pit, tailings storages, processing plant area, stockpiles and roads). The area (including buffer zones) that would be affected by this change in landuse is approximately 940 ha.

The agricultural suitability and rural land capability classes of other areas within the proposed MLA (not disturbed by mining or forming part of buffer zones) would not change as a result of mining. However, the fencing of the proposed MLA boundary and progressive exclusion of stock over the life of mine would result in the loss of land otherwise suitable for agricultural production.

Mitigation Measures

The rehabilitation objective for land disturbed by mining within the proposed MLA involves a change in landuse from agricultural production to native ecosystem. Rehabilitation of these areas would involve the gain of about 940 ha of vegetation. Stock would be excluded from rehabilitated areas.

Management of areas undisturbed by mining within the proposed MLA would be detailed in a Land Management Plan (Section 6) to be prepared in consultation with NSW Agriculture (NSW Ag), DLWC, neighbouring land holders and NPWS. The plan would detail strategies for the management of weeds and feral species, restoration of degraded areas and revegetation where necessary.

4.1.5 Final Void

Potential Impacts

At the end of mining operations the volume of the final void would be approximately 80,000 ML. Potential impacts associated with the final void include the following:

- operational and post-closure safety;
- pit wall stability;
- water management issues such as isolation from Lake Cowal, long term hydrology, water quality, and impacts on native fauna; and
- void water quality.

Mitigation Measures

It is proposed to leave the open pit as a void once mining operations cease. Backfilling of the void with waste rock is



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not a viable option due to the prohibitive costs, the potential to alter the input/evaporation balance and hence final water levels, and the necessity to keep the entire open pit active throughout the mining operations due to the shape of the orebody.

Operational and post-closure safety and stability considerations would be considered as part of the MREMP process (operational issues) and the Final Rehabilitation Report (post-closure issues). A geotechnical report on pit stability will be submitted to the DMR prior to the commencement of mining. As a minimum, the following measures would be taken:

- fencing and bunding to control access and ensure safety; and
- determination of optimal batter and berm characteristics above the anticipated final water level.

At the completion of mining in Year 8, the open pit dewatering operation would be maintained to supply water to the mill. On cessation of Project operation the dewatering system would be decommissioned and groundwater inflow and run-off from the internal mine site area would be allowed to accumulate in the open pit. Over time the void would gradually fill with water ultimately reaching an equilibrium level representing a balance between inflows and outflows. Detailed water balance and long-term water quality modelling for the final void has been undertaken and is contained in Appendices F (Water Management) and N (Long Term Compatibility).

The modelling results indicate that the void would take a period in the order of 100 years or more to fill to a pseudo equilibrium level at approximately RL 180 m (some 22 m to 24 m below the full storage level of the Lake). This would leave the equivalent of 11,000 ML of free storage in the void, below spill level (Gilbert and Sutherland, 1997).

Modelling results presented in Appendix N further indicate that:

- it is not hydraulically feasible for saline waters in the final void to flow upgradient and leak into the bottom of the Lake;
- water loss, if any, from Lake Cowal to the underlying aquifers and thence to the final void would be negligible and impossible to measure;
- final void water quality would not be acidic (Appendix C) and would be dominated by groundwater salinity; and
- final void water quality in the long-term would trend towards deep water hypersalinity. In the surface mixed layer there would be a seasonal variability in salinity from about seawater level in the summer months to levels approaching twice seawater level during winter.

The salinity of void waters is likely to be comparable with the ranges found in natural salt lakes. It is likely that the final void would support salt tolerant species of phytoplankton. However, given the physical attributes of the final void landform, it is recognised that those key ecotonal factors which characterise natural saline lake systems may not exist.

Potential impact considerations and mitigation measures, rehabilitation strategies and long-term compatibility goals for the final void are further detailed in Section 5 and Appendices A and N respectively. Section 6 details monitoring proposals for the final void.

As outlined in Appendix A, several studies have investigated the salt water tolerance of waterbirds (eg. Moorman *et al.,* 1991; Basham and Mewaldt, 1988) and some studies have reported harmful effects of salt water on birds (Wingdingstad *et al.,* 1987).

Numerous studies have however found that species are tolerant of hypersaline environments. Mahoney and Jehl (1986a) found that two species of birds, Wilson's Phalarope (*Phalaropus tricolor*) and American Avocet (*Recurvirostra americana*) which occupy hypersaline lagoons in the Great Basin of western North America, were able through a combination of behavioural and anatomical adaptations to rid their prey of most adherent lake water and thereby largely avoid the problems of salt-loading and the ingestion of harmful ions. The Eared Grebe (*Podiceps nigricollis*) and Californian Gull (*Larus californicus*) also have adaptations enabling existence in hypersaline environments (Mahoney and Jehl, 1986b; 1986c).

A number of Australian bird species are tolerant of high salinity waters, with fauna displaying many adaptations to cope with salinity-associated stress (Prof W.D. Williams, pers comm, 1997 in Appendix N, Attachment 5). These species are particularly prevalent in the Lake Eyre basin and other Australian inland lakes (*ibid.*).

Review of a number of relevant studies and reference sources indicates that plankton and possibly fish can occur in saline (and hypersaline) water bodies (Swanson *et al.,* 1988; Kingsford and Porter, 1992; 1993; Moorman *et al.,* 1991) such as the final void.

An objective of void rehabilitation is to create (where feasible) opportunistic habitat resources at the approximate level at which void water would reach equilibrium. Specific rehabilitation concepts for the final void are presented in Section 5.3.3. These concepts are to be refined and reviewed throughout operations as a component of the MREMP process.

The salinity of the void surface water after filling is expected to range seasonally from around 20,000-40,000 µS/cm over summer and up to 60,000 µS/cm in winter. This is comparable with the ranges found in natural inland salt lakes.

Eutrophication and blue-green algae issues are not expected due to the very restricted void catchment area, absence of stock, and a lack of nitrogen, phosphorus and organic matter sources.

With respect to metals, their solubility is expected to remain low and at levels that do not pose any threat to water quality (EGi, 1997).

4.1.6 Visual Impacts

Potential Impacts

A visual impact assessment of the Project was undertaken by EDAW (1997) and is contained in Appendix M. A description of the visual character of the Project area is provided in Section 3.2.1. Figure 3-1 indicates the approximate extent of the potential visual catchment of the Cowal Gold Project.

The main components of the mine that would be potentially visible from surrounding areas are:

- the northern and southern waste emplacements;
- the perimeter waste emplacement and lake isolation bund surrounding the pit and extending into the Lake;
- the tailings storage areas;
- structures associated with the processing plant and administration buildings; and
- the new access road into the mine site.

A site assessment carried out by EDAW identified that the new mine landforms associated with the proposal would be potentially visible from the following locations:

- Sections of the public road within the Travelling Stock Reserve (TSR - to be realigned around the western edge of the proposed MLA);
- The surface of Lake Cowal and areas on the eastern edge of the Lake; and
- Billys Lookout and Wamboyne Mountain.

The visual impact of the new mine landforms would primarily result from the contrast in colour and texture between undisturbed natural landscape areas and the newly placed materials. This impact would generally be confined to the active area of mine landforms as other areas would be progressively rehabilitated. There is also likely to be some contrast between the colour of newly established vegetation and existing areas of grassland in adjoining areas. However, this effect would progressively decrease with time as the vegetation matures.

The visual impact of the processing plant and associated facilities would result primarily from the contrast in scale, colour, texture and shape between the constructed elements and the surrounding rural landscape.

Detailed descriptions of the potential impact of the mine in relation to each of these situations are provided in Appendix M.

Mitigation Measures

While the overall on-ground visual impact of the proposed mine development is considered to be low, there are several locations where short-term visual impacts would be moderate to high. These localised potential impacts would be reduced significantly by a combination of the mitigation measures indicated in Table 4-1.

The specific locations where the above mitigation measures are proposed to be carried out are shown in Appendix M.

4.1.7 Land Contamination Potential

The Cowal Gold Project would involve the processing of gold-bearing ore from the open pit using a combination of flotation and cyanide leaching techniques. Table 2-7 in Section 2 of the EIS lists the major chemicals, reagents and other materials to be used and stored at the site. The land contamination potential as a result of the use of these materials and generation of other wastes by mining and processing activities is discussed in the following section.

A preliminary risk assessment for the Project is presented in Appendix L. The assessment identified risks to the public, public property and the environment (both on and off-site). Appropriate safeguards and contingency plans are discussed in the assessment and are summarised below.

Table 4-1 Proposed Mitigation Measures to Reduce Visual Impacts

Mitigation Measures	Outcomes
• Rehabilitation of mine landforms to establish a native ecosystem with vegetation type and structure similar to natural parts of the adjoining landscape.	• Creation of a vegetative cover that visually blends into the surrounding area.
• Construct earth mounding immediately alongside the realigned public road to block critical views.	• Screening of mine views for members of the public travelling on the realigned roads.
• Planting of trees and shrubs alongside those sections of road from which the mine operations are potentially visible (eg western and northern edges of the realigned TSR).	• Screening of mine views for members of the public travelling on the realigned roads. This tree planting programme has already been initiated.
• Painting the outside of the processing plant and associated buildings to help blend them into the adjoining landscape (colour selection and toning).	• External colours of the major buildings would be chosen to be compatible with colours in the surrounding landscape where possible.
• Development of a lighting layout that avoids the potential for direct views from the realigned public road.	• Direct views of lights on the mine site from the public road, railway and residences on land not owned by North would be avoided where possible.
• Use of unidirectional lighting fixtures and screens to block direct views of lights from the public road and residences in areas adjoining the mine site.	• The night sky glow created by the mine lighting would be similar to that associated with existing towns and villages in the region.

Potential Impacts

The main potential sources of land contamination at the Project site are:

- spillage of process reagents and chemicals;
- spillage of fuels;
- spillage of oily wastes;
- disposal of other waste materials;
- sewage;
- leaching of salts from mine generated wastes (waste rock and tailings); and
- release of process water or tailings containing cyanide.

Spillage of process reagents, process chemicals and fuels have the potential to cause land contamination where it occurs during transport, or where there is a major spillage of material from on-site storage tanks coincident with containment bund failure. The severity of potential spills would depend on the type and quantity of material involved. The preliminary risk assessment (Appendix L) itemises the types of events and materials that present the highest risk of contamination.

Mobile mining machinery and light vehicles are a potential source of fuel and oily waste spillage. The main types of oily wastes are lubricating oils, hydraulic oils, degreasing fluids, distillate and petroleum fuels. Spillages from vehicles during operation or while parked may result in impacts such as coating of soil particles, seepage into soil and spillage into watercourses. The overall significance and risk of these types of spillages occurring would vary depending on the quantity of material spilt and its characteristics.

Other potential wastes that may cause land contamination include recyclable and non-recyclable wastes and sewage. A Waste Management Plan would be prepared for the Project and would provide detail on the appropriate handling, disposal and recycling procedures for wastes generated at the Project site. Potential impacts associated with the treatment of sewage involve potential spillage of untreated or partially treated sewage and associated nutrient and bacteriological contamination.

Physical and chemical characterisation of existing soils and generated mine wastes (Appendices B and C respectively) have identified the potential for the generation of salinity if certain soil and waste types are exposed to surface oxidation processes. The containment of saline seepage is integral to the water management system and is summarised in Section 4.2 and detailed in Appendix F.

Cyanide contained in process water or tailings has the potential to cause land contamination if spilt or otherwise released in an uncontrolled manner. The ore processing plant is designed such that process water containing cyanide is recycled and therefore kept within the area encompassed by the processing plant run-off collection drain and storage. As a result, any potential spills would be restricted to this area of the site. Cyanide destruction points have been incorporated into the ore processing system to ensure cyanide levels in the tailings are below EPA guidelines at all times (Section 2.6.10 and Appendix G). However, the tailings and tailings decant water would still contain low levels of cyanide and have the potential to cause land contamination if spilt during transfer to the tailings storage, from the storage itself or from the decant pond and return water line.

Mitigation Measures

Appendix L contains an assessment of potential risks associated with the development of the Cowal Gold Project. The assessment identified the greatest environmental risk to be potential road transport accidents leading to spillage of hazardous materials (ie. process reagents, process chemicals and fuels). Other potential incidents (primarily spills or accidents resulting in spills) with the potential to cause land contamination are detailed in Table L8 of Appendix L. Proposed in-place prevention measures and protective responses are detailed in the table for each identified environmental risk scenario.

In summary, measures to minimise risks associated with transport include the following:

- preparation of detailed contingency plans to mitigate the effects of any spill of toxic material during transport to the mine site. This would include a detailed assessment of the proposed route to be taken by the trucks with prescribed actions to be taken following an accident;
- preparation of a plan of action to recover material spilt at the mine site;
- ensure the preparation of detailed emergency response plans by the materials suppliers in consultation with the local emergency services. These plans should aim to reduce the effects of a spill and the number of people remaining near the spill;
- ensure that the carriers strictly enforce the provisions of the Australian Code for the Transport of Dangerous Goods by Road and Rail;
- provision of a radio or telephone in truck cabs, to increase the likelihood of prompt notification of an accident;
- carrying of self-contained breathing apparatus in the cab of those trucks transporting sodium cyanide, to increase the likelihood of prompt response to an accident;
- carrying of material in such a manner as to minimise as far as practicable, the amount of material that would be spilt from a truck involved in an accident; and
- packaging of material in a manner to restrict water ingress. This would reduce the consequences of a spill in or near water.

A detailed Hazardous Waste and Chemical Management Plan is to be prepared for the Project as outlined in Section 6. The Plan would contain appropriate emergency response procedures in the event of spillage resulting in land contamination. It would also detail contingency plans for transport accidents on route to the Project area as negotiated with the transport or supplying company.

Mineral processing reagents would be stored and handled within bunded reagent storage areas located on the western side of the processing plant (Figure 2-12). A run-off collection drain would be installed around the perimeter of the processing plant and would drain to the processing plant contained water storage. These structures would combine to contain any materials that may result in land contamination if spilt.

Other safety features that would be incorporated into the design of the reagent storage areas include:

- installation of ventilation systems for areas where dispensing and mixing of chemicals occurs;
- installation of drain valves and pipework to facilitate the removal of rainwater from bunded areas;
- provision of portable pumps within the processing area for use in pumping any chemical spills within bunded areas back to the storage tanks or emergency holding tanks;
- provision of appropriate fire protection facilities compatible with the volatility and flammable properties of the stored reagents/chemicals; and
- provision of eyewash and emergency showers for processing plant workers to be used for immediate washdown should an accident occur.

Liquid processing reagents, chemicals and other potentially hazardous/contaminating materials would be stored in either drums or tanks and would be located in bunded areas to contain any spills. Storage would be in compliance with Australian Standard AS1940-1993 – *The Storage and Handling of Flammable and Combustible Liquids*. Bunded areas would be designed to contain spill volumes equal to:

- 120% of the volume of the largest tank within the bund; or
- 10% of the total volume stored within the area.

Solid chemicals and reagents would be stored in bulk storage bins and/or weatherproof buildings.

The fuel and petroleum storage area would be similarly bunded to contain potential spills. All fuel supply pipework would be sited aboveground to facilitate the early detection of potential leaks. The fuel and petroleum storage area would be operated in compliance with the requirements of the *Flammable and Combustible Liquid Regulation (NSW)* and Australian Standard AS1940-1993 – *The Storage and Handling of Flammable and Combustible Liquids*.

The potential for land contamination as a result of spillage from mobile machinery would be managed through regular maintenance of vehicles in dedicated, appropriately bunded workshop areas and restriction of vehicular access to the internal road network where possible. Depending on the type and scale of spill, contaminated soil would be either treated in-situ, where possible, or removed and disposed in the waste rock emplacements.

A Hazardous Waste and Chemical Management Plan would be prepared for the Project and would provide detail on the appropriate handling, disposal and recycling procedures for wastes generated at the Project site.

The management of potential contamination (run-off and/or seepage) as a result of salinity generated from waste rock and tailings primarily involves the development of suitable landform designs and water management systems. The design of the waste emplacements and tailings storages are described in Section 2.5 (waste rock) and Section 2.7 (tailings). Specific design elements to reduce the potential for saline run-off and seepage generation include provision of non-saline capping layers and progressive rehabilitation (Section 5). The water management strategy for these landforms involves maximising infiltration, reducing the potential for run-off drainage of potentially contaminated water to contained storages, or ultimately the open pit, and direction of any seepage towards the open pit (Section 2.9 and Appendix F).

Potential land contamination from spilt tailings or decant water containing cyanide would be mitigated through the provision of appropriate bunding of the transfer pipeline route from the processing plant to the tailings storage/decant pond. Automated monitoring of pipeline pressure levels would enable rapid detection of significant leakage followed by system shutdown, thereby limiting any volume of spillage. Regular, routine pipeline inspections would also be undertaken to identify and correct any minor leakages. Within the tailings storage, seepage would be minimised by foundation compaction, the provision of underdrainage and collection systems and, following the early phases of Project commissioning, the maintenance of a single, centrally located decant pond. This area of potential impact has been modelled over the long term (Appendix N).

The tailings storages have been designed and would be operated with sufficient freeboard to give a storage capacity to contain a 1 in 1,000 year ARI event. The water management system also provides additional security by directing and containing all spilt waters within the contained internal catchment system which flows ultimately to the open pit (Appendix F).

4.1.8 Bushfire Hazard

Potential Impacts

Bushfire hazard within the Project area is generally considered to be low due to the extensive areas of cleared grazing land, and low fuel loads that occur within the proposed MLA. The degree of hazard within the Lake Cowal area would be expected to vary according to the quantity of fuel (ie. grass) available and prevailing weather conditions. Periods of high winds and high temperatures combined with high fuel loads would present the greatest risk. Potential causes of bushfire in the area include the spread of fire from the surrounding areas to the proposed MLA (either by naturally started fires or uncontrolled burning-off) or the spread of fire from the Project site following an on-site accident.

Mitigation Measures

The Cowal Gold Project would be operated in a manner designed to minimise the threat of bushfire not least because of the large investments made in mine fleet and infrastructure, the fuels and chemicals stored on-site and the presence of rural neighbours.

All employees would undergo training on bushfire hazard including general fire awareness, measures to prevent accidental fires and the importance of reducing the risk of accidental fire for both safety and the protection of neighbouring properties.

A Bushfire Management Plan would be established in consultation with the bushfire control officer at the Bland Shire Council and other relevant government authorities. The implementation of this plan would aim to reduce the fire risk to the immediate rural areas. Details of this plan are outlined in Section 6.4.

4.2 Water Resources

The assessment of potential impacts on the conservation status and critical conservation values of Lake Cowal are the subject of the long term compatibility study contained in Appendix N. Several of the identified critical conservation values for Lake Cowal have a significant bearing on the management of water resources at the proposed Cowal Gold Project. These values relate to the existing hydrological cycle and water quality of the Lake. Other critical conservation values identified included wetland habitat, terrestrial habitat and visual character of the Lake (discussed in Appendix N and the relevant sub-sections of Section 4).

The following section describes how the proposed water management system for the Project would mitigate potential impacts on water resources in the vicinity of the mine including the preservation of the identified critical conservation values of Lake Cowal. Section 6 details those water management monitoring programmes designed to verify the performance of the mitigation measures proposed in this section.

4.2.1 Lake Cowal

Potential Impacts

The location of the Cowal orebody is such that mining of the deposit would require part of the open pit to extend beyond the full storage level of Lake Cowal (Figures 2-1 to 2-5). In order to allow safe mining and minimise environmental impacts, a series of barriers would be formed between the Lake and the pit to hydrologically isolate the Project from the Lake. A description of the lake isolation system is provided in Section 2.3.3. The water management strategy for this component of the mine is summarised in Section 2.9 and detailed in Appendix F.

The potential impacts associated with the proximity of the mine to Lake Cowal are described in Appendix N and summarised below:

- Alteration of the hydrology of the Lake as a result of collecting and using waters that would otherwise flow into the Lake;
- Increased turbidity during the construction of the temporary isolation bund and lake protection bund;
- Increased salinity due to exposure of saline soil and waste rock materials during open pit pre-stripping and placement of waste materials;
- Seepage of lake water into the open pit (or vice versa);
- Structural stability of the final mine landforms adjacent to the Lake over the long term including the risk of increased sedimentation;
- Increased turbidity during the construction of the water supply pipeline from the Bland Creek palaeochannel borefield;
- Movement of dust from active mine areas on to the Lake; and
- Seepage from the tailing storages to the Lake.

Construction of mine landforms within the Lake full storage line would result in an estimated increase in the average Lake water level of 1 mm (Gilbert and Sutherland, 1997).

Mitigation Measures

The Cowal Gold Project is unlikely to have any measurable affect on the water balance of Lake Cowal (Appendices F and N). The Project would not directly use water from the Lake for water supply or any other purposes. Rainfall runoff intercepted by the Internal Catchment Drainage System reduces (to a very small degree) the contributing catchment area of Lake Cowal. There would be expected to be a very slight increase in the volume of spill from the Lake to Nerang Cowal as a result of the isolation embankments intrusion into the Lake. Similarly, Lake levels which overlap the perimeter bund, but are below the full storage water line, may be very slightly higher (up to 1 cm) – refer Appendix N.

As described in Appendix F, the water management strategy during construction of the lake isolation system involves the erection of a continuous silt curtain around the construction zone of the temporary isolation bund. The silt curtain would be installed prior to construction commencing, in order to trap fine sediment and prevent suspended material migrating into the main body of the Lake.

Once the temporary isolation bund is constructed and dewatered (if the water level at the time deems this necessary), any water collecting behind the bund would migrate to a temporary collection pond located in the centre of the arc (Figure 2-17). Any water collected in this area would be pumped to the process water storage for use during construction. During mining operations and post-closure, following stabilisation and revegetation of the outer batters of the lake isolation system, any runoff from the outer batter surfaces is anticipated to be of suitable quality (comparable to runoff from undisturbed areas) to enable release to the Lake. In addition, sediment fluxes entering the Lake from the Project site are expected to reduce from the pre-mine levels, as the final void would intercept the majority of site runoff (Appendix N).

Soil and waste rock characterisation programmes have identified materials to be disturbed during the construction

phase that have the potential to generate salinity (Appendices B and C respectively). Accordingly, the water management strategy incorporates design elements to contain surface runoff or seepage likely to have increased salt concentrations. The materials used to construct the temporary isolation bund and lake protection bund would be of low salinity in order to mitigate potential salinity increases in the Lake. A layer of oxide waste rock would also be used to cap the external batters of the waste emplacements (Figures 2-6 and 2-9). The water management strategy for the emplacements involves maximising infiltration, minimising runoff and directing any runoff from disturbed areas or seepage towards the open pit (Section 2-9 and Appendix F) thereby minimising the potential for increased salinity.

The anticipated dust fallout generated by mine operations is detailed in Appendix I and Section 4.5. The baseline water quality monitoring programme has demonstrated variable but significant levels of total suspended solids in Lake waters (24 mg/L to 224 mg/L) depending on factors such as Lake volume, rainfall patterns and local catchment runoff, wind velocity and wave effects, etc. Potential increases in total suspended solids in Lake waters as a result of mine-generated dust outfall have been assessed utilising dust deposition predictions in Appendix I and assuming conservatively that mine-generated dust would preferentially concentrate near the lake protection bund and not mix with Lake waters in general. Results indicate that the affect of mine-generated dust on the level of total suspended solids typically found in Lake waters is negligible and would not be measurable in the context of the natural variation observed in baseline studies.

Potential increases in Lake water metal concentrations due to mine-generated dust outfall is also expected to be negligible. Hunt (1997) and Appendix A discuss the low metal concentrations found in baseline dust deposition. The anticipated metal concentrations in dust generated by mine activities are predicted to be within normal ranges for surface soils (Hunt, 1997).

Salt loads entering the Lake from the Project site (post-closure) are discussed in Appendix N (long-term compatibility study). Essentially, the studies indicate that such loads should decrease below pre-mining levels as a result of the mitigation works proposed and the long term routing of on-site runoff and seepage to the final void.

The potential for shallow seepage occurring from the Lake to the open pit would be overcome by the construction of the lake protection bund. As described in Section 2.3.3, the bund would be constructed as a low permeability embankment and would meet specific engineering criteria for compaction to ensure the required low permeability barrier is in place. In addition, soils within the footprint of the bund would be sub-excavated and replaced with compacted fill in order to restrict shallow migration under the embankment. Deep water loss, if any, from lake Cowal to the underlying aquifer and thence to the final void would be negligible and impossible to measure (Appendix N).

The predicted long-term water level in the final void is expected to be around RL 180, some 22 to 24 m below the full storage water line of the Lake (Appendix F). This precludes any upgradient migration of saline water from the open void and leakage into the bottom of the Lake (Appendix N).

The final profiles of the waste emplacements, tailings storages and lake isolation system have been designed to effectively preclude the risk of instability which could cause impact on the Lake (Appendix N).

It is proposed to bury, where possible, the water supply pipeline from the Bland Creek palaeochannel borefield to the Project site (Section 2.8). Burial of the portion of the pipeline that crosses the Lake would only be possible during periods of low water levels. If the Lake level is too high to allow burial at the time of construction the pipeline would be placed on the floor of the Lake and buried at a latter date when water levels allow. During burial of the pipe a temporary silt curtain would be erected around the disturbed area to trap fine sediment and prevent suspended material migrating into the main body of the Lake.

4.2.2 Surface Water Quality

Potential Impacts

Surface water runoff from mine landforms and disturbed areas could potentially contain sediment, salinity, oil and grease and process reagents. The potential sources of surface water contamination are summarised in Table 4-2.

Mitigation Measures

Detailed water studies have been undertaken in order to design a comprehensive water management system to reduce any potential surface water and groundwater impacts. As described in Appendix F and summarised in Section 2.9, the overall objective of the Project water management system is to contain all potentially contaminated water (contained water) generated within the project area while diverting all other water around the perimeter of the site. Water management strategies have been developed in conjunction with the mine waste and soil management strategies to mitigate the potential impacts described above. The management strategies involve the following principles:

1. Minimising disturbance areas

As discussed in Section 2.2, the general arrangement design has been developed to minimise the potential environmental impacts of the Project. One of the specific design criteria used was the creation of a compact site layout that minimises the overall disturbance area as well as ore and waste haulage distances.

2. Containment of Potentially Contaminated Water

A permanent Up-catchment Diversion System would be developed to allow upper catchment surface runoff to flow around the western, northern and southern edges of the site and back into existing drainage lines. Below the Up-catchment Diversion System an Internal Catchment Drainage System would be constructed to ensure waters

generated on the site are contained within the area of disturbance (ie. waters that potentially contain increased sediment loads, salinity or other substances). This system would consist of a series of permanent low mounds designed to act as internal catchment divides around the site. In order to direct infiltrating water from the waste rock emplacements toward the pit, areas would be graded or pre-formed with compacted oxide waste to ensure that the crossfall of the base of the emplacements is towards the pit. A detailed description of the containment strategy for the project is provided in Appendix F. Following the period of advance pit dewatering, the site would operate under a negative water balance.

3. Recycling of Contained Water

Within the Internal Catchment Drainage System a series of sediment control structures, catchment dams and waterways would be constructed around individual infrastructure components. These structures form the Erosion, Sediment and Salinity Control System used during the life of mine (Appendix F).

Eight contained water storages (D1 to D8) would be located in those areas containing, or likely to contain, potentially hazardous substances (Figures 2-17, 2-18 and 2-19). A summary of the capacity and function of each of these contained water storages is provided in Table 4-3. Under the proposed water recycling scheme, water from these contained water storages would be reticulated to the processing plant for reuse.

Drains would be constructed around the perimeter of the processing plant and would collect and channel surface

Table 4-2 Potential Sources of Surface Water Contamination

Source of Contamination	Type of Contamination
Waste rock emplacements	Runoff and/or seepage containing sediment, increased salinity
Run-of-Mine (ROM) and low grade ore stockpiles	Runoff and/or seepage containing sediment, increased salinity and potential acid rock drainage
Tailings storage/reclaim dam/pipeline	Runoff and/or seepage containing dissolved salts, cyanide, other reagents and potential heavy metals
Pit dewatering/pipeline	High salinity groundwater, direct rainfall, and potential acid rock drainage
Process water/pipeline	High salinity (pit dewatering make-up water) and dissolved salts
Processing plant	Cyanide, process reagents, fuel, oil, other substances
Sewage treatment area	Untreated or partially treated sewage containing bacteria, organic matter and nutrients
Other infrastructure (roads, soil stockpiles)	Runoff from roads and infrastructure areas continuing fuel, oil, hydraulic fluid, detergents, sediments and process reagents

Table 4-3 Summary of Contained Water Storages

Storage Number and Name	Function	Capacity
D1 Northern Waste Emplacement Contained Water Storage	Run-off/seepage collection storage for northern perimeter of the northern waste emplacement. Water pumped to process water storage D6	Run-off from contributing catchment resulting from a 1 in 100 year ARI rainfall event lasting 48 hours. Approximate design capacity 60 ML.
D2 ROM Stockpile/Northern Waste Emplacement Contained Water Storage	Run-off/seepage collection storage for low grade ore and ROM stockpiles. Water pumped to process water storage D6	Run-off from contributing catchment resulting from a 1 in 100 year ARI rainfall event lasting 48 hours. Approximate design capacity 120 ML.
D3 Lake Protection Bund Contained Water Storage	Run-off storage for open pit area and perimeter waste emplacement. Water pumped to process water storage D6	Run-off from contributing catchment resulting from a 1 in 100 year ARI rainfall event lasting 48 hours. Approximate design capacity 105 ML.
D4 Southern Waste Emplacement Contained Water Storage (South Side)	Run-off/seepage collection storage for southern perimeter of the southern waste emplacement. Water pumped to process water storage D6	Run-off from contributing catchment resulting from a 1 in 100 year ARI rainfall event lasting 48 hours. Approximate design capacity 35 ML.
D5 Processing Plant Contained Water Storage	Processing plant run-off storage. Water pumped to process water storage D6	Run-off from a 1 in 1,000 year ARI storm of 48 hr duration. Approximate design capacity 55 ML.
D6 Process Water Storage	Process water storage. Main storage for plant make-up water supply	Run-off from a 1 in 1,000 year ARI storm of 48 hrs duration above normal operating level. Approximate design capacity 20 ML.
Tailings storages and D7 (Reclaim Dam)	Tailings and rainfall runoff containment. Water pumped to process water storage D6	Run-off from a 1 in 1,000 year ARI storm of 48 hrs duration above normal operating level.
D8 Southern Waste Emplacement Contained Water Storage(North Side)	Run-off/seepage collection storage for northern perimeter of the southern waste emplacement. Water pumped to process water storage D6	Run-off from contributing catchment resulting from a 1 in 100 year ARI rainfall event lasting 48 hours. Approximate design capacity 70 ML.

waters to contained water storage D5. Any incident rainfall, spilt process water, or other substances (including spilt process chemicals in the unlikely event of a tank rupture or other accidental spill) would report to the storage. The processing plant drainage system layout and storage are shown on Figure 2-12.

The process water storage D6 would contain make-up water for the process plant. Inputs to D6 include:

- water pumped from contained storages around the waste emplacements and lake protection bund (D1 to D4 and D8);
- process plant area runoff (D5);
- tailings decant water pumped from D7; and
- waters pumped from pit dewatering bores and the Bland Creek palaeochannel borefield.

Residual cyanide levels in storage D6 should be well below those levels expected in the tailings storage itself. Recycled waters from the tailings thickener would go directly to the mill.

Toe drains and contained water storages D1, D2, D4 and D8 would be constructed in stages around the waste emplacements and ore stockpile areas, as required. These structures are designed to capture any potentially saline surface runoff or seepage emanating from the waste rock emplacement areas.

Any contained water generated on the top surface and internal batters of the perimeter waste emplacement would be directed to a contained water storage located adjacent to the eastern edge of the open pit (contained water storage D3).

The tailings reclaim dam (contained water storage D7) has been designed to contain water from the tailings decant and under-drainage pipe network seepage control systems (Section 2.7). Temporary toe drains and containment bunds would be constructed around the tailings embankments to collect runoff from the external batters and any accidental spills from the tailings reticulation lines. Automated monitoring of the tailings pipeline pressure levels would enable rapid detection of significant leakage followed by system shutdown, thereby limiting any volume of spillage.

The contained water storages would be managed in such a manner to minimise potential water quality impacts. Although turbidity levels within contained water storages (including periods subsequent to first flush events) are not expected to exceed those encountered in the Lake (due to wind generated turbidity effects), turbidity within these storages would be tested prior to any discharge. Containment storages would be sized to contain all water to at least a 1:100 year rainfall event (1:1,000 year for those storages containing runoff from the plant site and tailings storages). Discharge to the Lake would only occur during events exceeding design criteria from storages D1 and D4 (all other containments would discharge to the open pit).

Should testing indicate that turbidity levels require amelioration prior to any discharge to the Lake appropriate measures would be employed (eg. application of flocculants).

4. Progressive Stabilisation and Revegetation of Disturbed Areas

Areas disturbed during mining operations would be progressively rehabilitated during the mine life. Rehabilitation would involve reprofiling of mine landforms, where necessary, to provide the required long-term landform stability. Following stabilisation, the available areas would be revegetated with appropriate plant species. It is anticipated that once rehabilitated areas become established, surface runoff would be of comparable quality to neighbouring (non-mined) areas. Passive treatment systems in the form of temporary sediment retention storages, silt curtains, hay bales and vegetation buffers may be employed as interim erosion and sediment control measures during the rehabilitation process.

4.2.3 Groundwater – Pit Dewatering

The groundwater level (potentiometric surface) in the Project area during 1994 to 1995 varied from about RL 204 m near the Lake shore line to RL 196 m about 4 km west of the Lake. This indicates a general groundwater flow direction from east to west under the influence of a hydraulic gradient of about 0.001 which increases to about 0.003 further west (Kalf and Associates, 1997 - Appendix N).

The proposed pit dewatering system is summarised in Section 2.4.2 and detailed in Appendix F. Pit dewatering would involve the construction of a perimeter borefield to dewater the open pit area in advance of mining. Results of groundwater modelling studies (Coffey Partners International, 1997) indicate yields of approximately 10 ML/day for the first 3 months with a progressive decline over the subsequent 12 to 18 months to approximately 5 ML/day.

The water extracted during pit dewatering would be highly saline and would be pumped to temporary on-site storages located within the tailings storage prior to start up of the processing plant. Once the plant is commissioned this water would be progressively used during ore processing operations. It is expected that temporary water storage cells would be emptied in Year 1.

Potential Impacts

The potential impacts associated with pit dewatering activities are:

- Drawdown effects associated with dewatering over the life of mine;
- Changes to the hydrogeological regime; and
- Disposal of highly saline extracted groundwater.

Mitigation Measures

Once dewatering commences and the pit is excavated, the pit would become a groundwater sink. Coffey Partners International (1995a) have modelled this situation in order to determine the dewatering requirements and have

calculated the potentiometric surface drawdown created in the shallow and deeper alluvium and fractured bedrock aquifers. The modelling results indicate drawdowns after several years of continuous pumping at a distance of 10 km east of the pit, of less than 1 m in the shallow alluvium aquifers and 3 m in the fractured rock aquifer. There are no registered groundwater users within 10 km of the mine site. This water is highly saline and would not be used for dust suppression on areas where soils are to be revegetated.

Figure 4-2 shows the predicted groundwater flow direction towards the pit. It is expected that these flow directions would be maintained during mining and post-closure as the water level in the pit recovers and reaches an equilibrium level well below the full storage level in the Lake.

As discussed in Appendix F, hydrological modelling indicates the void would take a considerable period of time to fill to a final level (in the order of a hundred years). The rate of filling is expected to be relatively rapid initially and decline as the water level in the pit approaches the long-term steady state level. Consequently, the flow system directions shown in Figure 4-2 would be maintained, although the gradients and consequently the flow rates are expected to decrease over time. The final void would, however, remain as a groundwater sink even under unfavourably wet climatic conditions.

The long term compatibility of the partly filled final void is discussed in detail in Appendix N.

Monitoring of local and regional groundwater levels would be undertaken during development of the open pit to assess the impacts of dewatering activities on the area's hydrogeological regime.

The performance and workability of the proposed strategy for managing extracted groundwater prior to plant commissioning has been assessed using a water balance simulation model (Appendix F). The model was set-up to simulate the first 18 month period prior to plant commissioning under a range of climatic, operational and dewatering rate scenarios. The modelling indicates that all groundwater dewatered during the construction phase would be effectively consumed in the processing plant during the first 6 to 18 months after commissioning.

4.2.4 Groundwater – Bland Creek Palaeochannel Borefield

Additional make-up water would need to be supplied from four production bores located within the Bland Creek Palaeochannel (Section 2.8). Groundwater investigations have been undertaken to assess the effects of the proposed extraction on groundwater flows and piezometric levels (Coffey Partners International, 1995b).

As shown in Figure 3-6, the Bland Creek Palaeochannel consists of an alluvial sequence subdivided into an upper and lower zone (Williams, 1988; Coffey Partners International, 1995b). The upper zone ranges from 95 to 133 m thick (in the area of the proposed borefield) and consists of a shallow brown clay unit with infrequent, discrete sand lenses. Aquifers within the upper zone are usually of limited lateral extent, have relatively low yields and high salinities. The lower zone sediments are located within the deep sections of the Bland Creek Palaeochannel. Aquifers in this zone are generally high yielding with low salinities. The proposed borefield would target the lower zone aquifers.

Potential Impacts

The groundwater resource contained within the Bland Creek Palaeochannel is currently partially utilised by landholders in the area for irrigation and stock watering purposes. The closest two irrigation bores to the proposed borefield are located approximately 20 km to the south. Groundwater modelling of drawdown affects indicates levels in these irrigation bores may fall by an estimated 7.5 m after several years of continuous pumping (Coffey Partners International, 1995b).

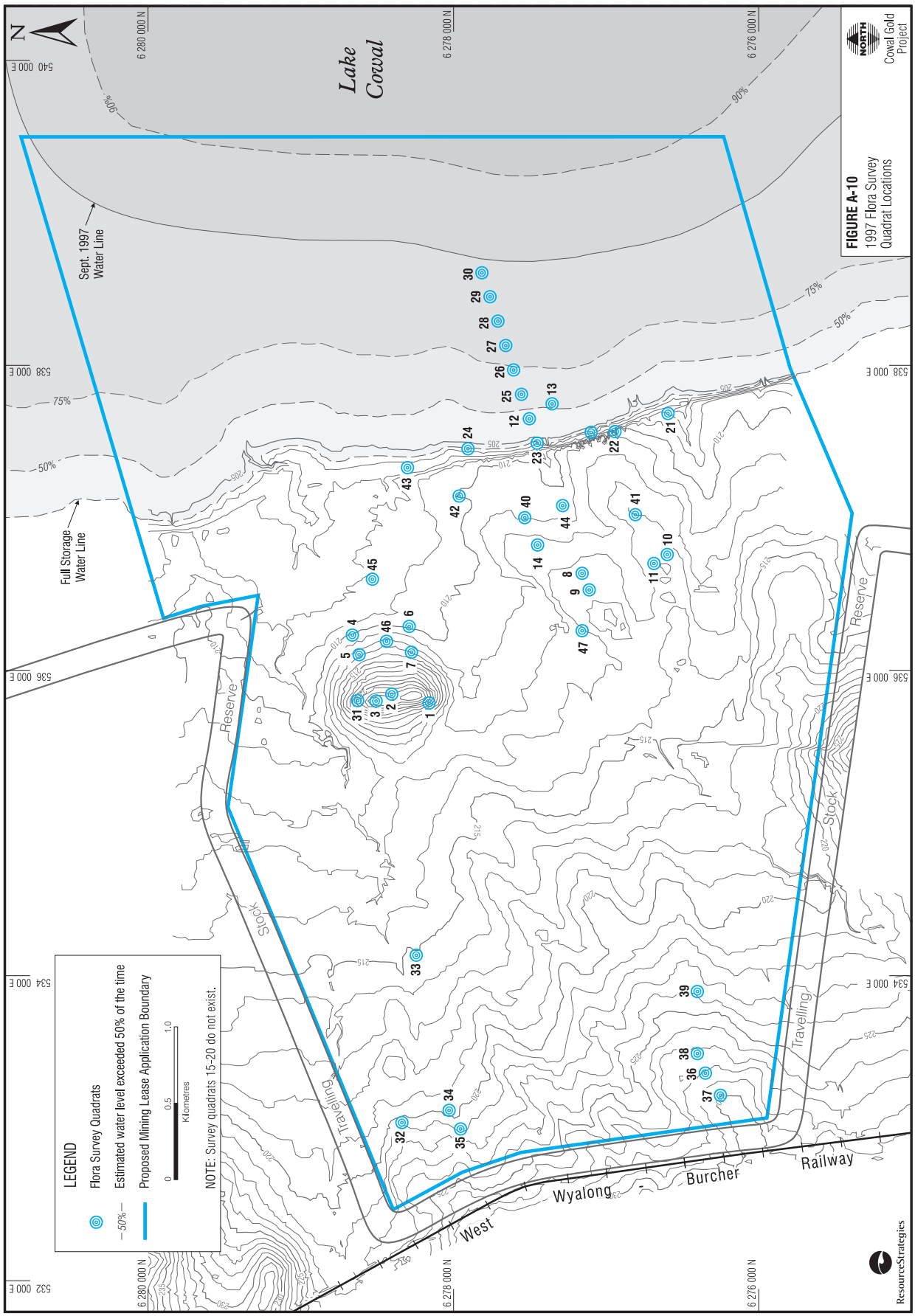
Registered stock watering bores are located to the south of the proposed borefield, within and external to the Bland Creek Palaeochannel (Figure 4-3). The closest bores (29574, 29575 and 31341) occur between 2 and 5 km outside the eastern boundary of the palaeochannel and at least 10 km from the nearest proposed production bore. Potential drawdown effects on bores outside the palaeochannel are not expected to be significant, but would be monitored during extraction using a network of monitoring (observation) piezometers.

Two registered stock watering bores are located to the south of the proposed borefield within the Bland Creek Palaeochannel (31122 and 33243). The bores are located near the eastern edge of the palaeochannel boundary. Groundwater modelling for these bores (Coffey Partners International, 1995b) indicates potential drawdowns in these bores of approximately 7 m.

Mitigation Measures

The priority in which the Project water supply would be drawn from the various sources is indicated on Figure 2-15. Groundwater from the Bland Creek Palaeochannel has the lowest priority and would be used where make-up water from all other on-site sources (ie tailings decant, pit dewatering, and reuse of site runoff captured in the various site collection storages) is inadequate. During mining operations there may be periods where minimal or no water is extracted from the borefield.

In order to monitor the predicted groundwater drawdowns, monitoring (observation) piezometers would be installed within and adjacent to the Bland Creek Palaeochannel. Approximate locations are indicated on Figure 4-3. The actual number and location of the monitoring piezometers would be determined in consultation with the relevant government authorities. In the event that disruption to the efficiency of the closest irrigation bores occurs (Section 4.2.4), North have undertaken to implement ameliorative measures (eg. bore reconditioning, pump lowering and/or refitting).


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
FIGURE A-10
1997 Flora Survey Quadrat Locations
NORTH
Cowal Gold Project
LEGEND
Flora Survey Quadrats
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
NOTE: Survey quadrats 15-20 do not exist.
Reserve
Stock
Travelling
Wyalong West
Burcher
Railway
ResourceStrategies
NOC-97-03_FF-002C.CDR

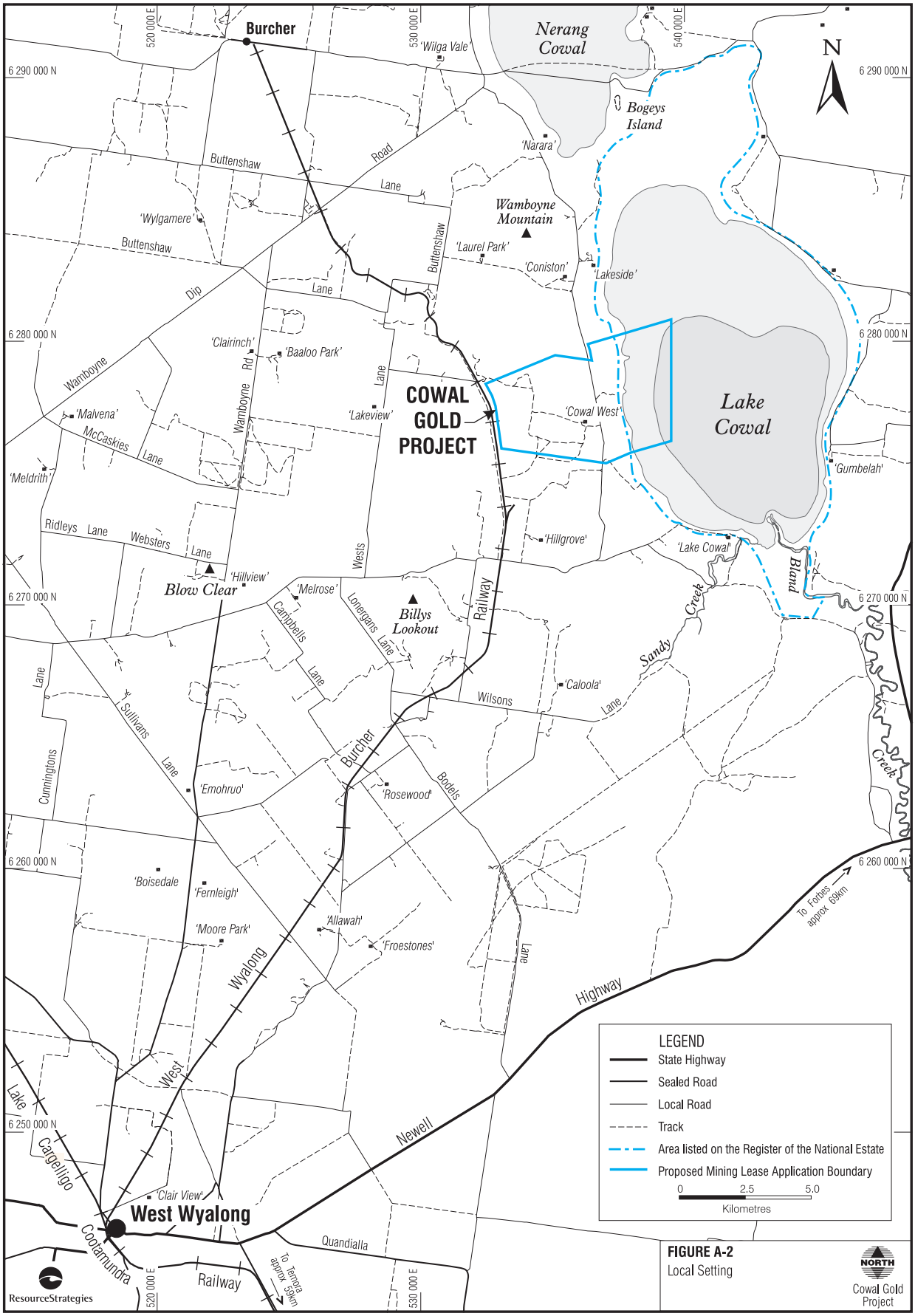


FIGURE A-2
Local Setting

Cowal Gold Project

NOC-97-03_FF-007C.CDR

4.2.5 Tailings Storage – Leachate Quality Control

The tailings storage is located 3.5 km west of the Lake shoreline. Section 2.7 describes the design, construction and function of the storage. The potential impacts on both surface and groundwaters within the area of the tailings storage could result from:

- incident rainfall runoff from the external embankments;
- seepage;
- overtopping and spillage of surface water; and
- rupture and spillage from either the tailings delivery or return water pipelines.

These potential impacts are described in more detail below.

Potential Impacts Due to Rainfall Runoff

The design of the tailings storage embankments is described in Section 2.7.3. The embankments would consist of two zones: a structural zone and a downstream (outer) rehabilitated zone. Without the implementation of appropriate mitigation measures (erosion and sedimentation control and progressive rehabilitation) runoff from the tailings embankments and adjacent disturbed areas has the potential to increase sediment loading down-gradient of the facilities. During construction, vegetation clearing and soil stripping within the footprint of the proposed storage area would create significant, temporary disturbance.

Mitigation Measures

The mitigation measures to reduce potential erosion and sediment transport from disturbed areas are described in Sections 2.9, 4.1.2 and Appendix F. Watering of exposed surfaces during construction activities may also be used to reduce dust and sediment mobilisation. The construction of the toe drain and containment bund (Figure 2-13) would be used to capture any sediment-laden runoff and direct it to the decant pond.

The progressive rehabilitation strategy of the tailings storage is described in Section 5. Once the outer batters are rehabilitated and stabilised, it is anticipated that any runoff would be of comparable quality to runoff from surrounding undisturbed areas. During the life of the mine, these areas would only be grassed so that they provide minimal habitat for wildlife.

Potential Impacts Due to Seepage from the Tailings Storage

Seepage is defined as the fluid that moves beyond the underdrainage network/decant tower and compacted floor of the tailings storage. Seepage can either appear at the surface downstream of a tailings storage or remain beneath the ground.

A detailed account of the geochemical characterisation of mine waste (including tailings) is presented in Appendix C. Geochemical characterisation has been conducted on oxide and primary flotation/concentrate recombined tailings. The characterisation included an evaluation of the acid forming potential, assessment of trace element concentration/solubility and cyanide chemistry in the tailings liquor (ie. cyanide speciation and decay characteristics).

In summary, oxide and primary tailings were both classified as non-acid forming. Leach columns used to assess the long term leaching behaviour and seepage chemistry of the tailings indicate sulphate salts may be generated following deposition. It is expected that the tailings pore water and ponded surface water (containing any generated salts, metals and residual cyanide forms) would be captured by the tailings underdrainage network and decant tower for recycling in the processing plant.

In order to assess the potential for seepage migration from the tailings storages (ie waters not collected by the underdrainage network and decant tower) detailed analyses and modelling have been undertaken (Appendix N). These analyses indicate that limited seepage would occur through the storage floor. Any seepage flow entering the underlying highly saline aquifers (during mining operations and for a limited time, post-closure) would be permanently diverted to flow towards the final void. Modelling indicates (Appendix N) that this seepage would move very slowly and would not reach the open pit during the operating life of the Project.

As discussed in Appendix N, any residual contaminants which enter the groundwater system below the tailings storage are expected to either be immobilised or substantially reduced in concentration near the base of the storage. It is anticipated that arsenic and zinc would effectively be immobilised in the soil profile. The groundwater modelling indicates residual cyanide concentrations would be reduced by a factor of one thousand (to negligible levels) near the base of the tailings storage.

In summary, any limited seepage from the tailings storages is likely to have a negligible impact on existing groundwater levels or quality and would migrate slowly towards the final void (Appendix N). Within some 30-40 years following Project closure, the tailings storages would be essentially de-saturated and measurable seepage through the floor would cease.

Mitigation Measures

The proposed seepage control methods for the tailings storage are described in Section 2.7.4 and summarised below:

- pre-stripping of soils beneath the embankment foot print;
- construction of a moisture-conditioned and compacted-to-low-permeability storage floor; and
- installation of an under-drainage and decant network.

The implementation of these control methods is designed to provide a physical control barrier to prevent seepage from the tailings storage area. The geochemical properties of the foundation layer provide further control of potential impacts on water quality (Appendix N).

The potential mechanisms by which this may occur are:

- consolidation of tailings materials above the clay blanket to reduce permeability; and
- adsorption of tailings chemicals onto clay colloids within the foundation layer and pre-existing subsoils beneath the storage.

The proposed rehabilitation and water monitoring strategies for the tailings storage and waste emplacements (described in Sections 5 and 6) have been designed to facilitate long term restoration of mine landforms, including the management of any seepage issues.

Potential Impacts Due to Surface Water Spillage

As described in Section 2.7.1, the proposed subaerial tailings depositional technique would promote the segregation of the coarse fraction on the perimeter and finer fraction towards the centre of the storage. As a result, the surface of the tailings storages would be conical in shape, sloping from the outer perimeter in to the decant area near the centre of each storage. The conical shape provides the opportunity for significant internal storage before spill/run-off occurs.

Mitigation Measures

The tailings storage has been designed with sufficient freeboard (ie. extra embankment height) to store excess water generated from the contingency rainfall event, which has been set at 1 in 1,000 year ARI (Appendix F). The required freeboard would be maintained during the Project life as the storage fills with tailings via a series of embankment lifts. As described in Section 2.9 and Appendix F, an Up catchment Diversion System would be constructed (Figure 2-17) to divert run-off from the catchment area west of the storages to the two drainage lines which flank both the northern and southern sides of the proposed MLA. The water management system also provides additional security by directing and containing all spilt waters within the contained internal catchment system which flows ultimately to the open pit (Appendix F).

Potential Impacts Due to Pipe Rupture

Potential exists for some tailings loss due to the failure (rupture) of the pipes or pumps that transfer the tailings to the storage. These potential losses may result in the contamination of land (Section 4.1.7) and/or water quality in the area of the rupture.

Mitigation Measures

The tailings delivery and return water lines would be contained within a bunded pipeline corridor that would run parallel to the service corridor between the processing plant and tailings storage (Figure 2-1). This bunded corridor would serve to contain any potential for losses or spills in the event of pipe rupture. Regular routine pipeline inspections as well as an automatic, pressure activated shut-down mechanism would be provided on tailings/process water reticulation systems to enable the early detection and stoppage of significant leaks or failures. In the event that spillage does occur within the bunded area, the affected area would be ameliorated in accordance with the procedures contained in the Hazardous Waste and Chemical Management Plan (Section 6). The bunded area drains back to the process plant.

4.2.6 Waste Dumps – Leachate Quality Control

Potential Impacts

Although the waste characterisation assessment conducted for the Project (Appendix C) has predicted waste rock would be non-acid forming, the potential for saline seepage occurring was identified. Saline seepage and sediment mobilisation from the mine waste emplacements could, if uncontrolled, impact downstream water resources.

Mitigation Measures

As described in Section 2.5.3 and Appendix F, the existing basal contours in the northern and southern waste emplacement areas are such that infiltrating rainfall would tend to appear along the outer perimeters if waste rock were to be placed directly on the existing land surface. This situation is contrary to the design objective of hydrological isolation of the mine site. Therefore, it is proposed to reverse the grade of the emplacement floor by a combination of sub-excavation, (to recover suitable soils for eventual rehabilitation of the completed waste emplacement), and construction of a lower permeability basal layer that would slope toward the mine pit area (Figure 2-9.)

Any infiltration generated within the emplacements would be directed by the basal layer towards the open pit where it would either be collected within dedicated storages for reuse in the processing plant (during operations) or report directly to the final void (post-closure).

4.3 Flora

4.3.1 Removal/Modification of Existing Vegetation

Detailed discussion of the potential impacts of the proposed development on the botanical status of the Project area and surrounds, and associated mitigation measures, is contained in the Species Impact Statement (SIS) (Appendix A). A summary of the relevant principal findings of the SIS is presented below.

Clearing has been the most obvious change to native vegetation in the region however several other processes have had effects on the vegetation assemblages. These processes include grazing of native shrub and grass species by domestic stock and feral grazers; weed incursion and introduction of exotic species; alterations to pre-settlement fire regimes; modification and pollution of waterways; increased use of pesticides and fertilisers; and isolation of portions of remnant vegetation (Adamson and Fox, 1982; Goldney and Bowie, 1990; Sivertsen and Metcalfe, 1995). Mining, rural settlement and forestry have also contributed to vegetation change in the region (Adamson and Fox, 1982).

Similarly, a number of State Forests and private woodlots in the region were actively managed to encourage growth of some species (eg. Callitris glaucophylla) and the clearance of

other native species (eg. *Eucalyptus populnea* subsp. *bimbil*) (Sivertsen and Metcalfe, 1995).

The proposed development of the Cowal Gold Project would entail disturbance of approximately 940 ha. Discussion of the potential impacts of the Project on native vegetation and weeds, as well as appropriate mitigation measures, is provided below.

4.3.2 Native Vegetation

Potential Impacts

Botanical survey and assessment of the Project area and surrounds (Anne Clements & Associates, 1995, 1996; Charles Sturt University, 1997; Bower, 1997) identified the presence of nine main vegetation communities.

Community 1 Remnant Woodland (*Eucalyptus dwyeri – Acacia doratoxylon – Callitris endlicheri*)

This community occurs on high exposed ridges with shallow soils, generally as scattered, unconnected islands (Bower, 1997). This community type does not occur within the proposed MLA area and no examples of it are likely to be affected by the proposed development (*ibid.*).

Community 2 Eucalypt Woodland (*E. dwyeri – E. populnea – E. microcarpa – Callitris glaucophylla – Casuarina cristata*)

Occurring mainly on well-drained sloping country and low ridges, this community is prominent on Cowal West Hill within the proposed MLA area. The proposal would entail removal of approximately 35 ha (ie. 70%) of this community type, within the proposed MLA area.

Community 3 Predominantly Cleared Agricultural Land in the Scattered Bimble Box Woodland (*Eucalyptus populnea*)

A major plant community of the south-western slopes region, it dominates the upper strata of the flatter landscapes that have largely been cleared for agriculture. Within the proposed MLA, approximately 700 ha (approximately 47%) of this community type would be removed/modified as a result of the proposed development.

Community 4 Fringing River Red Gum (*Eucalyptus camaldulensis*)

Remaining tracts of this community are generally restricted to narrow riparian strips associated with the margins of watercourses and the Lake. In the proposed MLA boundary this community occurs as a relatively degraded thin strip along the Lake high water mark. The Project would necessitate removal of approximately 20 ha (approximately 40%) of this strip.

Community 5 Lignum (*Muehlenbeckia florulenta*)

Dense thickets of Lignum occur primarily in the northern portion of Lake Cowal. No significant clumps of Lignum would be removed/modified as a result of the proposed works.

Community 6 Lakebed (*Medicago polymorpha – Eragrostis australasica*)

The proposed development, *viz.* the open pit and waste emplacement areas, would entail the removal of approximately 100 ha (approximately 11%) of this community type from the proposed MLA area.

Community 7 Mixed Woodland (*Acacia pendula – Casuarina cristata*)

This community occurs mainly on the alluvial flats and Belah (*Casuarina cristata*) is commonly the dominant associate. The proposal would entail removal of approximately 50 ha (approximately 70%) of this community type from the proposed MLA area.

Community 8 Wilga Woodland (*Geijera parviflora – Casuarina cristata*)

Reaching its optimum density on alluvial gilgai soils and other heavy soils on flats and lower slopes, Wilga (*G. parviflora*) is widespread in the area. The proposed development *viz.* the tailings storages and drainage works would entail the removal of approximately 35 ha (approximately 60%) of this community type from the proposed MLA area.

Community 9 Belah Woodland (*Casuarina cristata*)

Casuarina cristata is a common associate of many vegetation communities in the region, occurring primarily on drainage-impeded gilgai areas on grey soils. Occurring in the south of the proposed MLA area, the proposed development would entail the removal of approximately 1 ha (approximately 3%) of this community type from the proposed MLA area.

Mitigation Measures

The Project requires the removal of vegetation. Where possible remnant vegetation would be left in place. In addition new landforms would be progressively rehabilitated.

The Project area would be rehabilitated by revegetating the new landforms with selected communities of endemic vegetation that are both suitable to the physiographic and hydrological features of each landform, whilst expanding the areas of remnant endemic vegetation that currently exist in the immediate region.

It is proposed that regional seed collecting programs would commence in the construction phase, to allow sufficient time to commence rehabilitation of the new Lake foreshore at the completion of foreshore reconstruction activities. The intention is to improve the status of endemic remnant vegetation in the region.

Details of the proposed rehabilitation are presented in Section 5 of the EIS and Section 7 of the SIS. There would be a focus on using subject flora species in the species mix of the rehabilitated landforms. Mitigation measures pertinent to the individual vegetation communities identified from the Project area and surrounds are presented below.

Detailed description of the understorey species to be used in the rehabilitation programme and commonly associated with the following vegetation types are presented in Section 5.

Community 1 Remnant Woodland (*Eucalyptus dwyeri – Acacia doratoxylon – Callitris endlicheri*)

Although this community type does not occur within the proposed MLA area, *Acacia doratoxylon* and *Callitris endlicheri* are associated with hilltops, elevated lands, low ridges and hills in the region and therefore may be used in revegetation of the tailings waste emplacements, Cowal West Hill and upper slopes of new landforms. Hence the expanse of this community would be increased in the region.

Community 2 Eucalypt Woodland (*E. dwyeri – E. populnea – E. microcarpa – Callitris glaucophylla – Casuarina cristata*)

This community type would be used to revegetate the footslopes of Cowal West Hill and the waste emplacement batters and surrounds. *Casuarina cristata* and *E. microcarpa* would also be used to revegetate areas fringing the Lake and drainage lines. Following revegetation of the Project area, this community would be of greater extent than prior to the development.

Community 3 Predominantly Cleared Agricultural Land with Scattered Bimble Box Woodland (*Eucalyptus populnea*)

E. populnea would be planted on the Cowal West Hill footslopes and the waste emplacement batters and surrounds.

Community 4 Fringing River Red Gum (*Eucalyptus camaldulensis*)

Revegetation of the fringing areas of the Lake and drainage lines with River Red Gums would ensure that the trees removed at the beginning of the development are replaced in greater numbers.

Community 5 Lignum (*Muehlenbeckia florulenta*)

Lignum would predominantly be planted along the Lake foreshore. Lignum may also be utilised in revegetation of fringing areas of the Lake and along drainage lines. A considerable quantity of Lignum (compared to the amount that presently exists) would be established in the proposed MLA area.

Community 6 Lakebed (*Medicago polymorpha – Eragrostis australasica*)

Revegetation of the Lakebed is detailed in Section 5 (and Section 7 of the SIS). The freshwater communities of Lake Cowal can be divided into 4 types of zones, *viz.* flood zone, littoral zone, rush zone and permanent water zone. The Lakebed would be revegetated with species such as Lignum and Burr Medic (flood zone), Canegrass and White Water Lily (littoral zone), Cumbungi and Rush (rush zone), Foxtail and Pond Weed (permanent water zone). It is expected that a wide variety of aquatic floral communities would establish in the absence of significant competition for Lake landuses (eg. grazing, cropping).

Community 7 Mixed Woodland (*Acacia pendula – Casuarina cristata*)

This vegetation type would be used to revegetate the waste emplacement batters, Cowal West Hill footslopes and surrounds (Figure A-17, Section 7). *Casuarina cristata* would also be planted on areas fringing the Lake and on drainage lines.

Community 8 Wilga Woodland (*Geijera parviflora – Casuarina cristata*)

Wilga and Belah would be incorporated into revegetation of the Cowal West footslopes, waste emplacements and surrounds. Belah would also be used to revegetate areas fringing the Lake and on drainage lines.

Community 9 Belah Woodland (*Casuarina cristata*)

Revegetation of the fringing areas of the Lake and drainage lines with *Casuarina cristata* would ensure that this community would be of greater extent than prior to the development.

4.3.3 Weeds

Potential Impacts

During the 1993 botanical survey of the Project area and surrounds (Anne Clements and Associates, 1995), a total of 411 species were recorded composed of approximately 21% weed species (Charles Sturt University, 1997).

The 1997 survey of the Project area (*viz.* the proposed major disturbance areas) recorded 141 plants of which around 30% were weeds (*ibid.*).

Five species recorded during the 1993 survey were listed as noxious on the Bland Shire Noxious Weeds list. However only one of these species, African Blackthorn (*Lycium ferocissimum*), was recorded from within the proposed MLA (*ibid.*). This species was not recorded during the 1997 survey.

The presence and possible introduction of noxious weed species poses a potential threat to native plant species, by reducing floristic structure and diversity.

Disturbance, such as those associated with mining activities, can act as a catalyst for weed incursion and if management initiatives are not enacted, proliferation of weeds can occur.

Mitigation Measures

Weed infestations can be very difficult to control and therefore emphasis should be placed on prevention rather than cure. A control program would be implemented in consultation with appropriate advisory bodies such as the Department of Agriculture, Bland Shire Council and Rural Lands Protection Board to control or remove existing weed species and to limit the potential for their reintroduction on the proposed MLA. The spread of weeds would be monitored and reported annually.

4.3.4 Threatened Flora Species of the Lake Cowal Region

In accordance with the requirements of Section 5A of the *Environmental Planning and Assessment Act* (as amended), an 8 Part Test of Significance report was prepared for eleven threatened flora species (Bower, 1997). The plant species list assessed was compiled in consultation with the NSW NPWS Threatened Species Unit (Western Division) and Charles Sturt University (1997) based on habitat requirements and distribution records (Table 4-4).

The 8 Part Test was submitted to the NSW Department of Urban Affairs and Planning (DUAP) and the NPWS on the 13 October 1997 and concluded that based on the information at hand at the time, the proposed development is unlikely to have a significant effect on any threatened flora, species, populations or ecological communities or their habitats. A summary of the 8 Part Test findings are presented in Table 4-4.

Based on the information contained in Section 5A, 8 Part Test report (Bower, 1997) and pursuant to the requirements of the Director-General of the NSW NPWS (Appendix A, Attachment A-1) two threatened plant species, the Austral Pillwort (*Pilularia novae-hollandiae*) and Winged Peppercress (*Lepidium monoplocoides*), have been considered in the Species Impact Statement (Appendix A) for the proposed development.

A discussion of the primary ecological components of these species is presented in the Species Impact Statement (Appendix A). Section 4.1-4.3 details those primary potential impacts that could occur as a result of the proposed development of the Cowal Gold Project. Specific, species-related potential impacts of the Project and associated mitigation measures are detailed in Appendix A and summarised below.

Table 4-4 Threatened Flora Species of the Lake Cowal Region

Scientific Name	Occurrence of Potential Habitat in the Project Area	Potential for Project to Impact on Species' Population Status
Bothriochloa biloba	3-4	C-D
Callitriche cyclocarpa	3-4	C-D
Goodenia macbarronii	3-4	C-D
Kippistia suaedifolia	4	D
Lepidium aschersonii	4	D
Pilularia novae-hollandiae	2	B
Stemmacantha australis	4	D
Stipa wakoolica	4	D
Swainsona murrayana	4	D
Swainsona recta	4	D
Tylophora linearis	3-4	C-D

Legend:

Occurrence of Potential Habitat in the Project Area
1 Significant habitat resources present 2 Moderate habitat resources present
3 Marginal habitat resources present 4 Minimal or no habitat resources present

Potential for Project to Impact on Species' Population Status
A Significant impact potential B Moderate impact potential
C Marginal impact potential D Minimal or no impact potential

Austral Pillwort (*Pilularia novae-hollandiae*)

Potential Impacts

In relation to the proposed development, potential impacts to the Austral Pillwort are likely to be from loss of potential habitat areas (ie. portions of the Lake foreshore and gilgai land).

Mitigation Measures

Potential mitigation measures are likely to be limited by the habitat requirements of this species (that is the ephemeral nature of *P. novae-hollandiae*). However the embayments and foreshore areas subject to flooding and drying, that are proposed to be created as a component of the rehabilitation works, may offer habitat opportunities for this species. Advice would be sought from appropriate sources regarding establishment of this species in these zones when they are created. Rehabilitation of these areas would be progressive.

Winged Peppercress (*Lepidium monoplocoides*)

Potential Impacts

The population decline of this species is most likely attributable to past and on-going effects of grazing by domestic stock, Rabbits, increased numbers of Kangaroos and land clearing for agriculture (largely cereal cropping) (Leigh *et al.*, 1984; Ayers *et al.*, 1996).

The Project could potentially threaten this plant by clearing potential habitat areas and if grazing is to be a component on final landuse objectives, grazing may reduce prospects of this plant colonising within the proposed MLA area. It is noted that this genus is highly palatable to stock (Bower, pers. comm., 1997).

Mitigation Measures

Little detailed information exists on the habitat requirements of this species, however collections of this species from the western NSW region have been found primarily in Bimble Box communities. Subject to availability and to advice from recognised authorities, *L. monoplocoides* would be incorporated into the species mix to be developed for the Bimble Box communities revegetation.

4.4 Fauna

A precis of the potential impacts of the proposed development on fauna at the Project area and surrounds and mitigation measures is presented below. For further discussion of the potential impacts of the Project refer to the SIS (Appendix A).

4.4.1 Removal/Modification of Existing Habitat

Potential impacts generally associated with the removal and/or modification of areas of habitat relate to loss of resources that contribute to the lifecycle components of an array of fauna (ie. breeding, foraging, dispersal etc.). Potential impacts associated with disturbance of the Project area habitats are detailed below.

Potential Impacts

Lakebed

As previously noted, the Lakebed habitat area could potentially afford habitat (breeding and foraging) opportunities for amphibians, birds and small and large mammals such as macropods and microchiropteran bats. Notwithstanding the diminished potential habitat value of this area, any habitat resources presently available for fauna within the lakebed disturbance area, would be lost as a result of the proposed development and the removal of approximately 100 ha of this habitat type.

In addition, were this habitat area to be used as a movement resource, the proposed open pit works could impact on the behaviour patterns of dispersing species.

Riparian Zone

This habitat area comprises a narrow riparian strip of River Red Gum (*E. camaldulensis*), that has been substantially thinned as a result of past land uses.

In a study of River Red Gums and waterbird nesting (Briggs and Thornton, 1995), it was found that the River Red Gum wetlands such as those of the middle and lower Murrumbidgee River support large numbers of breeding waterbirds (Maher, 1990; Magrath, 1992), *viz.* Pelecaniformes and Ciconiiformes (Briggs and Thornton, 1995).

While the River Red Gum riparian habitat at the Project area has undergone degradation in recent years, any inherent habitat values associated those trees in the proposed disturbance area (ie. nesting resources for birds such as Cormorants, Herons, Darters, Egrets and Spoonbills), would be lost as a consequence of clearance of approximately 20 ha of this habitat type.

Greg Richards and Associates (1997a) notes that loss of hollow-bearing trees could infer a loss of potential roost habitat for bats such as Yellow-bellied Sheathtail Bat (*Saccolaimus flaviventris*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Greater Long-eared Bat (*Nyctophilus timoriensis*) and Inland Forest Bat (*Vespadelus baverstocki*).

Cleared Land with Scattered Woodland

This habitat type characterises the greater majority of the Lake Cowal region. A relict of past and present land use, this habitat is composed of numerous (and typically small) fragmented areas of woodland amidst large expanses of predominantly cleared grazing land.

Habitat values of this area relate principally to potential breeding, nesting, roosting, foraging and dispersal resources for mobile fauna (eg. bats, birds) as well as isolated potential habitat areas for amphibians and reptiles (ie. moister gilgai areas). Removal of approximately 700 ha (47%) of this habitat type from within the proposed MLA would entail loss of this potential habitat resource.

Vegetated Slopes

Approximately 35 ha of this habitat type would be removed as a consequence of the proposed development.

Fragmentation of native vegetation into numerous disjunct patches (ie. with varying degrees of connectivity), has probably been responsible for a decline in the range and/or abundance of a number of species that are known to inhabit woodland vegetation (Saunders, 1993).

Based on studies undertaken on the *Effect of Habitat Fragmentation on Regional Bird Populations: Lessons from the Western Australian Wheatbelt* (Saunders, 1993), it has been determined that selective clearance of woodland areas can result in an overall reduction of bird species diversity. Birds such as Tree-creepers, Honeyeaters and Lorikeets that are dependent on woodland can be adversely affected by loss of nest sites and food resources.

Mitigation Measures

Rehabilitation of the Project area would result in expansion of habitat opportunities for wetland and terrestrial fauna species, primarily due to the establishment of a greater extent of endemic vegetation. Progressive rehabilitation would ensure that these habitat opportunities would be created soon after construction ceases, in particular along the reconstructed foreshore. A greater diversity of habitat types would become available (possibly increasing species diversity) and the extent of habitats would increase. Rehabilitation measures are outlined in Section 5. Section 8 of the SIS provides an assessment of the long term compatibility of the development in regard to terrestrial and wetland habitats.

Across all the habitat types, any hollow-bearing trees would be inspected by suitably qualified personnel prior to clearance.

4.4.2 Threatened Fauna Species of the Lake Cowal Region

In compiling a threatened fauna species list for the Project area, a list of all fauna species known or considered likely to occur in the area was prepared (Table 3-10). From this list a preliminary threatened fauna species list was compiled (Table 4-5) which contained 43 species comprising one amphibian, two reptiles, 14 mammals and 28 birds. Using information from numerous databases and in consultation with the NSW National Parks and Wildlife Service, a specialist team from the Commonwealth Scientific Research Organisation (CSIRO) and Greg Richards and Associates, a revised threatened fauna species list for the subject area was determined.

In consideration of a host of factors such as habitat requirements, essential behavioural patterns and distribution records, the revised threatened fauna species list for the Lake Cowal region included all of the species contained on the list with the exception of the following three birds: Plains-wanderer (*Pedionomus torquatus*), Grey Ternlet (*Procelsterna cerulea*) and Masked Owl (*Tyto novaehollandiae*). Given the nature of land use in the Lake Cowal region and hence the highly degraded status of any potential habitat for this species, coupled with the prevalence of predatory species and the effects of the grazing, it was considered that the Plains-wanderer was unlikely to occur in the region.

Table 3-10 (a list of all fauna known or considered likely to occur in the Lake Cowal area) contains species that are considered to be unrealistic vagrants and possibly some misidentified species. This is likely to be the case for the Grey Ternlet which is an oceanic species (Simpson and Day, 1996) and may possibly have been confused with the number of Terns recorded from the area (eg. Gull-billed Tern, Caspian Tern, Whiskered Tern, White-winged Black Tern).

Given the essential habitat components and distribution records of the Masked Owl, it was concluded that this species was unlikely to occur in the assessment area. Further discussion on the threatened species of the Project area and surrounds is presented in the Species Impact Statement (Appendix A).

In addition two threatened microchiropteran bats (Large Bentwing-bat and Inland Forest Bat) were added following a review of a bat record database for the area (Greg Richards & Associates, 1997b).

Using the threatened fauna species list for the area the factors contained in Section 5A (ie. 8 Part Test of Significance) were addressed (Resource Strategies *et al.,* 1997a). The 8 Part Test report was submitted to DUAP and NPWS on the 13 October 1997.

Table 4-5 summarises the potential for the Project to impact upon species' population status. Based on the information at hand at the time, the key findings of the 8 Part Test assessment were as follows:

- No local viable populations of threatened fauna species would be likely to be placed at risk of extinction. The proposal is predicted to result in the loss of minor areas of potential forage/habitat primarily associated with small remnant woodland areas, open disturbed grassed land including the area subject to inundation, as well as the ecotone transitional zones. This loss would not be considered to be significant in terms of the availability of eminently more suitable habitat in the immediate locality and wider region.
- In relation to the regional distribution of the habitat of a threatened species, it was considered unlikely that a significant area of known habitat would be modified/ removed as a result of the proposal. Certain species known to occur in the locality may potentially occur at the site. It was considered that the proposed works would not constitute a significant adverse impact on local populations of any of these species subject to the findings of other specialist assessments, currently in hand, including operational phase components such as air quality, acoustics and tailings storages management. Relevant post-operational assessment focuses on final void status. This is based on the prevalence of areas of more suitable habitat to the north and north-east and (to a lesser extent) south of the proposed MLA area, the relative mobility of many species and the high level of disturbance across much of the Project site which has effectively reduced the potential value of the site as a habitat resource.
- Given the existing ecological condition of the Project area, the proposed development would be unlikely to alienate movement corridors or limit dispersal options for any local viable threatened species population and it would be unlikely that an area of known habitat for any threatened species would be likely to become isolated from currently interconnecting or proximate areas of habitat. Extensive rehabilitation of the Project site would aim to provide a means for the creation, enhancement and embellishment of linking corridors to potentially allow for linear genetic exchange between fauna populations occurring in the area.
- For a selected number of species (six bird and three bat species) the currently available information was inconclusive with respect to potential or identified impacts and Director's Requirements for an SIS were requested (Appendix A, Attachment A-1).

Accordingly the Director-General of the NPWS requires that the following fauna species in Table 4-6 be addressed in the Species Impact Statement.

A discussion of the primary ecological components of these species is presented in the Species Impact Statement (Appendix A). Section 4.1-4.4 details those primary potential impacts that could occur as a result of the proposed development of the Cowal Gold Project. Specific, species-related potential impacts of the Project and associated mitigation measures are present in Appendix A and summarised below.

Blue-billed Duck (*Oxyura australis*)

Potential Impacts

Changes to the hydrology of the Lake, such as intrusion of saline groundwater and water extraction, could potentially result in losses of wetland vegetation thus reducing breeding, foraging and roosting opportunities for this species.

The lakebed habitat area could potentially afford foraging opportunities for the Blue-billed Duck. However, given that Blue-billed Ducks are secretive birds and prefer dense vegetation, it is considered that the open and cleared nature of the Project area lakeshore would limit the area as a forage habitat.

Based on the breeding/foraging requirements of this species, the Project area is not considered to offer suitable habitat resources.

Mitigation Measures

Potential hydrological impacts of the proposed development and associated mitigation measures are summarised in Section 4.2. Final void status and amelioration is described in Section 4.1.5. Creation of areas potentially suitable as foraging and nesting habitat for the Blue-billed Duck (such as dense vegetation on the reconstructed foreshore) would further mitigate any potential impacts on local populations of this species as a result of the proposed development.

A variety of monitoring programmes (noise, air quality waterbird abundance and diversity) will also be undertaken at the Project area and surrounds.

Table 4-5 Threatened Fauna Species of the Lake Cowal Region

Common Names	Scientific Names	Occurrence of Potential Habitat (Breeding, Foraging, Roosting) in the Project Area	Potential for Project to Impact on Species' Population Status
Amphibians and reptiles			
Southern Bell Frog	*Litoria raniformis* (Keferstein)	3-4	D
Pink-tailed Worm-lizard	*Aprasia parapulchella* (Kluge)	3-4	D
South-eastern Lined Earless Dragon	*Tympanocryptis lineata pinguicolla* (Mitchell)	3-4	D
Birds			
Malleefowl	*Leipoa ocellata* (Gould)	4	D
Magpie Goose	*Anseranas semipalmata* (Latham)	3	C
Blue-billed Duck	*Oxyura australis* (Gould)	2-3	B-C
Freckled Duck	*Stictonetta naevosa* (Gould)	2	B
Australasian Bittern	*Botaurus poiciloptilus* (Wagler)	3-4	C-D
Black-necked Stork	*Ephippiorhynchus asiaticus* (Latham)	3	D
Osprey	*Pandion haliaetus* (Linnaeus)	4	D
Square-tailed Kite	*Lophoictinia isura* (Gould)	4	D
Black-breasted Buzzard	*Hamirostra melanosternon* (Gould)	4	D
Grey Falcon	*Falco hypoleucos* (Gould)	4	D
Brolga	*Grus rubicunda* (Perry)	2-3	C
Australian Bustard	*Ardeotis australis* (J.E. Gray)	4	D
Plains-wanderer	*Pedinomus torquatus* (Gould)	4	D
Black-tailed Godwit[+,++]	*Limosa limosa* (Linnaeus)	3	C
Painted Snipe[+]	*Rostratula benghalensis* (Linnaeus)	2	B-C
Bush Stone-curlew	*Burhinus grallarius* (Latham)	4	D
Grey Ternlet	*Procelstema cerulea* (Bennett)	4	D
Glossy Black-Cockatoo	*Calyptorhynchus lathami* (Temminck)	4	D
Major Mitchell's Cockatoo	*Cacatua leadbeateri* (Vigors)	4	D
Superb Parrot	*Polytelis swainsonii* (Desmarest)	3-4	C-D
Swift Parrot	*Lathamus discolor* (Shaw)	3-4	C-D
Turquoise Parrot	*Neophema pulchella* (Shaw)	3-4	C-D
Masked Owl	*Tyto novaehollandiae* (Stephens)	4	D
Regent Honeyeater	*Xanthomyza phrygia* (Shaw)	3-4	C-D
Painted Honeyeater	*Grantiella picta* (Gould)	3-4	C-D
Southern Scrub-robin	*Drymodes brunneopygia* (Gould)	4	D
Chestnut Quail-thrush	*Cinclosoma castanotus* (Gould)	4	D
Gilbert's Whistler	*Pachycephala inornata* (Gould)	3-4	D
Mammals			
Spotted-tailed Quoll	*Dasyurus maculatus* (Kerr)	4	D
Brush-tailed Phascogale	*Phascogale tapoatafa* (F. A. Meyer)	4	D
Koala	*Phascolarctos cinereus* (Goldfuss)	4	D
Squirrel Glider	*Petaurus norfolcensis* (Kerr)	4	D
Brush-tailed Rock-wallaby	*Petrogale penicillata* (J.E. Gray)	4	D
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris* (Peters)	2	B
Large Bentwing-bat	*Miniopterus schreibersii* (Kuhl)	4	D
Greater Long-eared Bat	*Nyctophilus timoriensis* (Geoffroy [Saint-Hilaire])	3	C
Large-eared Pied Bat	*Chalinolobus dwyeri* (Ryan)	4	D
Little Pied Bat	*Chalinolobus picatus* (Gould)	3	C
Eastern False Pipistrelle	*Falsistrellus tasmaniensis* (Gould)	4	D
Southern Myotis	*Myotis macropus* (Gould)	4	D
Inland Forest Bat	*Vespadelus baverstocki* (Kitchener, Jones & Caputi)	4	D
Eastern Cave Bat	*Vespadelus troughtoni* (Kitchener, Jones & Caputi)	3	C

+ Species listed on China-Australia Migratory Brids Agreement (CAMBA) ++ Species listed on Japan-Australia Migratory Brids Agreement (JAMBA)

Occurrence of Potential Habitat in the Project Area
1 Significant habitat resources present 2 Moderate habitat resources present 3 Marginal habitat resources present 4 Minimal or no habitat resources present

Potential for Project to Impact on Species' Population Status
A Significant impact potential B Moderate impact potential C Marginal impact potential D Minimal or no impact potential

Table 4-6 Threatened Fauna Species of the Project Area and Surrounds

Common Names	Scientific Names	Status in NSW+
Blue-billed Duck	*Oxyura australis* (Gould)	V
Freckled Duck	*Stictonetta naevosa* (Gould)	V
Australasian Bittern	*Botaurus poiciloptilus* (Wagler)	V
Black-necked Stork	*Ephippiorhynchus asiaticus* (Latham)	V
Brolga	*Grus rubicunda* (Perry)	V
Painted Snipe[1]	*Rostratula benghalensis* (Linnaeus)	V
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V
Greater Long-eared Bat	*Nyctophilus timoriensis*	V
Little Pied Bat	*Chalinolobus picatus*	V

+ As per *Threatened Species Conservation Act, 1995*

V = Vulnerable – a species not presently endangered but at risk of disappearing from the wild over a long period through continued depletion.

[1] Protected under International Agreement: China-Australia Migratory Birds Agreement (CAMBA).

Freckled Duck (*Stictonetta naevosa*)

Potential Impacts

Any component of the Project that has the potential to adversely impact on the potential habitat areas of this species, ie. Lignum dominated areas primarily to the north of the proposed MLA, could result in a reduction of Freckled Duck numbers and breeding activity at the Lake.

Specifically, potential impacts could result from the construction of the pit new Lake foreshore. The lakebed provides potential forage habitat opportunities for the Freckled Duck.

Mitigation Measures

The proposed development would not entail removal of any significant areas of potentially suitable Freckled Duck breeding habitat, ie. Lignum-dominated regions to the north of the proposed MLA.

Additionally potential habitat for the Freckled Duck is likely to be created (as a component of the foreshore rehabilitation programme).

Australasian Bittern (*Botaurus poiciloptilus*)

Potential Impacts

Potential impacts to the Australasian Bittern include alteration of hydrological regimes to the extent that any essential habitat components in the Lake Cowal system are adversely affected. Continuation/expansion of grazing and cropping practices in potential habitat areas, thus preventing establishment of nesting and roosting habitat, is also a potential impact to this species.

The Project area is considered unlikely to contain potentially suitable breeding or foraging habitat for this species as the Australasian Bittern prefers shallow areas vegetated with reeds or rushes.

Mitigation Measures

The new Lake foreshore rehabilitation and revegetation works include vegetation and habitat components that are considered suitable for this species as nesting/roosting/foraging resources.

Exclusion of grazing and cropping from much of the foreshore area would allow natural recruitment and regeneration of potentially suitable Bittern habitat.

Black-necked Stork (*Ephippiorhynchus asiaticus*)

Potential Impacts

While there are no major threats to this species (Marchant & Higgins, 1993), human encroachment associated with the proposed development may potentially exclude this bird from the Project area and immediate surrounds.

The lakebed of the Project area potentially represents a forage resource for this species. However, it is considered that the vegetated areas to the north of the Lake would offer more suitable habitat resources for this vagrant species.

This species is also considered to be particularly susceptible to collision with the electricity transmission line, based on the characteristics noted in Section 4.4.11.

Mitigation Measures

Potential forage habitat resources for this species are likely to develop as a component of the foreshore restoration and revegetation programme.

Mitigation measures relating to minimising the potential for bird strike of the electricity transmission line are summarised in Section 4.4.11.

Brolga (*Grus rubicunda*)

Potential Impacts

Altered environmental flows and flooding patterns can potentially adversely impact on Brolga egg and chick mortality. Introduction and/or absence of control of feral, predator species such as the Fox (*Vulpes vulpes*), Cat (*Felis catus*) and Pig (*Sus scrofa*), at the Project area can also lead to increased egg and chick mortality.

Feeding mostly occurs near water, however Brolgas are known to also feed in grasslands, dry wetlands or cultivated areas. Therefore disturbance to the lakebed, riparian zone and cleared land with scattered woodland may impact upon potential habitat resources of this species.

Mitigation Measures

The removal of grazing from the wetland areas within the proposed MLA would aid in the re-establishment of potential Brolga habitat (ie. forage) areas.

The pest control plan for the Project area would aim to eradicate feral species such as the Fox and Cat, which are considered major threats to Brolga chick and egg survival.

Painted Snipe (*Rostratula benghalensis*)

Potential Impacts

Although the main threats to this species are not conclusively documented, the proposed development could potentially affect a local population of this species by draining potential habitat areas and/or allowing uncontrolled grazing and cropping to occur in such areas.

Land usage within the Project area has resulted in this area being largely unsuitable for breeding and foraging, which are more likely to occur in the swamps and channels of the northern shore of the Lake.

Mitigation Measures
Lake Cowal has been identified as an important refuge for the Painted Snipe (Schodde, pers. comm., 1997). Detailed modelling indicates that the Project would not deleteriously affect the existing environmental flows and status such that the known habitat areas for the Painted Snipe within the Lake.

The habitat creation components of the rehabilitation programme would have the potential to increase and enhance habitat opportunities for this species.

Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*)

Potential Impacts
Although little is known of the biology of this species (Greg Richards and Associates, 1997b) removal of hollow bearing trees (with potential roost sites) as a component of the proposed development could impact on the status of any local population. Occurrence of feral cats as an indirect effect (eg. in response to potential rodent population fluxes) of mining operations could also potentially adversely impact on this species.

Mitigation Measures
Hollow-bearing trees in the proposed disturbance areas would be searched for bats by suitably qualified personnel, prior to removal. Should bats be detected a relocation programme would be undertaken.

As part of the rehabilitation programme extensive areas would be revegetated with Eucalypt woodland which would provide future potential roost sites and forage opportunities for this species. A pest control programme would help ensure that feral cats are controlled in the Project area.

To further mitigate the potential loss of habitat resources, artificial roost boxes could be placed within suitable habitat in the wider area. Artificial roosts have been widely used in America as a conservation measure (Richards, pers comm, 1997).

Greater Long-eared Bat (*Nyctophilus timoriensis*)

Potential Impacts
Known to roost in tree hollows, the proposed development has the potential to impact on this species by removing any potential roost sites contained within the River Red Gum (*E. camaldulensis*) trees to be cleared as a consequence of constructing the open pit and waste emplacements.

Mitigation Measures
Revegetation of the Project area with hollow-bearing species of Eucalypts (particularly River Red Gums) would in the longer term provide potential habitat for this bat species. Surveys conducted at the Project area did not identify any *N. timoriensis* roosting in the River Red Gums fringing the Lake. However, further monitoring and inspection of this habitat would be conducted prior to the removal of any mature River Red Gums. If detected bats would be relocated.

Artificial bat roost boxes have been widely used as a conservation measure in America (Richards, pers. comm, 1997) and could be utilised as a mitigation measure for this Project.

Little Pied Bat (*Chalinolobus picatus*)

Potential Impacts
The loss of mature roost trees in inland areas has been confirmed as a major threat to this species (Richards & Hall, 1996).

The loss of mature, hollow bearing River Red Gums (*E. camaldulensis*) from the Lake margin could potentially limit roosting opportunities for any local *C. picatus* population.

Mitigation Measures
The target survey did not indicate that the River Red Gums fringing the Lake are being used as a roosting habitat. However the habitat would be searched for bats prior to removal and if required, bats would be relocated.

Areas fringing the Lake would be revegetated with Eucalypt species including River Red Gums. In time, these trees may provide suitable resources for roosting and foraging requirements.

4.4.3 Aquatic Biota

Potential Impacts
Potential impacts to aquatic biota of Lake Cowal as a result of the Project relate primarily to those presented in Section 4.2 (Water Resources).

Aquatic biota of the Project area and surrounds may have undergone impacts from other factors such as:

- clearing and fuel reduction burning (primarily of Lignum or River Red Gum) practices;
- invasion by introduced fish species;
- cultivation of the Lakebed for crop production; and
- possible contamination from fertilisers, soil conditioning agents and biocides in agricultural runoff and irrigation water (Humphries *et al.*, 1991).

Mitigation Measures
Mitigation measures to reduce or exclude potential impacts on aquatic biota relate primarily to those presented in Section 4.2.1. A water management system has been proposed such that all on-site water is contained. Over the long term, final landforms are intended to retain and absorb rainfall with any overflow directed towards the final void. Other mitigation measures include:

- characterisation of construction material as non-saline to mitigate potential salinity increases in the Lake;
- construction of the low permeability lake protection bund to negate shallow seepage from the Lake to the pit; and

- erection of a continuous silt curtain around the construction zone of the temporary isolation bund in order to trap fine sediment and prevent suspended material migrating into the main body of the Lake.

4.4.4 Amphibians and Reptiles

Potential Impacts

Amphibians typically are restricted to water bodies such as rivers, creeks, or lagoons however they do undertake forays across elevated terrain in damp conditions. Reptiles can generally disperse over many land types however preference is likely to be for areas where cover/protection from predators is available.

In a general sense, an enormous array of accepted human activities impinge upon the viability of amphibian populations including:

- insecticide use in agricultural and horticultural areas, particularly aerial spraying;
- land reclamation by drainage in wetland areas, resulting in loss of breeding sites;
- the conversion of temporary ponds to dams for stock use resulting in the destruction of peripheral sheltering sites; and
- introduction of the Mosquito Fish (*Gambusia holbrooki*) which preys on frog eggs and tadpoles.

(Tyler, 1994 in Tyler, 1997).

Cogger *et al.* (1993) identified reptile communities in a number of habitats and regions in Australia as being under threat. Relevantly, one of those habitats is the fragments of original mallee (tall shrubland) and woodland habitats in the wheatbelt of western NSW (*ibid.*).

Threats affecting the greatest number of species are habitat clearance, overgrazing by domestic stock, cropping, urban development and predation by introduced mammals (Foxes, Cats and Rats) (Cogger *et al.,* 1993).

Reference to Appendix A (Attachment 4) indicates that 18 amphibian and 65 reptiles have been recorded from the Lake Cowal region. Threatened species recorded include the Southern Bell Frog (*Litoria raniformis*) and three reptiles (Pink-tailed Legless Lizard – *Aprasia parapulchella,* Burton's Snake-lizard – *Lialis burtonis,* Lined Earless Dragon – *Tympanocryptis lineata* subsp. *pinguicolla*).

The potential impact of the proposed development on these threatened herpetological species were assessed in accordance with the points listed in the 8 Part Test of Significance, as detailed in Section 5A of the E*nvironmental Planning and Assessment Act 1979* (Resource Strategies *et al.,* 1997a).

Vestjens (1977) noted that amphibians were significantly more prevalent in the low-lying areas of the Lake shore and flood plain than in any of the other habitat areas surveyed. The preference for this area was postulated to be a function of the increased forage value of the areas, especially during periods of inundation when numerous arthropods living in the soil and amongst vegetation are flushed out.

Based on the information presented above, potential impacts of the Project to amphibians and reptiles include drainage of suitable wetland areas, loss of essential/preferred microhabitat features and subsequent decline in food resources, sedimentation/siltation of water bodies, increased risk of mortality from vehicles, disruption to dispersal/movement behaviour and increased risk of exposure and predation.

Mitigation Measures

Based on the information concerning threats to amphibians and reptiles (Tyler, 1997; Cogger *et al.,* 1993) and the results of the herpetological survey of the Project area and surrounds, the proposed development is considered unlikely to impact on significant numbers of amphibians and/or reptiles. However the proposed rehabilitation programme for the Project includes features which provide for the creation of amphibian and reptile habitat. For example, the development of the woodland systems across much of the Project area would potentially increase habitat opportunities for reptiles and expand dispersal options for local populations.

Potential amphibian microhabitat is likely to be created as the freshwater ecological community successional structure develops. Such rehabilitation is planned to commence early in the Project life.

A Feral Pest Management Plan for the Cowal Gold Project is to be prepared in accordance with the best practice guidelines and recommendations of the Australian Nature and Conservation Agency – Vertebrate Pests Committee Working Group (1995) and the NPWS. This management plan would ensure the potential fauna habitat opportunities to be created by the rehabilitation works are not compromised.

4.4.5 Birds

Potential Impacts

Apart from habitat issues previously discussed, potential impacts on bird species' diversity and abundance, as a consequence of the construction and operation of the proposed mining development include:

- disruption to essential behavioural patterns as a result of noise generation and blasting activity, dust and air quality emissions, introduction of artificial lighting, road traffic and human interference; and
- increase in the mortality rate via exposure to/drinking of toxic residues (*viz.* cyanide) and collision with artificial structures (eg. powerlines, mining infrastructure).

Mitigation Measures

The impact of these issues, and measures designed to ameliorate potential impacts on avifauna, are detailed in Sections 4.4.5 to 4.4.11.

4.4.6 Tailings Water and Cyanide Toxicity

A detailed description of CN and its usage at the Project is provided in Appendix G. The following is a synopsis of the potential impacts of the cyanide flow-path on fauna at the Project.

Potential Impacts

Ostensibly birds and bats and any animals not excluded by the fence around the tailings storages might be affected by exposure to CN in water at the Project tailings storages. Birds however are the only group of wildlife that are likely to arrive in significant numbers regularly at the Project site.

Birds

Bird mortality on cyanide-bearing tailings storage facilities is recognised locally and internationally as an environmental problem (Hansard, 1995; Kay, 1990; Donato, 1997).

CN in the tailings storage at the Project site could be either ingested by birds through drinking of water, inhaled as hydrogen cyanide gas (HCN) or absorbed through skin contact with water or tailings slurry (eg. wading or swimming in contaminated water).

Once absorbed into the bloodstream, cyanide bonds strongly with iron, copper and sulphur which are constituents of many enzymes and proteins, in particular, the enzyme cytochrome oxidase which is essential to the utilisation of oxygen (Smith and Mudder, 1991). The inactivation of the enzyme leads to cellular asphyxiation and tissue death. Rapid damage to the central nervous system and the heart can also result from breathing high levels of cyanide over a short time, which can result in respiratory arrest and death (*ibid.*).

Donato (1997) investigated the impacts on wildlife caused by toxic tailings at seven gold mining operations in the Northern Territory. In this study, a total of 218 bird species were recorded on the case study mining leases and 71 species were recorded using tailings storage facilities. A total of 1,255 bird mortalities were recorded from four case study mining leases within a two year period.

The results of the study and research conducted by Donato (1997) indicate that at levels of CN exposure below 50 mg/L WAD cyanide limit, mortalities approach zero.

Published information and fieldwork illustrates the differences in lethal limits between species (eg. Ballantyne, 1974 in Donato, 1997; Wiemeyer *et al.,* 1986 in Donato, 1997). In terms of sub-lethal effects, work by Pristos and Ma (1997) and Ma and Pristos (1997) identifies cellular effects of CN on key organs of the Mallard Duck (however cellular activity did revert to control levels after a period of time).

Species behaviour can also increase a bird's exposure to CN toxicity (Donato, 1997). A species that uses water in the tailings storage (supernatant) as a roost would be less exposed to CN toxicity than a species that filter feeds through supernatant and slurry (Donato, 1997). Some species have been found to be diving in supernatant *viz.* Grebes (*Tachybaptus sp.*) and Hardhead (*Aythya australis*) which would increase their exposure to CN (Donato, 1997).

The presence of macroinvertebrates in tailings storages pond water may act as an attractant to waterbirds. However, aquatic organisms have been found to be adversely affected by concentrations of cyanide (free) as low as 1 mg/L (Sedlak *et al.,* 1997). Therefore it is considered that aquatic biota would be unlikely to occur in the tailings storages pond water.

Weimeyer *et al.* (1986 in Donato, 1997) found that some birds are able to recover from extreme exposure to CN. Birds affected by CN have been found to be easily resuscitated with oxygen and are often able to be released within 24 hours (Donato, 1997).

The findings of the Donato (1997) study support other published information that relevantly reducing WAD cyanide concentrations to below 50 mg/L reduces mortalities in open impoundments. For example, Henny *et al.* (1994) recorded no mortalities below 59 mg/L WAD cyanide concentration in a study in North America. Above this concentration, mortalities increased significantly.

Bats

The bat survey of the Project area (Greg Richards and Associates, 1997a) notes that the only threatened species recorded (ie. the Yellow-bellied Sheathtail-bat – *S. flaviventris*), was not found foraging over small water points such as stock dams and appeared to prefer the larger waterbody of Lake Cowal itself. Whether it requires free water in its diet, as opposed to obtaining it from insect prey, is unknown.

From the data from the few hours of bat survey (trip-lining) at one stock dam, and the data from inventory sites at this and other stock dams, there is an indication that a portion of the community that consumes free water.

Further to this, the bat survey and assessment (Greg Richards & Associates, 1997a) found that only three species were actually caught at the water surface by trip-lines, whereas five species were detected foraging over stock dams. Furthermore, two species (*C. morio and V. regulus*) were trip-lined but not detected over dams and both were only recorded in one habitat each (*ibid.*).

With regard to the potential for adverse impacts to occur if or when bats consume water from cyanide tailings storages, bat mortality at tailings dams at gold mines in the United States have been recorded (Clark, 1991), at unknown cyanide levels.

The only identifiable research on the toxicity of cyanide to bats was prepared by Clark *et al.* (1991) who found that Little Brown Bats (*Myotis lucifugus*) have an LD_{50} sensitivity of 8.4 mg sodium cyanide/kg of body weight. (As a comparison the LD_{50} for the Mallard Duck is 1.43 mg/kg of body weight.)

The presence of macroinvertebrates in tailings storages pond water may act as an attractant to bats. However, aquatic organisms have been found to be adversely affected by concentrations of cyanide (free) as low as 1 mg/L (Sedlak *et al.,* 1997). Therefore it is considered that aquatic biota

attractive to bats would be unlikely to occur in the tailings storages pond water. The lack of a food source, habitat and bright lighting in the tailings storage area, plus low CN levels in the tailings storage suggest that bat mortality should not be an issue of significance. Notwithstanding, specific monitoring and, if required, mitigation is proposed (refer mitigation measures).

Other Fauna
Any terrestrial fauna not excluded by the fence around the tailings storages could potentially be affected by exposure to CN in water at the Project tailings storages.

Mitigation Measures

Birds
Following consultation with a number of regulatory bodies and recognised experts, potential bird mortality as a consequence of CN toxicity is to be mitigated to the greatest possible extent by destruction of CN compounds (Appendix G). The destruction process is designed to result in CN levels in the tailings storages of less than 20 mg/L for 90% of the time and 30 mg/L for the remainder of the time. This level is in accordance with EPA criteria for the project which were determined following consideration of the following key points:

- the need for conservatism, due to the difficulty of setting a universal cyanide threshold for protecting birds, due to highly individualistic behaviour of birds and differences between mines;
- recognition of industry experience that indicates bird mortalities are only "virtually" eliminated at 50 mg/L CN_{WAD};
- consideration of the potential for chronic and sub-lethal effects and synergistic effects from other chemicals in tailings;
- consideration of likely natural degradation in conjunction with the attractiveness of the delta or beach habitat created near the discharge point;
- practical management and economic considerations; and
- large numbers of birds which use Lake Cowal and the likelihood of the significant use of the tailings storages.

In addition to chemical reduction of CN levels, a number of mechanisms to deter birds from tailings ponds have been employed at mining operations throughout the world.

A review of relevant literature (eg. Nevada Mining Association *et al.,* 1990; Bomford & O'Brien, 1990; Donato, 1997; Hagelstien, 1997 in Donato, 1997; Dodds-Smith and Filas, 1996; Wildlife Control Technology Inc., 1996) suggests that the use of physical deterrents alone as a control measure has limited long term value. Measures such as broadcast of audio and visual stimuli to scare/repel birds are widely accepted as having limited success in the short term and minimal in the longer term.

Netting of tailings storages is a proven control measure on small areas, however over larger expanses such as the storage areas at the Cowal Gold Project, inherent factors such as difficulty of structural maintenance, aesthetic impact, impediment to bird retrieval, preclude the use of this expensive technique.

A site-specific monitoring programme is to be implemented, whereby tailings storages are to be patrolled and monitored twice a day to record the level of bird usage and for evidence of birds being affected by tailings deposition.

Bats
In previous studies at a gold mine in north Queensland, Greg Richards and Associates (1997c) showed that there were significant differences in bat species richness and abundance when tailings dams were compared with natural water sources, with both variables being higher at the latter. This was attributed to the lack of vegetation surrounding tailings cells. Richards (1994 and unpublished PhD studies) concluded that in temperate forests bat species richness was positively correlated with the diversity and density of understorey plants, which apparently dictates the level of insect prey. It is highly likely then, that at the Cowal Gold Project area, where the amount of aquatic vegetation and aquatic insects would be insignificant or at least substantially lower than at natural waterbodies, that the two tailings storages may not be sites that are attractive to bats (Greg Richards and Associates, 1997a).

Based on the information presented on the potential impacts of cyanide to bat populations the following mitigation measures would be proposed:

- Following the assessment of the results of a monitoring programme to determine the usage of tailings storage areas by bats, bat exclusion mechanisms would be developed if required. This would entail strategic emplacement of sensor-activated units to emit bursts of ultrasound to "jam" echolocation signals of micro-chiropteran bats. Radio-tracking of individuals would be incorporated into the mitigation measures to test the necessity and efficiency of any mechanisms employed.
- As a further contingency, cyanide levels would be reviewed and if necessary altered at the destruction process.

Other Fauna
It is proposed to fence the tailings storages to exclude medium to large terrestrial fauna from the area. CN in the tailings storages areas would be kept at a level of less than 20 mg/L for at least 90% of the time, and less than 30 mg/L at all times, to limit potential impacts on fauna that are not excluded by the fence. Daily patrols of tailings storages for fauna and appropriate response measures would be undertaken.

Rehabilitation initiatives of the tailings storages areas during operations would be such that minimal habitat opportunities would be created for terrestrial fauna, thus the potential for their occurrence would be considered low.

As a general mitigation aim, tailings ponds would be maintained as small as possible through continual recycling through the processing plant.

4.4.7 Potential Impacts of Dust on Wildlife and Vegetation

A detailed assessment of the existing air quality and the potential impacts of the Project was carried out by Pavel Zib and Associates (1997) and is contained in Appendix I. Section 3.6 summarises the existing air quality of the Project area.

Atmospheric dust emissions are expected to be the main atmospheric emissions associated with the Project. Other possible sources of air emissions would be exhaust fumes from mobile equipment, blasting fumes and evaporative emissions from the processing area. All these emissions are expected to be minor.

Potential impacts of dust on fauna (*viz.* birds and livestock) at the Project area and surrounds was investigated by Hunt (1997).

Assessment of the elemental composition of soil and subsoil from the proposed tailings and tailings storage areas revealed that potential dust from this area during construction and operation would fall within the normal range of acceptability for surface soils for birds and livestock (Hunt, 1997).

Low concentrations of heavy metals were found in dust samples taken from the Project area. Potential dust deposition in areas accessible to birds or grazing livestock was considered negligible (*ibid.*).

Pascoe *et al.* (1996 in Hunt, 1997) provide an extensive review of metal toxicity in waterfowl. The report found that upstream sediments at a reservoir in Montana, USA, contained high levels of copper, arsenic, cadmium and zinc, however the daily intake of metals by waterfowl were below or within acceptable toxicity ranges.

It is considered therefore that dust fallout from the Cowal Gold Project would have no adverse effect on waterbirds or livestock using the area (Hunt, 1997).

Dust can affect vegetation by inhibiting physiological processes such as photosynthesis, respiration and transpiration and allow penetration of phytotoxic gaseous pollutants (Farmer, 1993; Eller, 1977). Visible injury symptoms may occur and generally there is decreased productivity (Farmer, 1993).

A study on the effect of dust on photosynthesis and its significance for plants (Thompson *et al.*, 1984) found that photosynthesis and leaf diffusion resistance was reduced at 5 to 10 g dust per m^2 leaf surface.

Given that predicted dust deposition contours indicate that levels of approximately 0.5 g/m^2/month would be experienced (Pavel Zib and Associates, 1997) at the main bird breeding areas adjacent to the proposed MLA area, vegetation species diversity and abundance is unlikely to be deleteriously affected.

Mitigation Measures

A range of air quality safeguards are to be employed to reduce emissions of atmospheric dust from the Project. These safeguards are based on current control techniques as recommended for open pit mining in NSW by the EPA. The main components of the controls can be summarised as follows:

During the construction phase standard dust control measures would be implemented including intensive watering, road surfacing and restricting the speed of vehicles travelling on unsealed surfaces.

Dust control practices to be implemented during the operational phase of the Project may include the following:

- regular watering of haul roads and other internal roads;
- minimising the area of soil stripping ahead of operations to minimise areas of exposed ground;
- prevention of truck overloading and the resulting spillage during loading and hauling;
- fitting of drills with dust suppression equipment;
- regular maintenance of all haul roads;
- progressive rehabilitation of mine landforms;
- limiting the freefall height during ore/waste stockpiling and dumping operations; and
- water sprays to be fitted to primary crusher, conveyor and stockpile feed points.

The on-going dust monitoring programme (detailed in Section 6.5.4) would verify the performance of these mitigation measures.

4.4.8 Potential Impacts of Noise and Blasting on Wildlife

Ambient noise surveys were conducted in July, August and December 1994 and January 1995 in order to characterise and quantify the existing acoustical environment in the area surrounding the proposed mine site and the predicted Project related noise emission levels. These surveys are described in Section 3.7 and Appendix H of the EIS.

Whilst some specific studies are reported in the scientific literature, no firm policy or guidelines exist on the noise levels considered acceptable, or conversely, the level or character of noise that may disturb or otherwise affect the primary ecological components of bird species (Richard Heggie Associates, 1997).

Richard Heggie Associates (1997) identified the major sources of noise and vibration emissions associated with the Cowal Gold Project as:

- noise emissions from mobile plant and equipment during the construction phase;
- noise emissions from mining operations including fixed processing plant and mobile equipment;
- ground vibration and airblast emissions resulting from blasting operations; and
- noise emissions from traffic on public roads.

Noise

Numerous studies have been undertaken on the effects of noise on wildlife (Shaw, 1978; Busnel, 1978; Ames, 1978; Lynch & Speake, 1978; Allaire, 1978; Streeter *et al.,* 1979; Algers *et al.,* 1978 in Richard Heggie Associates, 1997; Poole, 1982 in Richard Heggie Associates, 1997). In essence the studies indicate that many species are well adapted to human activities and noises.

Birds tend to habituate to constant steady noise levels, even of a relatively high level in the order of 70 decibels (dBA) (Richard Heggie Associates, 1997).

It was also found that continuous exposure to higher levels (70 dBA - 85 dBA and above) may cause some degree of behavioural changes in birds (non-specific to species) (*ibid.*).

Project noise levels under adverse weather conditions (1.5 m/s wind) were predicted at various distances from the near edge of Lake Cowal for the various phases of the construction and mining operations.

The analysis found that the maximum adverse conditions contributed noise level at 1.5 km (the closest conceivable bird breeding areas of significance on Lake Cowal) was 53 dBA during construction (L_{A1}) (ie. the level exceeded for 1% of the time (*ibid.*). This level is clearly well below (more than 7 times lower) than the level of 70 dBA, above which, some degree of environmental changes in birds have been observed (*ibid.*). During operations the maximum predicted contributed noise levels under adverse conditions were even lower; 45 (1.5 km) and <30 dBA (4.5 km distance) respectively.

Blasting

Richard Heggie Associates (1997) note that sudden loud or impulsive impact noises may be capable of causing birds to become startled which if repeated in the longer term, may affect feeding and possibly breeding habits in some bird species.

A review of a number of relevant studies (Heinemann, 1970; Stadleman, 1958 in Richard Heggie Associates, 1997) found that the effects of airblast have been observed in birds at levels of approximately 131 dB – 140 dB Linear and above (Richard Heggie Associates, 1997). The predicted level of airblast at 1.5 km from the Project is 107 dB Linear. This level of airblast is 45 times and 16 times, respectively, lower than the documented levels of 140 dB and 131 dB Linear (*ibid.*). At 4.5 km distance (ie. at the main waterbird breeding area) the level is 95 dB Linear (Appendix H).

Furthermore, literature review has shown that with respect to impulsive acoustic stimuli (eg. sonic boom, explosion), the majority of published reports of well controlled experiments concluded that the behaviour (including breeding) of domestic animals and some characteristically shy, wild species (*viz.* Wild Turkey) was unaffected by repeated sonic booms (Welch & Welch, 1970; Lynch & Speake, 1978).

Mitigation Measures

North propose to implement noise control and monitoring programmes during construction and operation in part at bird breeding areas. These measures are outlined in Section 6 of the EIS and include maintaining blasting and noise emissions within EPA standards, and hence, well within the researched levels for bird life disturbance.

4.4.9 Artificial Lighting

Potential Impacts

Little information is available on the potential impacts of lighting on wildlife and specifically, birds.

Potential impacts of lighting at the proposed development however are likely to focus on the alteration of forage zones, primarily for insectivorous bird species. Birds such as Australian Owlet-nightjar (*Aegotheles eristatus*) and Kookaburra (*Dacelo novaeguineae*) have been observed foraging on insects around lights at sporting fields (pers. obs.) and studies (Rydell, 1992; Blake *et al.,* 1994; Hickey & Fenton, 1990, all in Greg Richards and Associates, 1997b) show that insects can be up to 40 times more prevalent around lights (street lights, low and high pressure sodium lamps).

With respect to wildlife, Greg Richards and Associates (1997b) notes that at the Cowal Gold Project bats would undoubtedly congregate around lighting and that the bat species likely to be foraging in the area would be those in the aerial pursuit foraging guild. This activity could be considered a potential issue given that some bat species may be drawn away from their natural foraging habitat (*ibid.*). Conversely bats foraging around artificial lighting may be considered a positive impact, drawing insects away from habitat that may not necessarily be suitable for the aerial pursuit guild as a forage resource and concentrating prey in more accessible areas (*ibid.*). In areas such as the Lake Cowal region where forage opportunities for bats are likely to have been severely reduced since European settlement, provision of regular concentrations of food supplies for bats may be considered a positive impact (*ibid.*).

The presence of lights and concentrations of bats may increase the incidence of predation on them by Owls (*ibid.*). Although there appears to be little study on the topic, there have been numerous observations of bats appearing to forage above the lights for the majority of the time (*ibid.*). Apparently bats seldom cross the light cone except when chasing insects (Belwood and Fullard, 1984, Schnitzler *et al.*, 1987, Kronwitter, 1988, Hickey and Fenton, 1990, Rydell, 1991 all in Greg Richards and Associates, 1997b), which is assumed to be a predator avoidance strategy (Hickey and Fenton, 1990 in Greg Richards and Associates, 1997b).

Mitigation Measures

Direct views of the proposed mine lighting can be avoided by careful placement and orientation of individual lights and the screening effect of the mine landforms (EDAW, 1997).

Based on the information presented above, it is considered that only positive impacts would result from artificial lighting and therefore no mitigation measures in regard to flora/fauna would be required.

4.4.10 Human Interference

Potential Impacts

Potential impacts from human interference and presence associated with a mining operation include harassment of fauna, vehicle related mortalities and illegal hunting (US Department of the Interior, 1994) and mortalities in tailings storages.

Mitigation Measures

To ensure potential impacts associated with human interference are minimised, access to the Project area is to be restricted to Project staff, contractors and authorised visitors. Vehicular speed limits are to be set and enforced across the Project area thus greatly reducing the potential for fauna mortality as a result of vehicle strike.

Domestic pets and firearms would be prohibited from the Project area and employees and contractors would not be permitted to take native fauna or encourage fauna through feeding.

A clean, rubbish-free environment would be maintained throughout the Project area particularly around the administration and contractor areas. This would discourage scavenging and reduce the potential for colonisation of those areas by non-endemic fauna (eg. introduced rodents).

4.4.11 Bird Strike and Mining Infrastructure

Potential Impacts

Impacts associated with potential bird strike and mining infrastructure relate primarily to electricity transmission line collision. Appendix D provides a detailed discussion of the potential impacts of electricity transmission line bird strike. A summary of this information is presented below.

Research on avian mortality caused by electricity transmission line (eg. Faanes, 1987; Anderson *et al.,* 1977; Beaulaurier, 1981; Kingsford, 1990; Longworth & McKenzie (1987); Rusz *et al.,* 1986; Murray & Winning, 1992; CSIRO, 1996) indicates that in the absence of pre-planning and assessment, inappropriate alignment of electricity transmission lines can result in significant bird mortality. Rusz (1990 in CSIRO, 1996) specifically notes a discernible set of characteristics for birds frequently recorded colliding with transmission lines, including:

- species with awkward flight characteristics;
- relatively large body size;
- birds that lack manoeuvrability in the air; and
- species that fly at night.

Accordingly, birds such as Swans, Pelicans, Cranes, Herons, Waterfowl and Gulls are typically most frequently involved in collisions (Faanes, 1987).

Mitigation Measures

Appendix D contains details on the amelioratory measures that can be incorporated into the design, construction and operation of an electricity transmission line. These measures are summarised below.

In a study of transmission line bird strike management at Lake Cowal (CSIRO, 1996) it was found that although there are variations in the response of birds from location to location and species to species, there are a number of common engineering design and siting considerations which are critical to lowering the frequency of bird strikes. These include:

- length of the powerlines between poles, because most strikes occur in mid-span air space;
- the vertical plane or profile of conductors is more important than the horizontal profile;
- the horizontal profile of conductors parallel to the ground for descending birds;
- the height of the conductors above the ground in relation to the flight lanes and local bird behaviour;
- the height of the earth or ground wire above the conductors;
- the relationship of the lines to natural flight screens such as hills and trees;
- the orientation of the conductors across flight lanes and their visibility in relation to the sun;
- the diameter of the conductor or its enhanced visibility by means of visual aids; and
- the proximity to water, wetlands and important habitat.

In order to minimise bird strike, siting and design considerations would include (where practicable):

- identify significant bird habitat and minimise proximity of powerlines by a preferred 400 m;
- avoid as many over-water crossings as possible;
- place lines adjacent to and near the base of hills, rows of trees or cliffs to provide a natural screen that birds would automatically fly over;
- share the same easement as existing similar lines as long as the vertical dimension of the strike zone is not increased in foggy areas;
- place lines parallel to prevailing winds;
- decrease the vertical dimension of the stacked powerlines as indicated in the current design by placing wires in a horizontal array;
- visual aids such as orange PVC balls and coloured vibration dampers can be used in more open areas of higher bird-strike potential although their success may be based more on human perception than verifiable evidence (Rusz, 1990 in CSIRO, 1996); and
- in flight path areas, use fast-growing trees along the transmission line easement to create a visual screen and barrier to bird flight.

4.4.12 Mammals

Potential Impacts

Goldney & Bowie (1990) note that in the Central Western Region of NSW ground dwelling mammals have been most affected by past and on-going landuses.

In a working paper on the possible factors inducing faunal changes in western NSW and north-western Victoria in the 19th century, Allan (1983 in Goldney and Bowie, 1990) notes that the extinction of medium-sized ground dwelling mammals predated the major land clearance programmes of Europeans, the periods of gross overstocking of sheep and cattle, the arrival of feral animals (particularly rabbits and foxes) and the major droughts of the late 19th century (*ibid.*).

It was postulated that the extinction of this group of mammals in north-western Victoria and western NSW is related to the rapid demise of the Aboriginal population particularly along waterways (*ibid.*). It is argued that it was the rapid removal of Aboriginal land management practice of firing that initiated the sudden and dramatic extinction of the medium-sized mammals (*ibid.*).

Further to those pressures on fauna of the Central Western Region of NSW, potential impacts of the proposed development specifically relate to bats and include:

- removal of potential roost trees for hollow-obligate bats such as the Greater Long-eared Bat (*Nyctophilus timoriensis*) and Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), primarily associated with loss of mature River Red Gum (*E. camaldulensis*) along the Lake foreshore (Section 4.3.2);
- reduction in forage opportunities by removal of woodland vegetation and vegetative structure, known to attract potential prey species (Section 4.3.2);
- impacts of ingestion of potentially toxic CN-laden pond water in the tailings storage and decant areas (Section 4.4.6).

Mitigation Measures

Mammalian species diversity and abundance of the Lake Cowal region is low as a consequence of a host of factors such as habitat clearance, hunting, altered fire regimes, proliferation of feral species, grazing and cropping practices. A number of bat species have however been recorded from the area and the mitigation measures presented herein would focus on microchiropteran bat fauna.

The rehabilitation programme is to include revegetation of extensive areas with Eucalypt woodland. Development of a woodland system has the potential to provide future roost and/or forage opportunities for bats, over and above those that presently exist.

Section 4.4.6 presents measures for mitigating potential adverse impact on bat fauna as a result of exposure to cyanide (CN) in the tailings storage areas.

4.5 Air Quality

As discussed in Section 4.4.7, a detailed assessment of the existing air quality and the potential impacts of the Project was carried out by Pavel Zib and Associates (1997) and is contained in Appendix I. Section 3.6 summarises the existing air quality of the Project area.

Details of air emissions are also discussed in Section 4.4.7. Atmospheric dust emissions are expected to be the main atmospheric emissions associated with the Project. All emissions are expected to be minor.

The predicted dust emissions and total suspended particulates (TSP) generated by mining activities have been modelled for four years over the life of the mine (construction, Years 1, 3 and 6). Detailed emission inventories of atmospheric dust were prepared using dust emission factors for individual types of mining equipment and processing activities. A computer model of dust deposition was used to predict mean annual dust deposition rates and concentrations of TSP in the ambient air, to facilitate the plotting of dust contours. Full details and results of the modelling are presented in Appendix I.

4.5.1 Air Quality Criteria

Air quality guidelines used in the assessment were based on the NSW Environmental Protection Authority (EPA) guidelines for protecting the degradation of amenity. The specific effects contributing to this degradation of amenity mainly relate to the presence of visible dust either in the air or on surfaces. The adopted EPA incremental amenity criteria for dust deposition are indicated in Table 4-7

Based on the existing dust deposition rates (Section 3.6), the EPA criteria specify a mean annual increment of 2 g/m^2/month as the maximum acceptable increase over the existing levels for all land located outside the Project area.

The health effects of dust are related to the concentration of suspended particles in the air as distinct from dust deposition. The assessment of TSP was compared with the National Health and Medical Research Council of Australia (NHMRC) guidelines (1995) for protecting public health in residential areas. These guidelines state that the maximum permissible level of TSP is 90 $\mu g/m^3$.

In addition, the NSW EPA has recently listed among its objectives, limiting the mean annual concentration of PM10 (particles that have aerodynamic diameters of less than 10 microns in size) in residential environments to 50 $\mu g/m^3$. Particulate matter with diameters of less than 10 microns (PM10) usually constitute about 50% of the TSP in ambient air. When a ratio of 50% is applied to the proposed development, the mean annual concentrations of PM10 at all residences are predicted to be less than 5 $\mu g/m^3$.

4.5.2 Dust Deposition

Potential Impacts

The results of the dust emission modelling indicate that dust emissions from the site would vary over the proposed operating period for the mine. Dust deposition contour diagrams for the four years modelled are contained in Appendix I. Figure 4-4 represents a composite of these figures and shows the 2 g/m^2/month isopleths (dust contours) for each of the four years. Areas within the isopleths are predicted to have dust deposition rates in excess of the EPA criteria. For those years modelled, the highest levels are expected in the third year of operation corresponding to the anticipated peak of drilling, blasting and waste rock production.

Table 4-7 NSW EPA Criteria for Dust Fallout

Existing Dust Level (g/m^2/month)	Maximum acceptable Increase over Existing Dust Level (g/m^2/month)	
	Residential Suburban	Rural, Semi rural, Urban Commercial and Industrial
2	2	2
3	1	2
4	0	1

NB. If the existing dust level in any area is greater than 4 g/m^2/month then no increase in dust fallout is acceptable as a result of any proposed dust emitting works.

The results of dust deposition modelling indicated that all non-company owned residences outside the proposed MLA, at all stages of the development, are predicted to receive dust deposition rates of less that 0.5 g/m^2/month (well below the adopted EPA criteria).

The dust deposition contours indicate the following areas of land (upon which no residences are located) may receive dust deposition levels greater than the EPA criteria:

- a small portion of unoccupied grazing land located on the northern side of the proposed MLA during modelled year 1 and during construction;
- a very narrow strip of land (optioned to North) located adjacent to the southern proposed MLA boundary (during modelled years 1 and 6); and
- a small portion of land (optioned by North) located adjacent to the western proposed MLA boundary (during construction only).

The predicted exceedances outside the proposed MLA are only minor and temporary and would not impact adversely on the land adjacent to the Project site (Pavel Zib and Associates, 1997).

Mitigation Measures

Notwithstanding the predicted low impact of dust generating activities, a range of air quality safeguards would be employed to reduce emissions of atmospheric dust from the Project. These safeguards are based on current control techniques as recommended for open pit mining in NSW by the EPA. The main components of the controls can be summarised as follows.

During the construction phase standard dust control measures would be implemented including watering, road surfacing and restricting the speed of vehicles travelling on unsealed surfaces.

Dust control practices to be implemented during the operational phase of the Project may include the following:

- regular watering of haul roads and other internal roads;
- minimising the area of soil stripping ahead of operations to minimise areas of exposed ground;
- prevention of truck overloading and the resulting spillage during loading and hauling;
- fitting of drills with dust suppression equipment;
- regular maintenance of all haul roads;
- progressive rehabilitation of mine landforms;
- limiting the freefall height during ore/waste stockpiling and dumping operations;
- fitting of water sprays to the primary crusher, conveyor and stockpile feed points; and
- construction of a hood over the coarse ore stockpiles.

There would be a considerable distance between even the nearest non-company owned residence and the main sources of dust emissions within the Project site. This would result in the predicted maximum increases in the mean annual dust deposition rates remaining less than 25% of the EPA objective.

4.5.3 Total Suspended Particulates

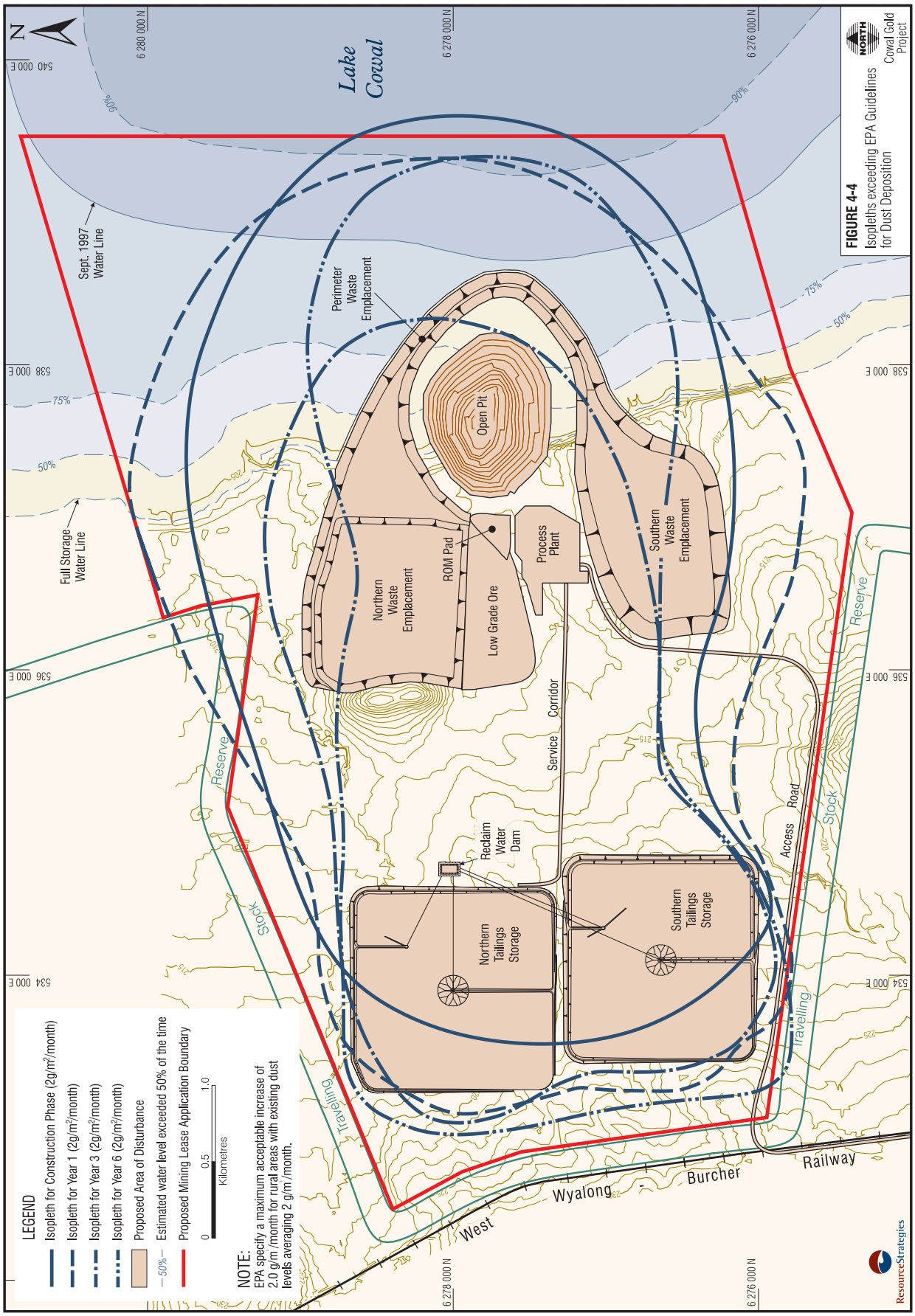
Potential Impacts

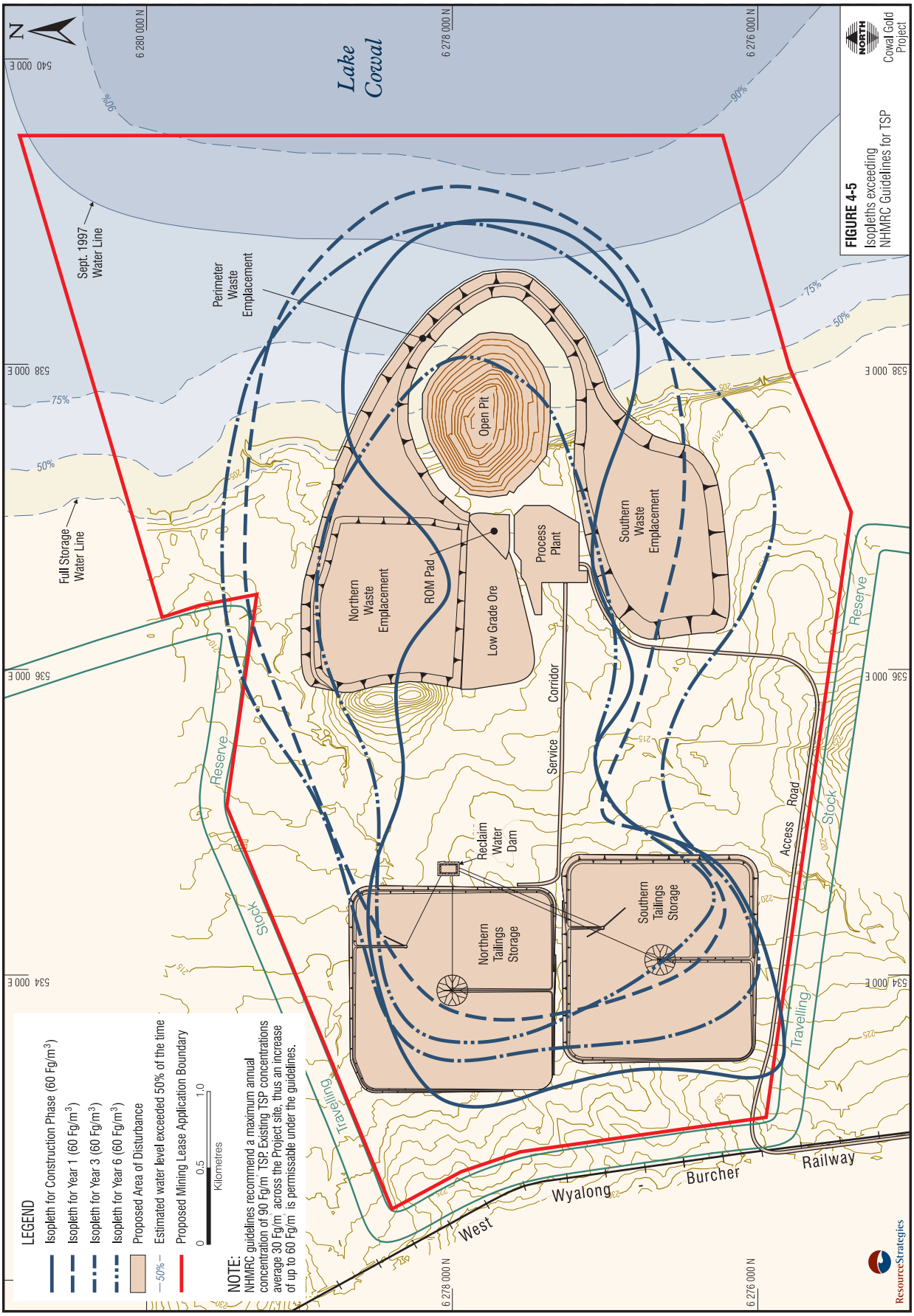
The mean annual concentrations of TSP and PM10 in the ambient air would remain at levels well below the applicable guideline value of 90 $\mu g/m^3$ at all non-company owned residences. Given the background TSP is approximately 30 $\mu g/m^3$, an increase of up to 60 $\mu g/m^3$ is possible without exceeding the guideline level. TSP contour diagrams for the four years modelled are contained in Appendix I. Figure 4-5 represents a composite of these figures and shows the 60 $\mu g/m^3$ isopleths (dust contours) for each of the four years. Areas within the isopleths are predicted to have TSP levels in excess of the nominated guidelines. As for dust deposition, the highest TSP levels are similarly expected in the third year of operation.

The results of the TSP modelling indicated that all non-company owned residences outside the proposed MLA, at all stages of the development, are predicted to receive additional TSP levels of less than 10 $\mu g/m^3$ (well below the adopted EPA criteria).

Particulate matter with diameters of less than 10 microns (PM10) usually constitutes about 50% of the TSP in the ambient air. When a ratio of 50% is applied to the proposed development, the mean annual concentrations of PM10 at all residences are expected to be less than 5 $\mu g/m^3$ (well below the adopted criteria of 45 $\mu g/m^3$).

As with dust deposition modelling, the use of conservative assumptions shows that on the small portion of land located outside the northern boundary of the proposed MLA area, and a very small strip of land outside the southern boundary, may on occasions exceed NHMRC guidelines of 90 $\mu g/m^3$ for TSP.


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Reclaim Water Dam
Northern Tailings Storage
Southern Tailings Storage
Access Road
Travelling Stock Reserve
Wyalong - West
Burcher Railway
6 280 000 N
6 278 000 N
6 276 000 N
534 000 E
536 000 E
538 000 E
540 000 E
90%
75%
50%
LEGEND
Isopleth for Construction Phase (2g/m²/month)
Isopleth for Year 1 (2g/m²/month)
Isopleth for Year 3 (2g/m²/month)
Isopleth for Year 6 (2g/m²/month)
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0 0.5 1.0 Kilometres
NOTE:
EPA specify a maximum acceptable increase of 2.0 g/m²/month for rural areas with existing dust levels averaging 2 g/m²/month.
FIGURE 4-4
Isopleths exceeding EPA Guidelines for Dust Deposition
Cowal Gold Project
NORTH
ResourceStrategies
NDC-97-03_S4-001E.CDR


N
Lake Cowal
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Service Corridor
Reclaim Water Dam
Northern Tailings Storage
Southern Tailings Storage
Access Road
Reserve
Stock
Travelling
West Wyalong
Burcher
Railway
FIGURE 4-5
Isopleths exceeding NHMRC Guidelines for TSP
Cowal Gold Project
LEGEND
Isopleth for Construction Phase (60 Fg/m3)
Isopleth for Year 1 (60 Fg/m3)
Isopleth for Year 3 (60 Fg/m3)
Isopleth for Year 6 (60 Fg/m3)
Proposed Area of Disturbance
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0 0.5 1.0 Kilometres
NOTE:
NHMRC guidelines recommend a maximum annual concentration of 90 Fg/m TSP. Existing TSP concentrations average 30 Fg/m across the Project site, thus an increase of up to 60 Fg/m is permissable under the guidelines.
ResourceStrategies
NOC-97-03_S4-002D.CDR

Mitigation Measures

The use of standard dust control measures and safeguards should ensure the Project complies with EPA standards for TSP and would not adversely affect public health in the surrounding areas as detailed in Section 4.5.2.

4.5.4 Other Emissions

Other emissions associated with the Project would be exhaust fumes from mobile equipment and blasting fumes. Evaporative emissions from processing areas are typically very minor and so restricted in gold plants, not to warrant specific monitoring. The use of cyanide around the plant will however, be closely monitored through implementation of a Hazardous Waste and Chemical Management Plan (detailed in Section 6). It is expected that these emissions would be minor and confined to the Project site, thus not impacting on surrounding areas.

4.6 Acoustics

Ambient noise surveys were conducted in July, August and December 1994 and January 1995 in order to characterise and quantify the existing acoustical environment in the area surrounding the proposed mine site. The surveys, which are described in Section 3.7 and Appendix H, indicated that the background noise levels were normal for a rural area. The potential noise impacts from the proposed mine were also modelled. These are outlined in the following section.

4.6.1 Noise Criteria

Mine Construction/Operation

The noise criteria used to assess potential noise related impacts of the Cowal Gold Project on neighbouring lands are detailed in Appendix H. The following summary of the criteria used is provided.

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the EPA which administers the Noise Control Act, 1975. In implementing its environmental noise control policy, the EPA has two broad objectives:

(a) That the noise from any single source does not intrude greatly above the prevailing background noise level; and

(b) That the background noise level does not exceed the level appropriate for the particular locality and land use.

To assist in balancing possible adverse effects on individuals and potential benefits to the broader community arising from infrastructure development and resource use, the EPA has drafted a schedule of recommended L_{A90} background noise levels for various land-use categories. In order to satisfy its first broad objective, the EPA has recommended that maximum operational noise levels (L_{A10}, ie. the noise level exceeded 10% of the time) should not exceed the background noise level (L_{A90}, ie. the noise level exceeded 90% of the time) by more than 5 dBA.

On the basis of the recorded background noise levels (Tables 3-13 and 3-14) and the EPA's Noise Control Manual, the recommended daytime and night-time L_{A10} design limits for noise emissions for winter and summer are presented in Table 4-8, for Monday to Sunday operations.

As discussed in Appendix H, the EPA is currently reviewing guidelines in relation to noise emission from industry. At present, the EPA appears to have no definitive position in regard to permissible levels of noise emission under various (non-neutral) weather conditions. Until further guidance is issued by the EPA, it is assumed that a new mining operation should be required to comply with the EPA $L_{A10\ (15\ minute)}$ planning noise limits under neutral atmospheric conditions, recognising that actual weather-affected $L_{A10\ (15\ minute)}$ noise emission levels would sometimes be lower than these "neutral" levels, and sometimes higher.

Blasting

A detailed description of the blasting criteria used for the noise modelling is provided in Appendix H. Criterion relating to structural damage, human comfort and effects on wetland birdlife are discussed. The adopted criterion for the control of blasting impact at residences are indicated in Figures 9.2.1 and 9.2.2 (Appendix H) and Table 4-9.

Mine Traffic

For rural situations the EPA recommends that residences should have an $L_{Aeq,T}$ of not more than 50 dBA for new developments (ie Cowal Gold Project) and 55 dBA for existing situations during daytime hours (7.00 am to 10.00 pm). An $L_{Aeq,T}$ 5 dBA below these levels is generally acknowledged as applicable to night-time hours (10.00 pm to 7.00 am).

Table 4-8 Recommended L_{A10} Contributed Noise Level Design Goals - Monday to Sunday (dBA)

Locations	Winter		Summer	
	Daytime (7 am - 6 pm)	Night-time (6 pm - 7 am)	Daytime (7 am - 10 pm)	Night-time (10 pm - 7 am)
Coniston	35	33	35	33
Lakeside	35	33	36	33
Lake Cowal	35	33	35	33
Gumbelah	35	33	36	33

4.6.2 Noise Emissions

In order to determine the acoustical impact from the Cowal Gold Project, a computer model was used to assess the relationship between significant proposed noise-emitting operations, the surrounding terrain and nearby potentially affected residences. The procedures used to predict the noise impact on local residences from the mining operation are detailed in Appendix H.

Richard Heggie Associates (1997) identified the major sources of noise and vibration emissions associated with the Cowal Gold Project as:

- noise emissions from mobile plant and equipment during the construction phase;
- noise emissions from mining operations including fixed processing plant and mobile equipment;
- ground vibration and airblast emissions resulting from blasting operations; and
- noise emissions from traffic on public roads.

4.6.3 Noise Emissions Associated with the Project

Potential Impacts During Construction and Mining

Modelling of noise emission levels for construction (Year -1) and mining operations (Years 3 and 8) at the respective residences has been conducted assuming concurrent operation of all items of mobile equipment and processing plant under neutral meteorological conditions. The results of the model show L noise contributions during daytime and night-time under neutral conditions meet the noise level design goals (Table 4-10). Figures 4-6, 4-7 and 4-8 present the predicted noise emission contours under neutral conditions for construction and operational Years 3 and 8.

As a further conservative measure, and notwithstanding the fact that the noise level design goals apply to neutral atmospheric conditions only, additional modelling was performed under 'adverse conditions' (ie. a 1.5 m/s wind blowing from the noise sources towards the receiving residence and a 3°C/100 m temperature inversion, each together with an air temperature of 20°C and relative humidity of 70%). The predicted noise levels under the modelled conditions are given in Table 4-11. Predicted noise emission contour diagrams under adverse conditions for construction and operational Years 3 and 8 are provided in Appendix H.

The contributed L_{A10} noise emission levels at all the modelled residences comply with both daytime and night-time noise level design goals under adverse conditions.

Mitigation Measures

As indicated above, modelling indicates the Project would meet the noise level design goals at all modelled residences.

Notwithstanding, North have options to purchase several properties neighbouring the proposed MLA (Figure 1-4). The resulting buffer would serve to increase the distance between noise emitting sources and non North-owned residences.

In addition, noise and blast monitoring would be conducted at residences adjoining the proposed MLA, where necessary. In the unlikely event that the noise level design goals are exceeded, the owners would be consulted regarding appropriate ameliorative measures, such as changes to operating blast times or bunding of noise source areas.

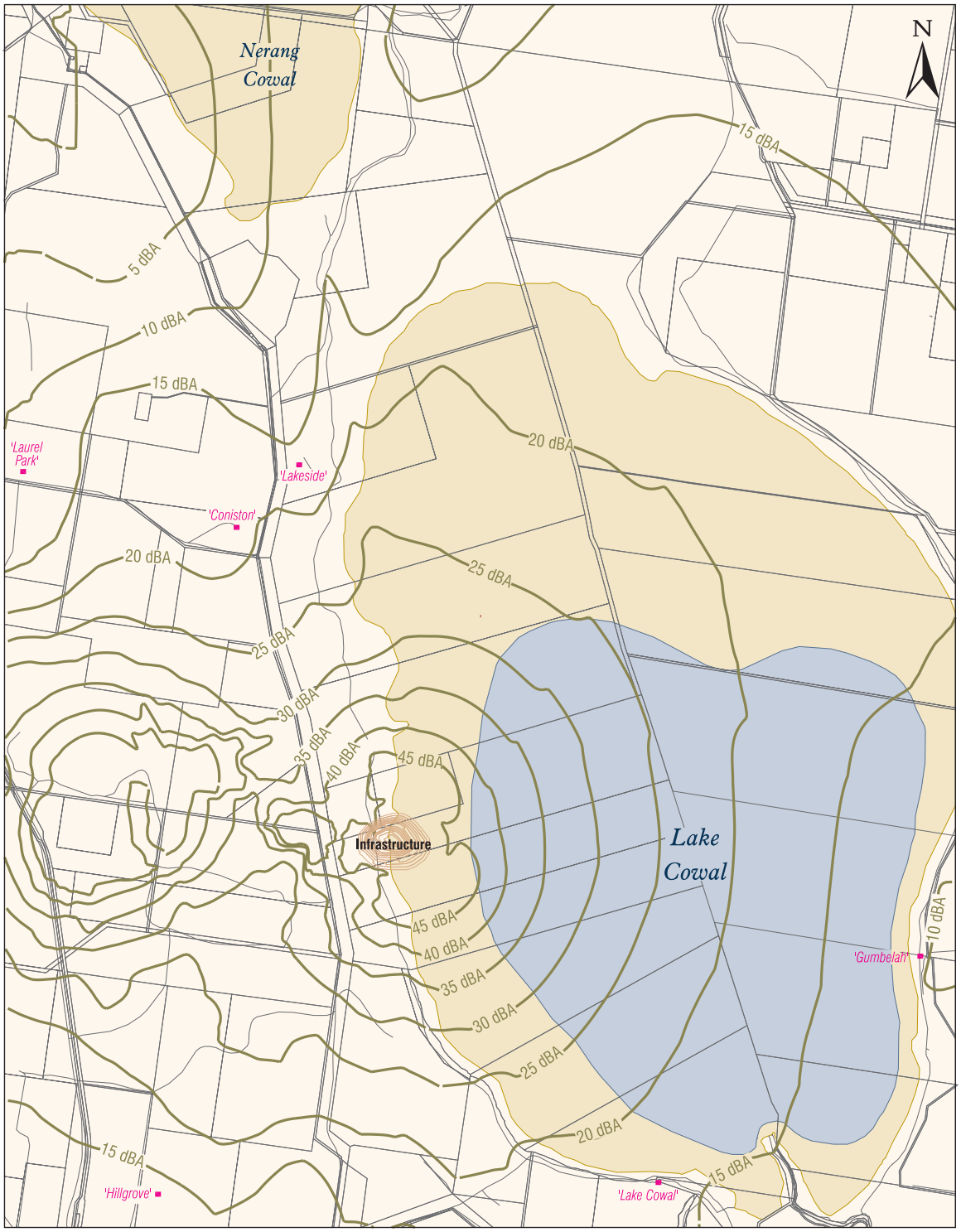
NPWS was consulted during the noise assessment and supplied a set of technical references regarding noise levels that may disturb or otherwise affect the feeding or breeding patterns of wetland birds. Discussion of the findings of these references and potential impacts on wetland birdlife associated with noise emissions are provided in Appendix H and Section 4.4.8.

Table 4-9 Limiting Criteria for the Control of Blasting Impact at Residences

Time of Blasting		Airblast (dB Linear)	Ground Vibration, Peak Particle Velocity (mm/sec)
Monday – Saturday	0900 hrs to 1500 hrs	115	5
Monday – Saturday	0600 hrs to 0900 hrs 1500 hrs to 2000 hrs	105	2
Sunday and Public Holidays Any day	0600 hrs to 2000 hrs 2000 hrs to 0600 hrs	95	1

Table 4-10 Predicted L_{A10} Noise Contributions under Neutral Conditions Construction and Mining Years 3 and 8

Location	Predicted L_{A10} Noise Contribution – dBA			Recommended L_{A10} Design Goal – dBA			
	Construction	Mining Operations		Winter		Summer	
		Year 3	Year 8	Daytime 7am – 6pm	Night-time 6pm – 7am	Daytime 7am – 10pm	Night-time 10pm – 7am
Coniston	16	11	21	35	33	35	33
Lakeside	20	10	19	35	33	36	33
Lake Cowal	16	14	13	35	33	35	33
Gumbelah	19	9	11	35	33	36	33


N
Nerang Cowal
Lake Cowal
Infrastructure
'Laurel Park'
'Lakeside'
'Coniston'
'Gumbelah'
'Hillgrove'
'Lake Cowal'
5 dBA
10 dBA
15 dBA
20 dBA
25 dBA
30 dBA
35 dBA
40 dBA
45 dBA
LEGEND
Noise Contour (L_{A10})
Homestead
0 1 2
Kilometres
ResourceStrategies
NOC-97-03_S4-003C.CDR
FIGURE 4-6
Predicted Construction Noise Levels (L_{A10}) under Neutral Conditions
NORTH
Cowal Gold Project

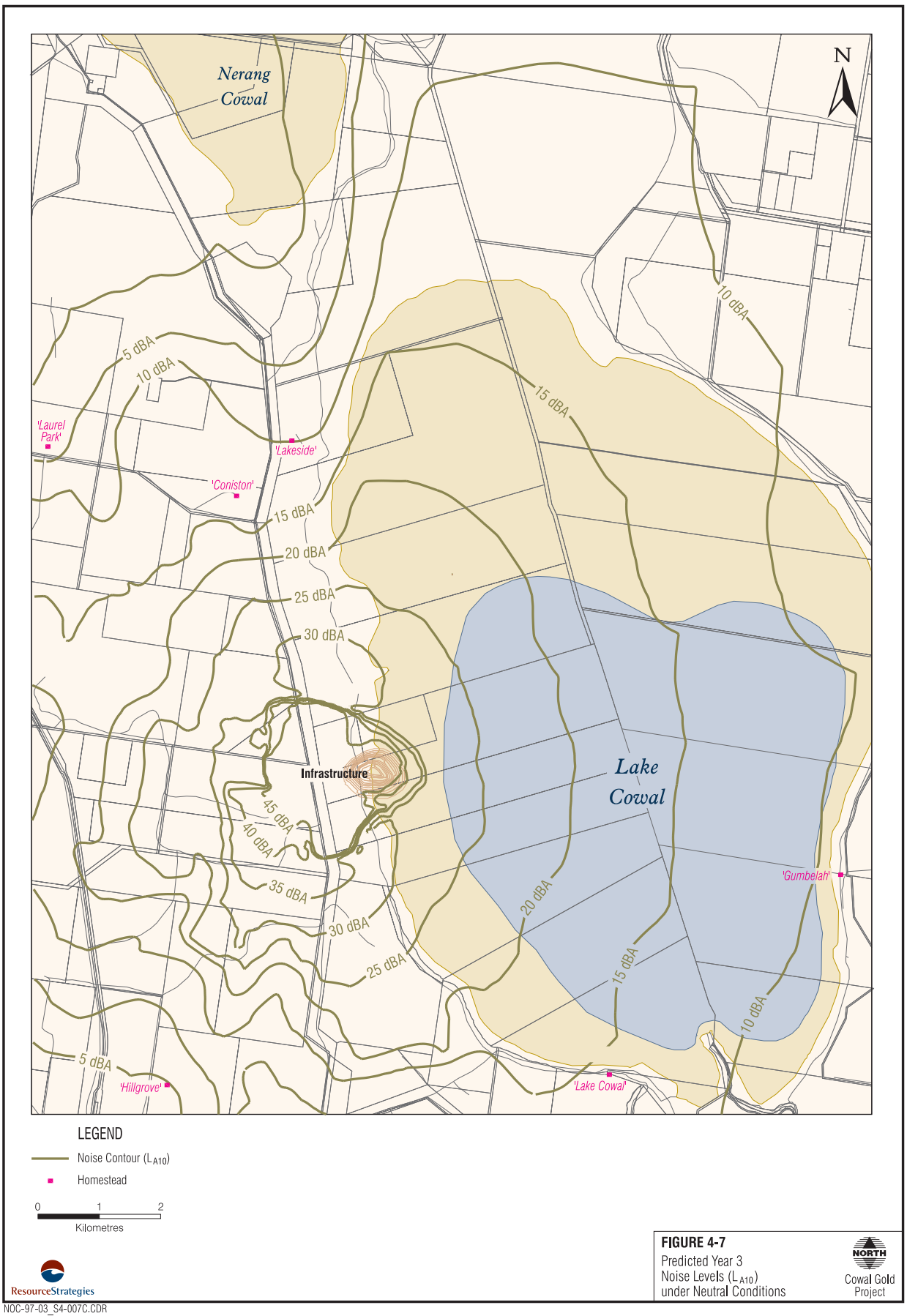
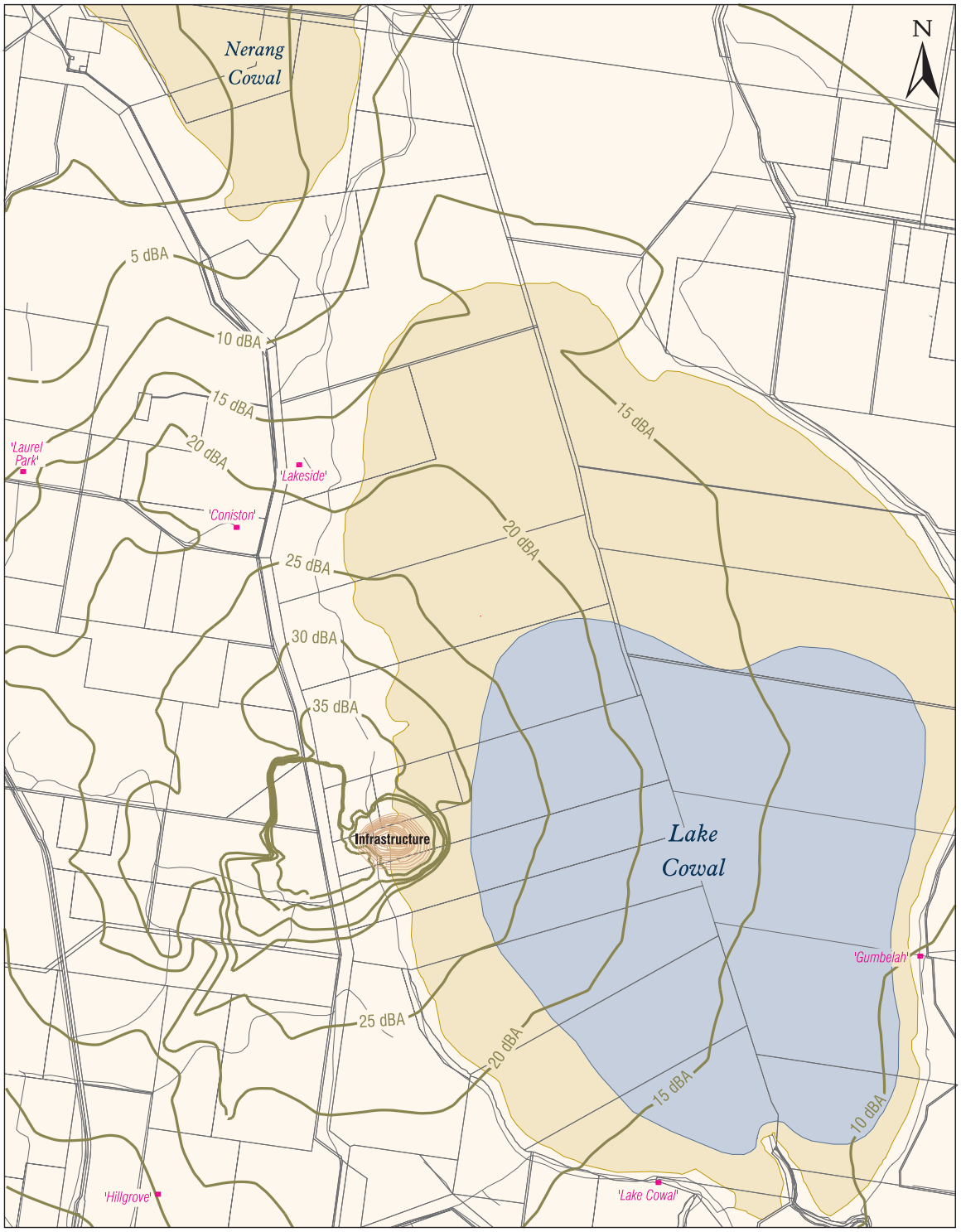


FIGURE 4-7
Predicted Year 3
Noise Levels (L_{A10})
under Neutral Conditions

NORTH
Cowal Gold Project



NOC-97-03_S4-008C.CDR

Table 4-11 Predicted L_{A10} Noise Contributions Under Adverse Weather Conditions

Location	Predicted L_{A10} Noise Contribution - dBA					
	3°C/100 m Inversion			1.5 m/s Wind		
	Construction	Mining Operations		Construction	Mining Operations	
		Year 3	Year 8		Year 2	Year 8
Coniston	24	22	27	26	26	31
Lakeside	22	20	24	25	23	28
Lake Cowal	24	20	19	25	22	22
Gumbelah	20	16	15	21	17	17

Potential Impacts Due to Blasting

The levels of ground vibration and airblast have been conservatively predicted for the maximum proposed ore and waste production rate. Details of the production blast design used are provided in Appendix H. The predicted levels of blast emission are shown in Figures 9.2.1 and 9.2.2 (Appendix H) and Table 4-12.

Compliance with the EPA's recommended general human comfort criteria for ground vibration and airblast are predicted to be met at distances of 435 m and 670 m respectively. As all residences are located greater than 4.5 km from the open pit, blast emissions at all surrounding residences consequently clearly comply with the EPA criteria.

Mitigation Measures

Based on the results of the detailed noise and blasting study (Appendix H), the blast emission criteria should be met at all times. However, monitoring of noise, vibration and movement at these residences would be conducted as necessary. In the unlikely event that EPA criteria are exceeded and a nuisance is created, appropriate ameliorative measures would be investigated (ie re-scheduling blast times where climatic conditions are unsuitable, or bunding).

North propose to develop a suitable protocol to facilitate prompt resolution of any complaints raised as a result of blasting. Complaints would be received through a formalised complaints procedure (eg. dedicated 24 hour phone line and complaints register). Where appropriate, monitoring would be implemented to access the validity of the complaint. Where necessary, preventative measures would be introduced to satisfy EPA criteria.

Of the ground vibration and airblast associated with blasting at the Cowal Gold Project, only airblast has the potential to affect birds. Discussion of the findings of the available references and potential impacts on wetland birdlife associated with blasting are provided in Appendix H and Section 4.4.8.

Table 4-12 Predicted Levels of Blast Emission

Residence	Distance from Blasting (km)	PVS Ground Vibration Velocity (mm/s)	Peak Airblast (dB Linear)
Coniston	4.7	0.11	95
Lakeside	5.1	0.10	94
Lake Cowal	5.7	0.08	93
Gumbelah	7.2	0.06	90

Potential Impacts Associated with Mine Traffic Noise

A detailed description of the road traffic noise impact assessment is provided in Appendix H. The following is provided by way of a summary.

Calculations of noise emissions from road traffic associated with the Cowal Gold Project were conducted using the US Environment Protection Agency's method for the identification of the $L_{Aeq\ (1hour)}$ at receiver locations along the access route between West Wyalong and the Project site.

The peak hour traffic generation for the construction and mine operational phases expressed as vehicle type are indicated in Table 4-13.

Approximately 30 residences are situated adjacent to the proposed access route between West Wyalong and the Cowal Gold Project, at offset distances of between 30 m and 1,100 m from the roadway. The closest 18 residences were assessed in the predictive noise modelling. The locations of these residences are provided in Appendix H.

Noise levels ($L_{Aeq\ (1hour)}$) were calculated at the 18 closest residences for the combined peak hourly vehicle trips of trucks and buses during the construction phase (ie. 11 passbys), together with 26 light vehicle passbys. The results of these calculations are shown in Table 4-14.

The corresponding $L_{Aeq\ (1hour)}$ noise levels during the mine operational phase are given in Table 4-15, together with the maximum permissible number of heavy vehicle movements per hour to comply with the recommended 50 dBA "daytime" and 45 dBA "night-time" design goals.

The calculation of the $L_{Aeq\ (1hour)}$ was based upon an average noise level of 85 dBA at 7 m from passing heavy vehicles and of 73 dBA at 7 m from light vehicles travelling at an average speed of 100 km/h.

The results of the calculations show that, for the proposed vehicle movements during daytime and at night, the $L_{Aeq\ (1hour)}$ design goals of 50 dBA (daytime) and 45 dBA (night-time) are met at all residences except the five residences situated 30 m from the road, where a 4 dBA exceedance of the night-time design goal is predicted.

Mitigation Measures

The assessment of road traffic noise generated by the associated increase in vehicle movements along the proposed mine access road, has identified five residences likely to receive noise levels in excess of the design goal during the peak night-time traffic flows. In order to mitigate the identified potential impact the following mitigative measures may be investigated at these residences to reduce noise levels:

- relocating the 60 km/h zone further north along the Ungarie Road;
- limiting of heavy vehicle movements during the night-time to five per hour to ensure that the 45 dBA $L_{Aeq\ (1hour)}$ design goal is not exceeded at the five residences located 30 m from the access route;
- bunding of roadways near residences, where appropriate; and
- individual building insulation of the most adversely affected residences.

4.7 Heritage

4.7.1 Aboriginal Heritage

Several studies of the ethnography and archaeology of the Project area and its surrounding environment have been conducted by Culture & Heritage (1995, 1997) and Australian Archaeological Survey Consultants (1995). These reports are contained in Appendix E. A summary of the known history of the Project area and description of the identified archaeological sites is provided in Section 3.9. The location of identified archaeological sites are indicated on Figure 3-16.

Potential Impacts

The construction of the Cowal Gold Project would involve the development of mine landforms over some of the identified archaeological sites. Artefacts in the vicinity of the open pit, waste emplacements and tailings storage may be buried or destroyed if not salvaged. A summary of the known sites likely to be disturbed by development of the Project is provided in Table 4-16. The location of these sites is shown on Figure 3-16.

Mitigation Measures

An archaeological site management programme to protect, wherever possible, or salvage known sites within the Project area would be developed in consultation between the West Wyalong Aboriginal Land Council (WWALC), the Wiradjuri Regional ALC, the NSW ALC, NPWS and North. Site management would be directed towards protecting sites as well as enhancing local knowledge and appreciation of the cultural heritage of Lake Cowal. This would involve assisting the museum run by the WWALC by:

(i) establishing displays reflecting aspects of the cultural heritage of Lake Cowal;

(ii) sponsoring a booklet that provides a readable account of Aboriginal heritage and history at Lake Cowal and West Wyalong; and

(iii) sponsoring the search for and return of the carved trees originally taken from the Bland (Culture and Heritage, 1995).

Details of the programme developed to date are provided in Appendix E and Section 6. The direct consultation and negotiation process has involved direct contact between the company and Land Council representatives in order to explain views on the development and to negotiate management preferences. The advantage (and intention) of this approach was to encourage a co-operative management process.

In accordance with the legislative requirements of the *National Parks & Wildlife Act* (1974), sites to be salvaged or disturbed during mine construction and operation (as listed in Table 4-16) would require Consents to Destroy.

Table 4-13 Peak Hour Traffic Generation – Construction and Operational Phases

Vehicle Type	Construction Phase (No. per hour)	Operational Phase (No. per hour)
Trucks	1	1
Buses	10	3
Light Vehicles	26	40

Table 4-14 Predicted $L_{Aeq\ (1hour)}$ Noise Levels from All Road Traffic During Construction

Receiver Offset Distance	No of Residence	Combined $L_{Aeq\ (1hour)}$ Noise Level
30 m	5	49 dBA
50 m	7	46 dBA
75 m	4	43 dBA
100 m	2	42 dBA

Table 4-15 Predicted $L_{Aeq\ (1hour)}$ Noise Levels from All Road Traffic and Maximum Permissible Heavy Vehicle Passbys during Mine Operations

Receiver Offset Distance	No of Residences	Combined $L_{Aeq\ (1hour)}$ Noise Level	Maximum Allowable Truck Passbys	
			Daytime	Night-time
30 m	5	49 dBA	15	5
50 m	7	45 dBA	31	10
75 m	4	42 dBA	56	18
100 m	2	41 dBA	86	28

Table 4-16 Archaeological Sites Potentially Disturbed by the Project

Mine Landform	Archaeological Site
Waste Emplacements	LC1, LC2, LC3, LC4
Open Pit	P1, P2
Tailings Storage	F, G, I, J, K. L, M, N

Committees established to monitor or liaise with the mining operators or managers would include local Aboriginal representation. North would sponsor a Land Council position specifically for the purpose of cultural heritage management at Lake Cowal as required over the construction and establishment phase of the mine. Management tasks would include co-ordinating and managing site works as they relate to archaeological issues as well as advising the company, NPWS and Land Council as circumstances necessitated.

By way of summary, the following mitigation measures would be employed.

Open Pit & Waste Emplacement Area

- Site P1 (background artefact scatter). Artefacts to be collected and stored at the WWALC;
- Site P2 (scarred tree). Section of tree to be removed and displayed at the WWALC;
- Site LC1 ("mens site"). Excavation to determine the chronology and function of the site;
- Site LC2 (base camp). Fencing and signposting;
- Site LC3, 4 & 5 (small sites). Fencing and signposting;
- Sites LC6 a & b. The archaeological survey of the proposed electricity transmission line corridor is presented in Appendix D.

Tailings Storage Area

Several artefact scatters were located during the survey of the proposed tailings storage site. However, it is concluded that much of the cultural material is not particularly unusual, much of the cultural material is already disturbed, distribution and density of material in the tailings storage area is comparatively sparse (when compared to the Lake foreshore) and similar material occurs in exposures outside the Project area.

The material nevertheless has some interpretative value as an archaeological resource and may have some cultural value to the local community. Accordingly, North propose to facilitate the collection of a representative sample of the material for curation by the WWALC and would undertake further investigations where necessary.

Burials

The West Wyalong Local Aboriginal Land Council is concerned about the possibility of human remains being disturbed within the lease area. Field indications suggest that this is unlikely as sand bodies have already been severely disturbed by past and present landuse practices (eg. ripping rabbit burrows). Examination of these disturbed deposits did not locate any fragmented bone suggesting it is unlikely that any skeletal remains are contained within these deposits.

The existence of burial sites would be investigated by way of sites' manager supervision of earthworks in the vicinity of the small sand bodies near the Lake in case skeletal materials are unearthed.

Field inspections suggest this possibly is unlikely.

4.7.2 European Heritage

Potential Impacts

European settlement history of the Lake Cowal area was studied by the Bland Historical Society in 1993. A summary of the history is provided in Section 3.8.

No significant heritage items within the Project area were identified during the 1993 survey. The Bland Shire LEP does not list any items of local regional or state significance within the area to be disturbed by mining activities.

Mitigation Measures

As there are no known sites of European heritage significance within the Project area, specific management programmes are not required. However, in the unlikely event that construction and development of the Project results in the uncovering of items of heritage significance, appropriate identification and management procedures would be employed. These may include photography for archival purposes, interpretation by appropriate authorities, collection and relocation where necessary.

4.8 Social and Economic Aspects

The social and economic significance of the proposed Cowal Gold Project at the local, state and national levels is reported by CIE (1997) and is contained in Appendix K. A summary of this report's findings is presented below.

For the purpose of the following discussion, the local community is considered to be those people living in the Bland Shire which includes West Wyalong, Wyalong, and many small townships and farmhouses in the vicinity of these centres. Social context is determined by reviewing influences on the population of the Bland Shire and the availability of community services and infrastructure. The implications of the Project have been predicted by assessing the economic and other impacts on the local community, including adequacy of existing infrastructure to accommodate an increase in demand from the project workforce.

4.8.1 Employment Effects

Construction Phase

The construction phase is expected to last for 2 years, with an average workforce of approximately 200 persons with a peak of approximately 300.

A portion of the construction work force would be involved in both the construction phase and ongoing operational phase.

Although contractors would be encouraged to preferentially hire local labour, it is likely that the majority of the staffing requirements would be for specialist labour sourced from outside the region. This construction workforce would provide significant multiplier effects to the local economy through increases in retail, wholesale and trade services.

The demand for trades and labourers during the Project's construction phase could assist in temporarily ameliorating unemployment in the district and provide growth opportunities for local business.

Operational Phase

The Project would require 200 employees during the first eight years of the operational phase. At the completion of mining (year 8) employee numbers would decline to about 90. It is expected that 90 of the 200 employees would be employed by North directly, with the remaining 110 employed by contractors. Approximately 60% of the 200 positions are expected to be filled by local residents with the remainder being sourced from either existing North staff or from outside the region.

Accordingly, significant impact on local employment is anticipated, providing opportunities for the unemployed and the part-time or underemployed. Increased employment opportunities would assist in reducing the out-migration currently experienced among certain age groups.

4.8.2 Housing

During the construction phase, it is expected that there would be a high demand for temporary accommodation including motels, rental properties and caravan parks.

West Wyalong is well suited to cater for a transient population due to its location on the cross-roads of the Newell Highway and the Mid Western Highway. The town has 14 motels and 2 caravan parks which have adequate capacity to accommodate approximately 160 employees in motels alone during the construction phase (given the current low occupancy rates).

Demand for permanent housing would be high prior to the commencement of the operation phase through to when full production is reached. The demand for housing is stimulated by the employees who would reside in the local area.

North has estimated that approximately 30 houses would be required for staff. Four houses have been acquired to date and the remainder would be either purchased direct or newly constructed.

North's demand for property would provide a boost to the residential property market which has experienced a lull over recent years. The current lull in the property market may be attributed to the high reserve prices set by property owners in the area (CIE, 1997). Existing residential properties are only likely to be purchased if they are cheaper than building new houses tailored for employees and their families.

4.8.3 Social Infrastructure

Potential Impacts

The anticipated permanent population increases in local centres during the construction and operation phases are expected to comprise a mixture of age groups, both single and married. Accordingly, a range of community services and facilities would be required, including recreational, sporting, child health and social welfare facilities and services. This demand may decline subsequent to mine closure.

Mitigation Measures

Existing facilities and services within the Bland Shire include:

- health facilities (including two full-time and one part-time doctors, 3 days a week dental service, hospital and regular specialist and community health services);
- educational facilities including family day care, playgroups, primary schools, one high school and a TAFE campus;
- recreational facilities including tennis courts, golf course, gymnasium and sports ovals;
- social and community services including social security advisors, Red Cross, Aboriginal Land Council, Homecare and Meals-on-Wheels; and
- cultural/entertainment facilities including hotels, restaurants and churches.

Considering the existing diverse range of services and facilities locally available and a degree of spare capacity due to the declining population of West Wyalong, the demand generated by the incoming Project population is not expected to unduly exceed the existing levels of services and facilities.

4.8.4 Social Adjustment

Potential Impacts

The West Wyalong communities would experience some inevitable social adjustments in response to the proposed development.

The influx of people to the existing social networks may impact on the existing local social structure.

With an increase in the local population base, increases in employment opportunities, business turnover, optimum use of sporting facilities and other infrastructure is anticipated.

Adverse social effects may include:

- increased traffic offences;
- brawling;
- petty crimes;
- increased town activity that may result in a loss of character.

Over the life of the mine, population increases are expected to ease but not eliminate a net population outflow from West Wyalong.

Mitigation Measures

The expected increase in employment opportunities generated directly and indirectly by the Project would assist in arresting the out-migration among certain age groups such as school leavers.

Negative outcomes of social adjustment shall be minimised through a number of community initiatives aimed at integrating the newcomer population with the local population. Such initiatives shall include specially organised sporting and social activities, and regular consultation between Project management and local authorities.

4.8.5 Property Demand and Values

Potential Impacts

It is estimated that North would purchase or construct 30 houses for new staff. Houses to be constructed would be built on new plots or existing plots. Increased demand for residential property is expected to provide stimulus to the existing property market and may, depending on supply conditions, allow residents to achieve reservation prices that have been placed on their properties. Improvement in West Wyalong's services, facilities and road infrastructure is expected to have a positive impact on local property values.

This impact may be followed by a decline in property values subsequent to mine closure depending on regional economic activity and trends.

A previous study assessed properties surrounding the Northparkes gold and copper project, some 75 km north east of the proposed mine site. The assessment reviewed property transactions and included discussions with local property agents and landholders. The findings of the study indicated that the mine has had no detrimental affect on property values in the immediate areas surrounding the mine buffer zone. Property values had shown an increase from the period prior to the approval to the time of reporting (1995). The mine was not considered by buyers (around the time of reporting) to be a significant factor in their decision to buy or not to buy.

Mitigation Measures

The purchase of all land in the vicinity of the Project area would limit the availability of arable grazing land in the short-term. Given the limited land area occupied by the mine, no change in the value of agricultural production is expected.

4.8.6 Economic Effects

An increase in demand for accommodation and general goods and services including food, beverages and entertainment would be experienced during the construction phase. The 12 year operational phase would provide a diverse range of economic benefits to the local, regional and national economies. The benefits to the local community are expected to be substantial through an increase in demand for goods and services and the housing industry due to an increase in demand for accommodation.

It is anticipated that the total capital expenditure for the mine would be approximately $220 million with approximately 10% of capital expenditure expected to occur within the local region.

Increased expenditure by wage and salary earners is also expected with the production of approximately $9 million in wages and salaries and an anticipated associated increase in expenditure of up to $5.1 million.

Employment flow-on effects are also likely to increase the number of job opportunities which result from the mine (52 jobs estimated over and above direct employment of 200) and therefore an increase in $4 million in income.

Statewide benefits are expected to include an increase in the gross state product for NSW to an estimated annual total of $190 million. Additional economic benefits include general permitting fees, royalties and taxes to the Federal and State Governments.

4.8.7 Urban Infrastructure

Impacts on Tourism

Tourism in the area is a substantial contributor to the local economy. Tourist activity in West Wyalong is heavily based on its strategic location at the cross roads of the Mid Western Highway (linking Sydney to Adelaide) and the Newell Highway (linking Melbourne to Brisbane).

The mine is not expected to have a detrimental effect on tourism in the area as it is not visible from either of the two major highways running through the town. The prohibition on duck shooting in NSW has significantly reduced the number of people visiting the Lake for recreational activity and sport.

There would be a reduction in the availability of short-term accommodation during the Project's construction phase. This is not expected to present a problem as the town is well situated for short-term accommodation with a total of 14 motels and 2 caravan parks.

Special interest tourism associated with Lake Cowal (eg. bird watching) has suffered from a lack of infrastructure in the area, limited public access to the Lake and natural fluctuations in Lake level (eg. the primary bird breeding areas at the northern end of the Lake are some distance below the high water mark).

The areas which offer the greatest potential for growth in special interest tourism (eg. the northern end of the Lake) are distant from the Project and should not be materially affected by it. There is also some potential for special interest tourism to increase as a result of the mine development (eg. industry and environmental interest group tours).

4.8.8 Post-Mining Social and Economic Aspects

Potential Impacts

At the cessation of mining operations the use of retail supplies and community facilities and services would decline. An outflow of skilled labour and reduced demand

for housing and accommodation would also be anticipated. The exact scale of this impact is difficult to quantify, but likely to be similar to the "no mine" case presented in Appendix K.

Mitigation Measures

A consultative committee process would be initiated to identify the scale of the above potential impacts and provide relevant planning information to effect an efficient phase-out process. This process would include:

- Scale down of the Year 7 workforce would be used to provide an indication of the scale of the potential impacts and allow for planning for full mine closure;
- Post-mining issues are to be identified for discussion by the community consultative committee at Year 5 (two years prior to the cessation of mining);
- A plan would be developed for the phase-out of mine workforce which would address as far as practical identified community concerns; and
- The plan would be revisited and refined at Year 9 well before the operation is due to close.

4.9 Transport

The existing road, rail and air transport networks in the Lake Cowal area are summarised in Section 3.11. Potential impacts of the Project on the transport network during both the mine construction and operational phases have been assessed by Traffix (1997) and are contained in Appendix J. The following summary of the identified impacts during mine construction and operational phases is provided. Proposed mitigation measures are universal to both construction and operation and are described in Section 4.9.2.

4.9.1 Construction Traffic Phase

On-site construction activities are anticipated to occur over a two year period. During this period the level of activity would vary significantly as the various major mine components are developed. Construction workforce numbers are also likely to vary, however, for the purpose of impact assessment purposes on transport a workforce of 200 has been used.

On this basis the traffic generation from the site would be associated with the movement of 200 employees on a daily basis, six days per week. Workers would be deployed over a single 12 hour shift.

North propose to implement a transport system which makes use of a fleet of 12 seat capacity mini buses. These would provide a shuttle service between West Wyalong and the mine site. It is anticipated that 120 employees would be transported by the bus fleet. The balance of 80 workers (including 30 from West Wyalong and 50 from the townships) would make use of private cars, with car pooling actively encouraged.

In addition to the above, an average of 4 truck trips per day are anticipated (2 in, 2 out) during the construction period, with an additional one oversize vehicle arrival per week on average.

Potential Impacts

Potential Impacts (construction phase) on daily traffic flows and during peak periods were assessed by Traffix (1997). The assessment indicated flow increases on individual routes would be significant between West Wyalong and the Project site (sections of Billys Lookout Road, Wamboyne Road and Ungarie Road), but negligible on all other roads in the region (Mid Western Highway, Newell Highway). The performance of these latter roads would be unchanged, and existing levels of service would be maintained.

It is estimated that the Project would generate peak hour traffic of about 37 vehicles during busy construction periods. As part of the Traffic impact assessment, these flows were superimposed onto the road network and turning movements at the critical intersections determined (ie Ungarie Road – Wamboyne Road intersection, Ungarie Road – Mid-Western Highway intersection). The assessment indicated that average delays at these intersections would be only marginally increased while levels of service would remain unchanged.

4.9.2 Operational Traffic Phase

The operational phase of the Project would span a 13 year period, with operations being scheduled over 7 days per week, 52 weeks per year. This incorporates 8 years of open pit mining and processing followed by a 5 year processing-only stage. The mine would be operated by approximately 200 employees, comprising 80 day workers and 120 shift workers. The latter would be rostered over three 12 hour shifts on a rotational basis with some overlap, so that only 80 shift workers would be present on site at any one time.

It is anticipated that the shift workers would be transported to/from site using the proposed mini-bus shuttle service, while day workers are expected to predominantly use private cars (assumed average car occupancy of 2.2). In addition, an average of 10 visitor trips per day (5 in, 5 out) is expected over the life of the mine.

The movement of heavy vehicles to and from the mine would be related to deliveries of diesel fuel and other process consumables. Numbers of heavy vehicles would vary significantly according to the type of ore being processed (ie more reagents would be required during the processing of oxide ore) and the stage of the project (ie diesel requirements would reduce significantly once open pit mining ceases). The traffic assessment was conservative and used the predicted maximum number of heavy vehicle movements for any one year (ie. 4,226 truck loads per annum during the processing of oxide ore). This equates to a maximum average of 24 truck trips per day (12 in, 12 out) over the life of the mine. The maximum operational phase traffic generation (ie daily and hourly trips per vehicle type) is tabulated in Appendix J.

Potential Impacts

Potential impacts (operations phase) on daily traffic flows and during peak periods were similarly assessed by Traffix (1997). As for the construction phase, increases on

individual routes would be significant between West Wyalong and the Project site but negligible on all other roads in the region

Mitigation Measures

The traffic impact assessment conducted by Traffix (1997) concludes that the regional road system would perform satisfactorily under predicted future traffic levels, during both the construction and operational phases of the mine. However, during the course of the assessment several intersections on the proposed route were identified where improvements could be made to provide safe and convenient access to the site. It is emphasised that these improvements are necessary under existing traffic conditions, and that their need does not arise from the subject development proposal.

The improvements are shown in Appendix J and include the following:

- provision of a short passing lane within Wamboyne Road at Billys Lookout Road, together with improved priority control; and
- provision of a short passing lane in the Mid Western Highway at Ungarie Road, together with improved priority control, improved line marking and improved road shoulders within the intersection.

In addition:

- the existing dirt road within the gazetted road reserve running parallel with the railway line north from Billys Lookout Road to the gazetted railway crossing to the west of the south-west corner of the proposed MLA, would be reformed and sealed;
- a road realignment would be constructed at Billys Lookout within the existing road reserve to straighten the existing road section (see also Appendix O);
- sealing and minor realignments of the section of road from the Lake Cowal station silo to Wamboyne Road at Blow Clear; and
- intersection improvements along Wamboyne Road south to its intersection with Ungarie Road.

Internal traffic arrangements would be designed in accordance with appropriate guidelines, including the movement of vehicles and the parking requirements for employees and visitors. The Project would be serviced by a suitably sized carpark for staff and visitors.

4.10 Transport, Storage and Handling of Goods

Potential Impacts

Potential impacts related to the transport, storage and handling of goods to and on the proposed Project site were assessed by ANSTO (1997). This assessment is presented as Appendix L.

The following potential impacts may result due to the transport of dangerous goods to the Project site and storage and handling of such goods:

- spillage of material during transport;
- major spillage of material from on-site storage tanks; and
- spillage of diesel fuel onto the ground outside the mine site.

Mitigation Measures

Site bunding is considered to be a very effective barrier to the release of spilt material. Additionally a Hazardous Waste and Chemical Management Plan will be formulated and supplemented prior to mine construction. This plan, as detailed in Section 6, would provide safeguards, emergency response procedures for potential spill events, hazardous material inventories, as well as appropriate transport, handling, disposal and waste recycling procedures. Potential impacts will be further mitigated through compliance with relevant statutory considerations and Australian Standards (eg. AS 1940 – 1993 – *The Storage and Handling of Flammable and Combustible Liquids*).

Section 5

Section 5
Rehabilitation

5.0 REHABILITATION

This section outlines the proposed concepts for the progressive rehabilitation of the Project area.

The post-mining and processing rehabilitation proposals should be regarded as preferred concepts. Post-closure rehabilitation requirements and water management provisions would ultimately be formulated in consultation and with the agreement of key government agencies and other stakeholders.

This process would also require more detailed design studies and management plans prior to implementation. Rehabilitation trials would also be carried out over the life of the mine to refine the designs and confirm design performance. The agreed rehabilitation concept would be formulated into an annual rehabilitation plan. The proposals put forward in this section are therefore preferred concepts, maintaining a degree of flexibility to take into account future consultations, research and design.

5.1 Rehabilitation Philosophy and Objectives

The rehabilitation philosophy for the Project has been derived from the following factors:

- the location of the proposed Project within an area acknowledged for its conservation status as an inland wetland ecosystem;
- the consequent need to operate and rehabilitate the proposed mine in such a way that the conservation status of the Lake and its critical conservation values are preserved.

As a consequence, the rehabilitation philosophy for the Project can be stated as:

"To operate as a non-intrusive landuser and to create stable rehabilitated landforms that increase the areas of endemic vegetation in the Project area and the status of land-lake habitats."

This philosophy has led to the following rehabilitation objectives:

(i) The design and implementation of rehabilitation works at the new Lake foreshore in a manner consistent with the NSW State Wetlands Management Policy (DLWC, 1996).

(ii) Undertaking that the water quality of Lake Cowal is not detrimentally affected by the new landforms;

(iii) Revegetating the new landforms with selected communities of endemic vegetation that are both suitable to the physiographic and hydrological features of each landform, and which expand on the areas of remnant endemic vegetation that currently exist in the immediate region;

(iv) The run-of-mine placement (wherever possible) of subsoils and topsoils on final landforms to enable the progressive establishment of vegetation. This requires that the placed covers are of sufficient depth and properties to absorb and store rainfall.

(v) The expansion of habitat opportunities for wetland and terrestrial fauna species;

(vi) The design of landforms and selection of revegetation species in accordance with accepted principles of long term sustainability (eg. genotypic variation, vegetation succession, water/drought tolerances).

(vii) Land management practices which exclude grazing while sufficiently mature communities are established, with decisions on managed grazing to be made after this time.

The enclosed rehabilitation objectives and plan have drawn upon (and have close linkage to) the following key studies:

- the soil and waste geochemical investigations (Appendices B and C);
- the vegetation surveys and vegetation association mapping (Appendix A);
- the regional remnant vegetation studies conducted by Sivertsen and Metcalfe (1995);
- the findings of the long term compatibility studies, notably the ecological compatibility and final void studies (Appendix N).

5.2 Rehabilitation Programme

5.2.1 General Principles

(i) The rehabilitation of Project landforms is to be progressive and conducted in accordance with approved, verified plans which are to be updated annually.

(ii) The stability of newly prepared (ie. topsoiled) landforms prior to the establishment of long term vegetation is to be protected via the construction of moisture-retaining graded drains, water-holding structures (eg. surface depressions) and, where appropriate, the use of authorised hybrid cover crops to provide initial erosion protection.

(iii) Rehabilitation of the outer embankments of the tailings storages to be grassed during processing operational years, reducing habitat opportunities for avifauna.

(iv) Endemic groundcover, understorey, and tree seed and seedlings would be cultivated and utilised (Section 5.4).

(v) The annual rehabilitation programme and budget is to be prepared by a site team incorporating the Project's senior management.

Plate 5-1 presents a conceptual future view of the rehabilitated Project area.

5.2.2 Land Clearance

As demonstrated on Plate 1-3 and by the description of vegetation in Section 3.4, the Project area is characterised by cleared grazing/agricultural land or scattered remnant woodland and isolated individual trees. A portion of the remnant woodland on Cowal West Hill would be removed along with a small number of mature River Red Gums in the footprint of the pit and perimeter waste rock emplacement (the new Lake foreshore).

The general arrangement of the Project as it develops over time is discussed in Section 2 (Figures 2-1 to 2-5). The total area to be disturbed by Project activities is approximately 940 ha. Although progressive, the majority of surface disturbance would occur in the construction phase and first three years of mining operations (Figures 2-1 to 2-3).

Land clearance protocols would be as follows:

(i) Any pre-mining commitments (eg. salvage of Aboriginal artefacts in pit area or approval of soil conservation and erosion control plans) to be checked off for completeness.

(ii) Trees to be checked for presence of fauna (eg. roosting bats) with a relocation programme undertaken in the event that they occur.

(iii) Land clearance and soil/waste stripping (for rehabilitation and construction purposes) is to be progressive and a stripping programme would typically consist of the following (Figure 5-1):

- in the pit/bund areas a non-saline layer of organic Lake sediment (up to 0.3 m thick) would be salvaged;
- from this same area a thick layer of non-saline Lake sediment (extending from approximately 0.3 m to 5 m below the surface) would be salvaged from the pit footprint area;
- transported cover material consisting of interbedded clay, sand and gravel varying in depth over the pit area (5 m to 55 m) would be selectively stockpiled;
- oxide material broadly differentiated into soft oxide material (occurring at depths of approximately 40 m to 65 m and consisting of extremely weathered clayey silt and saprolite) and hard oxide material (occurring at depths approximately 60 m to 90 m and consisting of partially weathered host rocks) would be selectively used for construction fill or stockpiled;
- primary material – unweathered host rock generally occurring at depths below 90 m and consisting of volcaniclastics, diorites and lavas would be selectively used for rock armouring;
- in the waste emplacement and tailings storage areas generally between 0.1 m and 0.35 m of topsoil (and, in select areas, suitable low-moderate salinity subsoil) would be stripped and separately stockpiled.

5.2.3 Soil and Waste Handling

Definitions

The soils and waste materials (weathered rock, oxide and primary rock) to be excavated by Project activities have been assessed for their geochemical properties and suitability for rehabilitation purposes [Appendices B (Soils) and C (Waste Geochemistry)].

Topsoil is defined as the generally darker, more organic material on areas to be disturbed. In the pit area it is typically up to 0.5 m thick and at the waste emplacement and tailings storage areas it ranges in thickness from 0.1 m-0.35 m. Topsoil would be stripped, stored and/or progressively replaced as the final surface material on new landforms.

Low-salinity Subsoil is defined as soil material that is physically and chemically suitable for stockpiling and replacement on final landforms as "subsoil" or a plant-rooting and moisture retention medium. It should have an electrical conductivity extract (EC_e) of less than 8 dS/m and, depending on its chemical properties, may or may not require gypsum treatment during stockpiling and subsequent reuse as a "subsoil" on final landforms. In the pit and bund areas it occurs as lake sediments to considerable depth (up to 11 m). Elsewhere in the Project area it generally occurs to maximum depths of 1 m-1.5 m (below which more saline subsoils naturally occur).

Gypsum-treated Subsoil is defined as subsoil that occurs below low salinity subsoil. It would be selectively used as (covered) construction fill or be stockpiled and subsequently reused on final landforms as deep cover on the tailings storages and waste rock emplacements. The amelioration of dispersive (sodic) properties during stockpiling (and in the comparatively short durations of exposure on final landforms prior to being covered with low salinity subsoil and topsoil) would be effected by the addition of gypsum, in accordance with existing agronomic practices.

Sufficient reserves of cover materials have been identified to meet conceptual rehabilitation requirements (Appendix B2 and Figure 5.1). Soil material management and storage is discussed below.

Oxide Waste Rock is defined as the weathered rock and hard oxidised volcanic/saprolitic material mined from the pit. The majority of oxide waste would be placed in the waste rock emplacements or used as select (covered) fill for construction works.

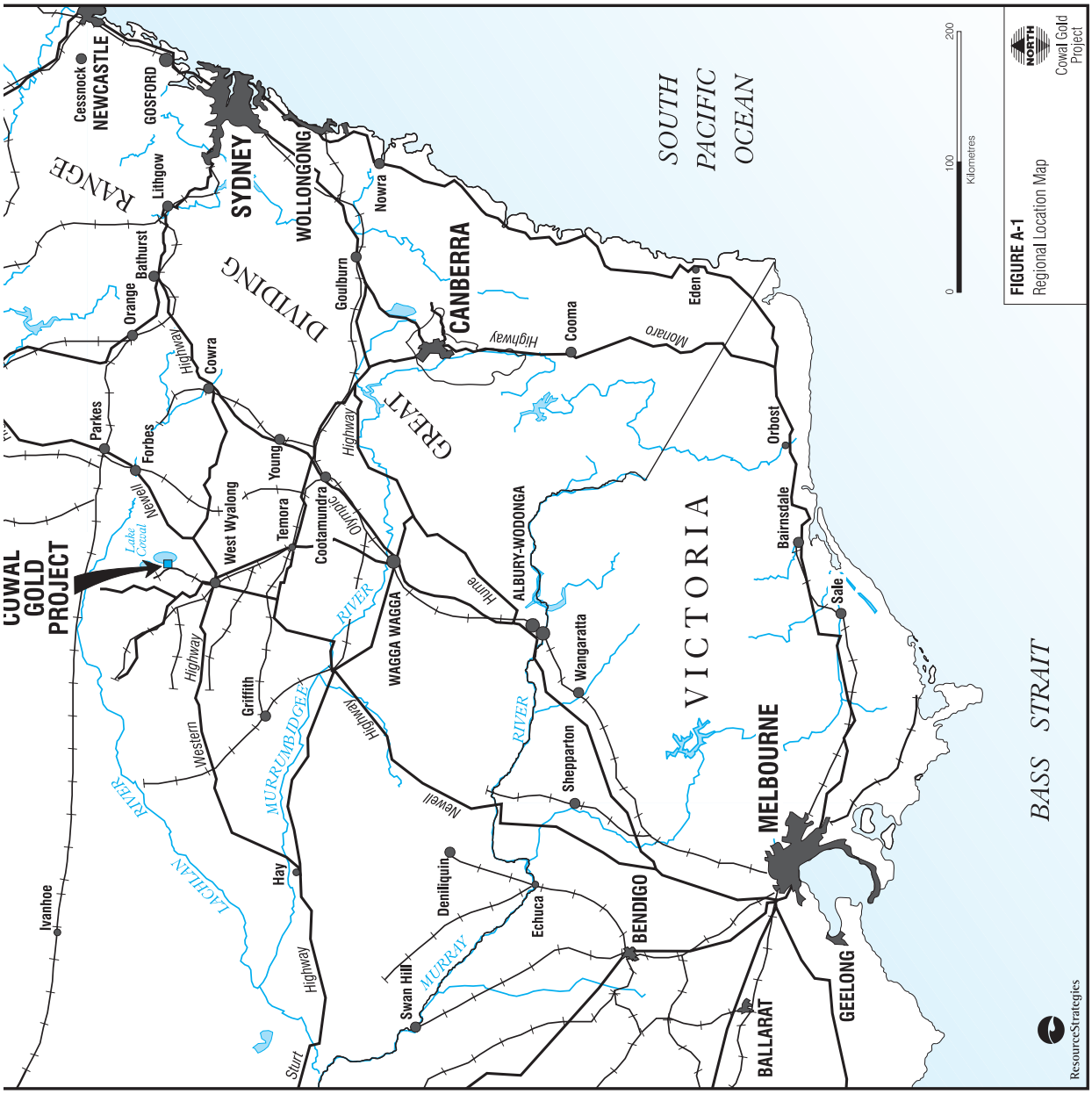
Primary Waste Rock is defined as the unweathered, mined volcanic waste rock from the pit. It would be placed in the waste rock emplacements, to be deep covered by oxide waste followed by subsoil covers and topsoil, prior to revegetation.

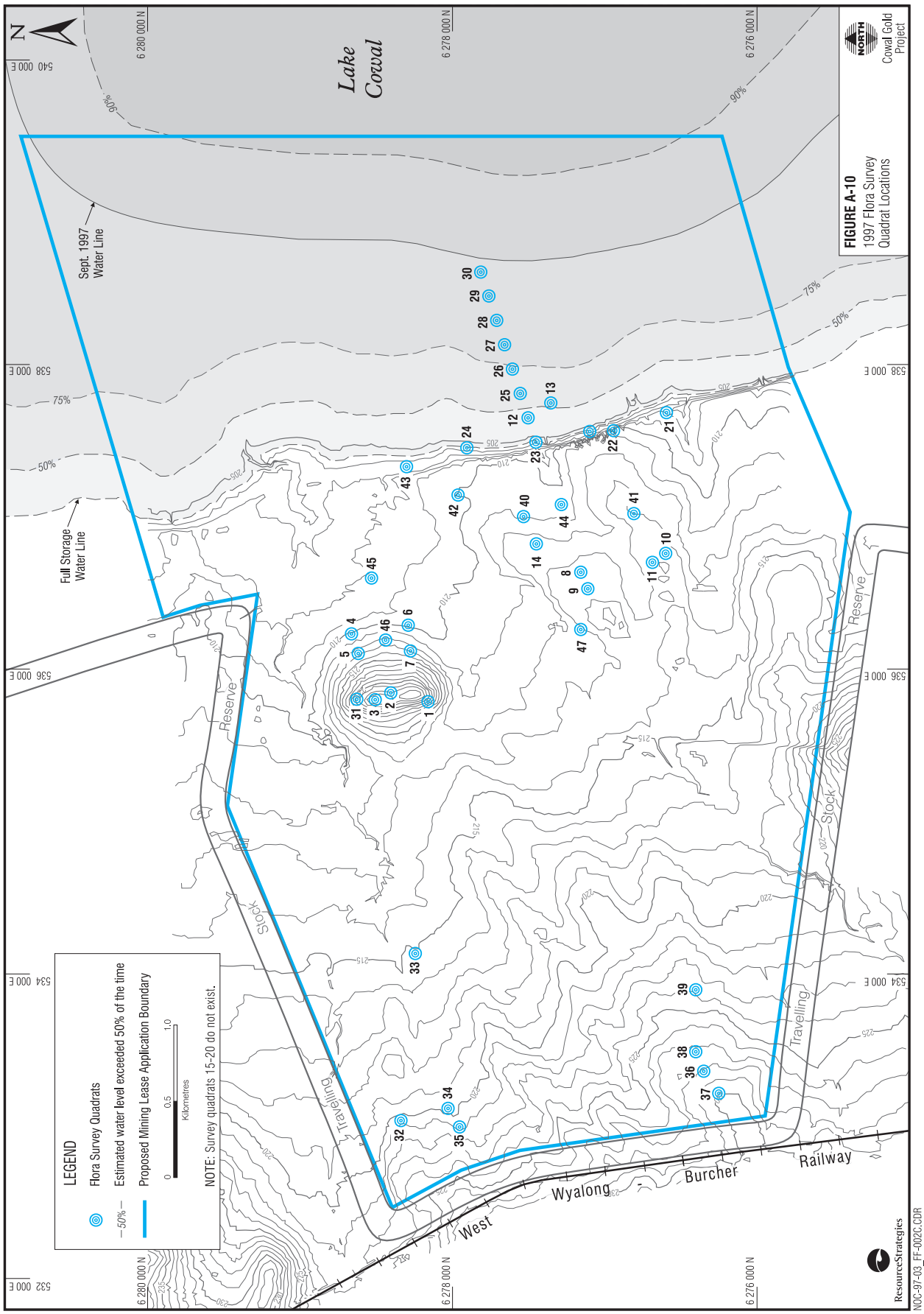
Topsoil and Subsoil Stockpiling Protocols

Prior to progressive clearing and soil stripping, infill testing of soil profiles would be undertaken to confirm the precise depths of topsoil in a particular area.

Topsoil would be stripped and stockpiled separately to subsoils. Longer term topsoil stockpiles would be constructed in line with accepted practices (2-3 m high) and stockpiling procedures would be confirmed in consultation with DLWC. The proposed location of soil stockpiles is shown on Figure 5-2.

Low salinity subsoil would be tested prior to stripping to confirm the suitable depth for excavation. It would be stockpiled separately, and fertilised and sown with an appropriate cover crop. Gypsum would be applied during stockpiling if necessary.


COWAL GOLD PROJECT
Lake Cowal
Parkes
Forbes
Orange
Bathurst
Lithgow
Cessnock
NEWCASTLE
GOSFORD
SYDNEY
WOLLONGONG
Nowra
Goulburn
CANBERRA
Cooma
Eden
Orbost
Bairnsdale
Sale
West Wyalong
Young
Cowra
Temora
Coolamundra
Griffith
WAGGA WAGGA
ALBURY-WODONGA
Wangaratta
Shepparton
Deniliquin
Hay
Ivanhoe
Swan Hill
Echuca
BENDIGO
MELBOURNE
BALLARAT
GEELONG
Highway
Western
Newell
Olympic
Hume
Monaro
RANGE
DIVIDING
GREAT
RIVER
MURRUMBIDGEE
MURRAY
LACHLAN
VICTORIA
SOUTH PACIFIC OCEAN
BASS STRAIT
0
100
200
Kilometres
FIGURE A-1
Regional Location Map
Cowal Gold Project
ResourceStrategies
NOC-97-03_FF-023A.CDR


Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
75%
50%
90%
Reserve
Stock
Travelling
Railway
West
Wyalong
Burcher
LEGEND
Flora Survey Quadrats
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
Kilometres
NOTE: Survey quadrats 15-20 do not exist.
FIGURE A-10
1997 Flora Survey
Quadrat Locations
Cowal Gold Project
NORTH
ResourceStrategies
NDC-97-03_FF-002C.CDR

Gypsum-treated subsoil would be stockpiled separately and would be ameliorated for storage by the application of gypsum, fertiliser and a cover crop.

All stockpiles would be signposted with the date of construction and type of soil. The mine's environmental department would keep a database on the location and volume of each stockpile, in addition to a stockpile maintenance record (eg. weed management, fertiliser regime) the details of which would be confirmed in consultation with DLWC.

5.2.4 Erosion and Sediment Control Rehabilitation Works

Operational erosion and sediment control (ie. while the mine landforms are being constructed and rehabilitated) is detailed in Appendix F and Section 2.9. Summarised details as they relate to landform rehabilitation are presented in this section.

The guiding principle of erosion and sediment control is the protection of Lake water quality. This is to be achieved by the permanent separation of the Project site into Up-catchment and Internal water management systems (Figure 5-2).

The Internal Containment System effectively and permanently isolates the Lake from mine site runoff, with the exception of the eastern perimeter of the waste emplacement (comprising the temporary isolation bund, the lake protection bund, and a portion of the perimeter waste emplacement).

The Internal Containment System (Figure 5-2) enables runoff from the great majority of Project landforms to be contained on-site, where the water would be used by the Project. The system is to be created by the construction of a stabilised drain around the tailings storage (in the west) draining eastwards to link with existing natural drainage lines to the Lake. Water entering these drains is Up-catchment water and can be classified as of "undisturbed" origin. Runoff from areas inside the drains is "internal" and forms the Internal Containment System.

Early stabilisation of the Up-catchment and Internal dividing drain is a priority and would be conducted in the first three months of construction.

Stabilisation methods are likely to include:

(i) the preparation of a drainage works stabilisation procedure and protocol, to be prepared in consultation with DLWC and NSW Ag prior to any site works commencing;

(ii) the use of stabilising techniques such as meshing, hydromulching and the application of suitable rapid germinating pasture species in the drains;

(iii) the use of constructed rip-rap and gabion rock baskets at critical sites such as drainage confluences and outfalls to natural (existing) drainage lines.

Within the Internal Containment System, runoff would be conveyed to constructed runoff ponds via a combination of natural (existing) drainage lines and by graded contour banks (Figure 2-17 to 2-19). As with the Up-catchment drain, a combination of rapid stabilisation techniques would be required to effect the level of runoff quality control desired by the Project

Runoff control and rehabilitation works on the eastern perimeter of the waste emplacement would require detailed protocols and management systems to allow only "clean" runoff to the Lake. This would be achieved by the following construction activities:

Temporary Isolation Bund

(i) If the bund cannot be constructed when the Lake water level is lower than the bund's footprint, a silt curtain (an artificial membrane) would be manually placed in the immediate construction area.

(ii) Select inert rock would then be placed in a compacted arc to construct the bund.

(iii) A drain and temporary runoff pond would be constructed behind (west of) the bund to collect runoff west of the bund's arc to keep this area dry. This runoff would be pumped to the Project. The temporary isolation bund only needs to be in place until stabilisation of the lake protection bund and first batter of the perimeter waste emplacement (ie. the new Lake foreshore) is effected.

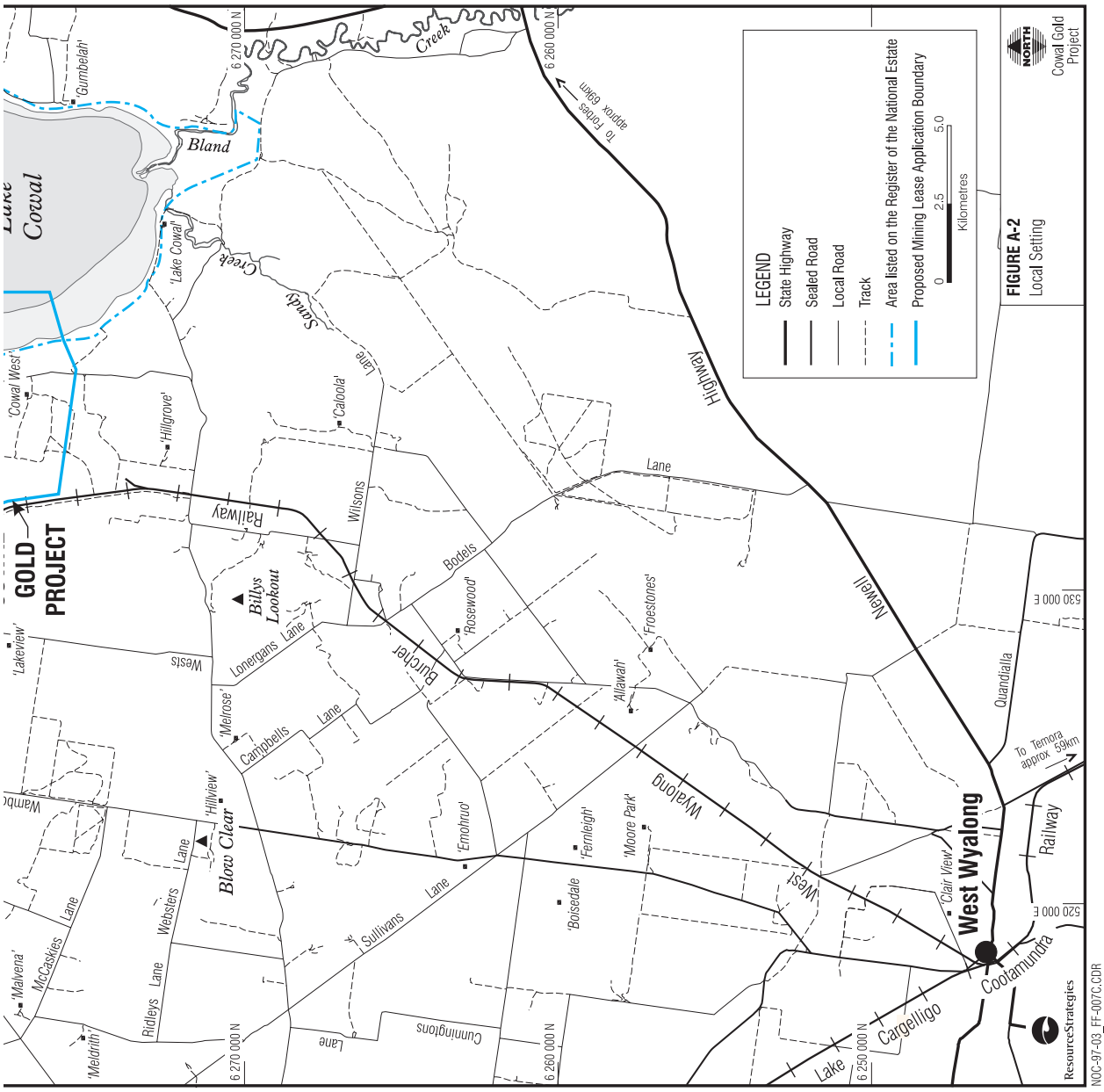
(iv) The bund surface would then be capped with organic Lake sediments, pre-stripped west of the bund and ultimately revegetated with endemic freshwater species. Proposed details for the rehabilitation of the temporary isolation bund are discussed in Section 5.3.1.

New Lake Foreshore

This landform includes the lake protection bund and about a 10 m temporary collection pond section of lakebed to (and including) the temporary isolation bund. Erosion and sediment control on this landform is to be effected as follows:

(i) The temporary isolation bund (and associated drain and temporary collection pond) which lies slightly to the east of the toe of the lake protection bund would be in place prior to lake protection bund construction; the section of lakebed between the temporary isolation bund and the new Lake foreshore would be effectively dry.

(ii) Rapid vegetation stabilisation of the lake protection bund and first batter of the waste emplacement would be effected by the planting of select lakebed vegetation and lake:land interface species (Section 5.3.1 for details), aided if necessary by the artificial stabilisation of the topsoiled surfaces (eg. by the use of netting and/or mulching). Section 5.3.1 recognises four freshwater ecological community zones or habitats for waterfowl at the new Lake foreshore (Figure 5 -3).


GOLD PROJECT
Lake Cowal
Bland
Creek
Gumbelah
'Lake Cowal'
'Cowal West'
'Hillgrove'
'Caloola'
Sandy Creek
Lane
Railway
Wilsons
Bodels
'Rosewood'
'Froestones'
'Allawah'
Billys Lookout
Lonergans Lane
Wests
'Lakeview'
'Melrose'
Campbells Lane
Burcher
Highway
Newell
Lane
'Hillview'
Blow Clear
Websters Lane
McCaskies Lane
'Malvena'
'Meldrith'
Ridleys Lane
Sullivans Lane
'Emohruo'
'Fernleigh'
'Moore Park'
'Boisedale'
Cunningtons Lane
Wyalong West
'Clair View'
West Wyalong
Quandialla
To Temora approx 59km
Railway
Coolamundra
Cargelligo Lake
To Forbes approx 69km
6 270 000 N
6 260 000 N
6 250 000 N
530 000 E
520 000 E
LEGEND
State Highway
Sealed Road
Local Road
Track
Area listed on the Register of the National Estate
Proposed Mining Lease Application Boundary
0
2.5
5.0
Kilometres
NORTH
Cowal Gold Project
FIGURE A-2
Local Setting
ResourceStrategies
NOC-97-03_FF-007C.CDR

Top Surface and Batter Erosion and Sediment Control
Erosion control on the bulk of the waste emplacement areas and the tailings storages is designed to absorb and store rainfall. This is based on providing a relatively thick soil cover which can absorb and store excess moisture for use by vegetation. This involves constructing an internally draining, irregular (rough) tailings storage surface, and constructing broad swales on waste rock emplacement surfaces. Batters are to be left with surface roughness and with reverse grading berms which longitudinally "drain" to low depressions within the berms. Coupled with the significant depths of cover (subsoil and topsoil) provided in the design, the landforms would effectively act as "sponges". Further details are provided in Section 5.3.

The sediment and water management drains and ponds constructed during the first four years of construction and operations would be retained until permanent stability is demonstrated.

5.2.5 Final Landform Concept Development

Landforms are to be:

(i) designed wherever possible to be compatible with regional landscape features;

(ii) progressively constructed as a run-of-mine operation wherever possible and left with untrimmed surface roughness to lower runoff coefficients and promote water absorption and storage;

(iii) revegetated with endemic vegetation communities, selected specifically for their suitability to the created elevation, substrate conditions and the overriding objective of re-establishing a greater extent of endemic vegetation on the Project area.

5.3 Final Landform and Revegetation Concepts

This section presents the rehabilitation concepts for the various Project landforms, coupled with the revegetation enhancement opportunities that arise from proactive planning of the landforms.

5.3.1 New Lake Foreshore

Definition for Rehabilitation Purposes

Included in this discussion are the following landforms, which together comprise the new Lake foreshore:

- the temporary isolation bund;
- the lake protection bund and the lower batter of the perimeter waste emplacement; and
- the intervening section of lakebed between the temporary isolation bund and the lake protection bund.

Preparatory Works
The temporary isolation bund would be reworked (and breached) by light machinery (eg. small excavator and bob cat) when the Lake level was lower than the bund, to create a series of low mounds. The mounds would comprise a mixture of the inert bund rock and lakebed sediments.

Freshwater Ecological Community
With respect to the new Lake foreshore the creation of a freshwater ecological community is an aim of the rehabilitation programme.

Freshwater communities, as waterfowl habitat, are composed of four types of zones (Braithwaite, 1975) *viz.*:

- flood zone;
- littoral zone;
- rush zone; and
- water zone.

These zones would be adopted as the basis for the revegetation strategy for the new Lake foreshore with particular emphasis on the flood, littoral and rush zones (use of water zone concepts will be limited due to the characteristic of strongly fluctuating Lake levels). When selecting revegetation species, the Lake's hydrological regime (wetting and drying cycles) as well as species performance during revegetation trials would be considered.

Water depth, permanence and regularity of inundation determine which of the freshwater communities would occur in a given situation (Figure 5-3). Reference to Figure 5-2 (and for detail, Appendix F) shows that the Lake level fluctuates over a considerable lateral extent (due to its flat bed). Consequently it would be expected that a wide variety of aquatic floral communities would establish in the absence of significant competition for Lake landuses (eg. cattle grazing, farming).

Flood Zone
This community is the most temporary of the freshwater habitats for waterfowl. A flood provides an immediate food source for a number of species (eg. Grey Teal) in the form of waterborne seed and insects (Frith, 1959). With the stabilisation and subsequent recession of floodwaters, the nutrient supplies in the shallow water support vigorous breeding of aquatic invertebrates and plankton. Ducklings of the Grey Teal are known to forage heavily on these aquatic insects as is the adult Pink-eared Duck which also utilises the plankton.

Littoral Zone
Littoral communities are characteristic of temporary or seasonal swamps on the corresponding zone of inundation around permanent habitats where there is an absence of water turbulence.

Ecological succession is the key to formation of littoral communities and their utilisation by waterfowl (Braithwaite, 1975). The drying out of the floor of the littoral zone is essential. The bottom is consolidated for optimum germination of aquatic plants and nutrients are released from oxidation of organic matter on exposure to air. Inundation causes an effect not dissimilar to a flood. The differences are: water level fluctuations are usually less rapid, the inundation occurs over a longer period, there is less turbulence from water currents and the water has time to clear as suspended solids settle. With an adequate nutrient supply these factors are conducive to the growth

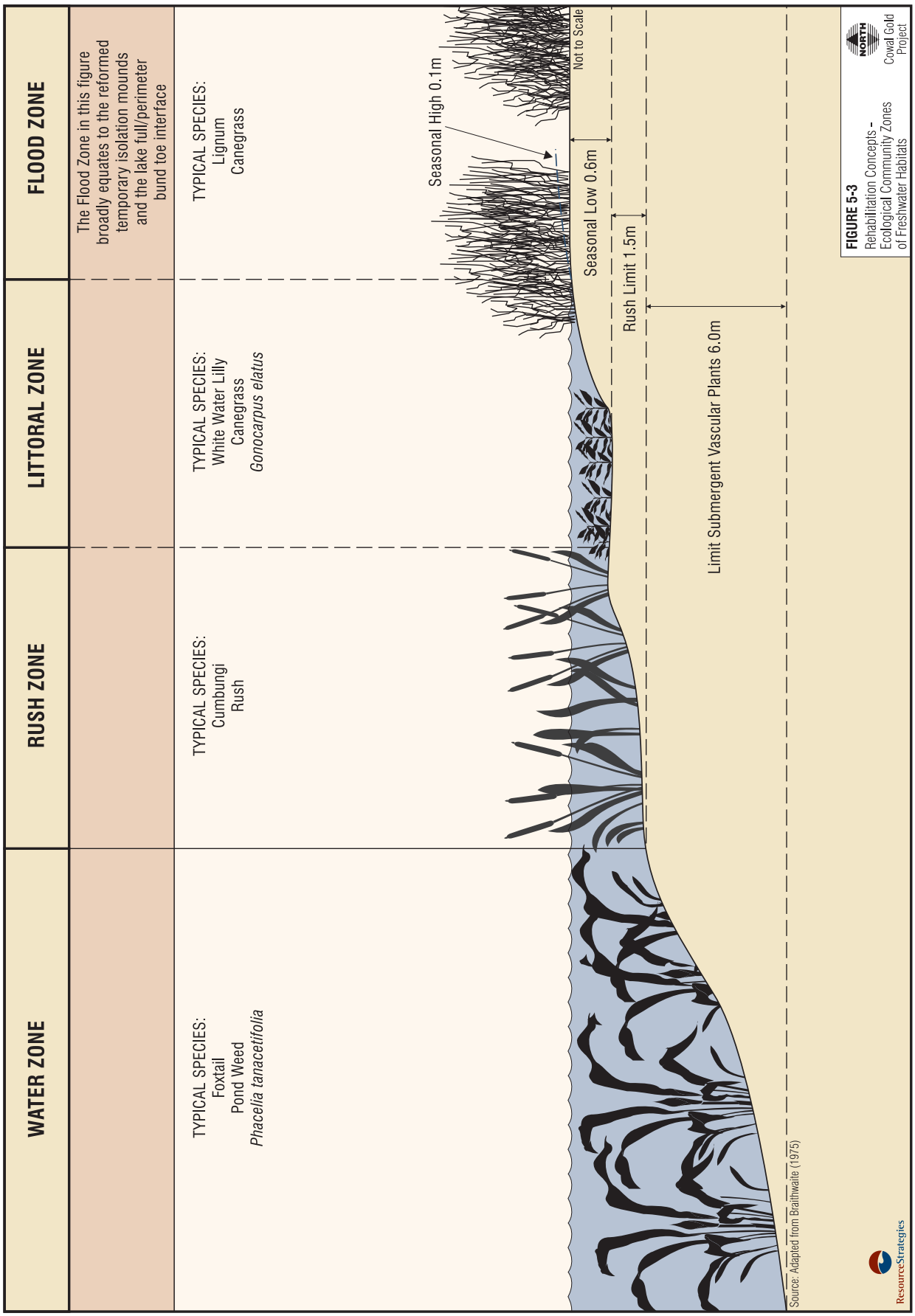


FIGURE 5-3
Rehabilitation Concepts - Ecological Community Zones of Freshwater Habitats

of a characteristically vigorous plant community (families *Characeae, Nymphaeaceae, Alismataceae, Gramineae, Haloragaceae*) and accompanying invertebrate fauna. Water snails (*Physastra*) and caddis fly (*Trichoptera*) larvae for example, can proliferate in this community type (Braithwaite and Frith, 1969).

Rush Zone

In Australia two genera of rushes predominate: Cumbungi (*Typha*) and Rush (*Eleocharis*). Both are important food plants, particularly in times of drought. The seeds of both genera are important to many waterfowl and in the south, the new shoots and leaf bases of Typha are a major food of Black Swans (Frith, Braithwaite and McKean, 1969).

Water Zone

A wide variety of aquatic plants (mainly of the families Potamogetonaceae, Hydrocharitaceae, Ceratophyllaceae and Haloragaceae) occur in water that is too deep for the establishment of rushes. The main requirements for their establishment appear to be water clarity, absence of turbulence and a reasonably firm substrate (Frey, 1966). Minor areas of this zone may occur about the new foreshore, particularly after consecutive wetter seasons.

Grazing waterfowl utilise the foliage of many of these plant genera. Other waterfowl utilise the seed or abundant invertebrates found in the foliage. In the absence of ancillary communities such as those that occur in the littoral zone, it is the species composition, health and vigour of the plants in permanent water that is the key determinant of the productivity of a permanent wetland (Braithwaite, 1975).

With respect to the short section of lakebed between the (rehabilitated) isolation bund and the perimeter bund, similar principles would apply whereby specific planting of zonal plant communities is proposed (Figure 5-3). The new Lake foreshore would be profiled during construction with the guiding influence of ecological enhancement in its design and layout. Consequently, the new Lake foreshore would be constructed with points and embayments at the Lake full/dry land ecotone as opposed to a more engineered, straight line profile.

Revegetation proposals for this component of the new Lake foreshore have considered the micro-variations in slope, elevation and hydrology that occur (Figure 5-4). The overriding objective is to re-establish the alliances that would have occurred in these habitats prior to significant clearing and intensive landuse. A broad number of vegetative suites are proposed, from Eucalypt woodland on the foreshore batters (banks), to Lignum/Canegrass and a variety of aquatic plant assemblages in the littoral zone. The opportunity to trial the establishment of regionally endangered species (such as Austral Pillwort) in this zone is proposed. The suppliers of revegetation species are expected to be local contractors or specialist nurseries, and if opportunities arise from landuse activities elsewhere around the Lake, transplanting species to the Project area.

5.3.2 Mine Waste Emplacements

Construction Philosophy

The footprint areas of waste rock emplacements would be stripped of topsoil and (if required for subsequent use) subsoil to the nominated depth (generally less than 1 m).

Where the ground surface following stripping dictates, emplacement base drainage control would be provided by the select placement and compaction of oxide waste or subsoil (Figure 5-5).

Primary waste, which forms about 80% of the volume of mined waste rock, would comprise the majority of waste emplacements. Oxide waste would be placed but would also be selectively used to construct the surface rehabilitation zone (generally during run-of-mine operations) and comprising:

- approximately 1.5 m – 2 m thick layer of select run-of-mine oxide waste;
- approximately 0.5 m ± of gypsum-treated low salinity or non-saline subsoil;
- approximately 0.25 m – 0.30 m of topsoil.

Batter drainage would be effected by the use of wide reverse-graded berms every 5 m vertical height. The berms would diffusely grade inwards and the surfaces be kept as rough as possible to maximise absorption. This, together with the considerable depth of cover over primary rock, would have the effect of absorbing and storing rainfall in all but extreme events (in which case, runoff would longitudinally fall along the berms to be held for absorption by a series of depressions constructed every 50 m – 100 m in the reverse-grading berms). This avoids the use of artificial drainage structures on the batters. Drainage on the top surfaces of the emplacements would be similarly managed via a series of small shallow basins (depressions), deep cover of high absorption capacity, and woodland vegetation with a high water demand. The use of depressions is aimed at maximising internal drainage without creating permanent ponding during normal and heavy rainfall events. A rockfill drainage outfall to the void would be constructed on both the northern and southern emplacements to convey any excess runoff to the void during extreme rainfall events.

The cover system selected for the waste emplacement (and tailings storages) is based on the following principles:

- the aridity of the Lake Cowal region, whereby annual average evaporation exceeds precipitation by a factor of at least 4 to 1 and where the rainfall pattern is evenly spread over the year;
- the high water-holding capacity of the contour-shaped surfaces;
- the high absorption and water-holding capacity of the deep cover system, which is intentionally left uncompacted and with surface roughness;
- the high soil moisture usage potential of deep rooted, woodland overstorey with a shrub and gross understorey;
- the non-acid forming characteristics of the primary waste rock.

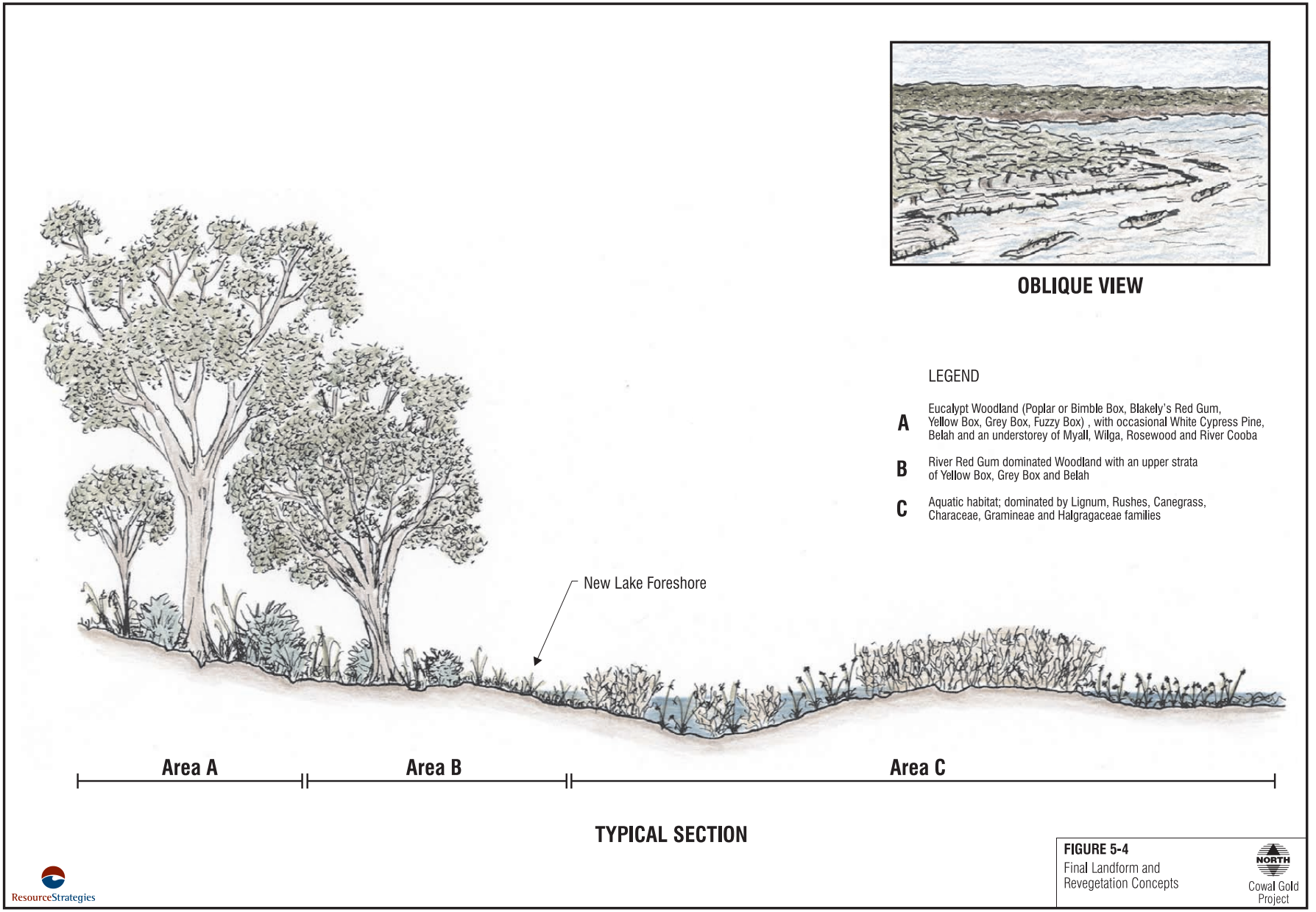
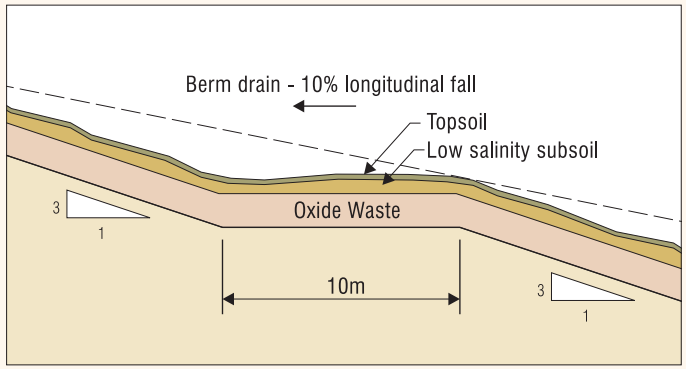
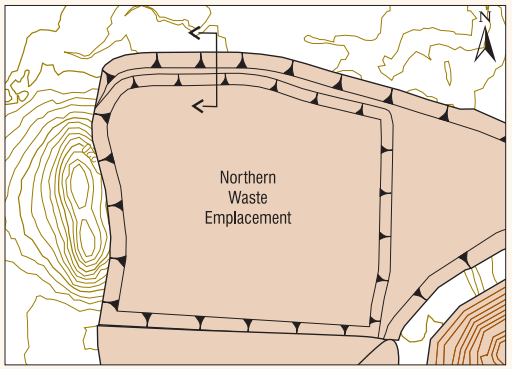


FIGURE 5-4
Final Landform and Revegetation Concepts

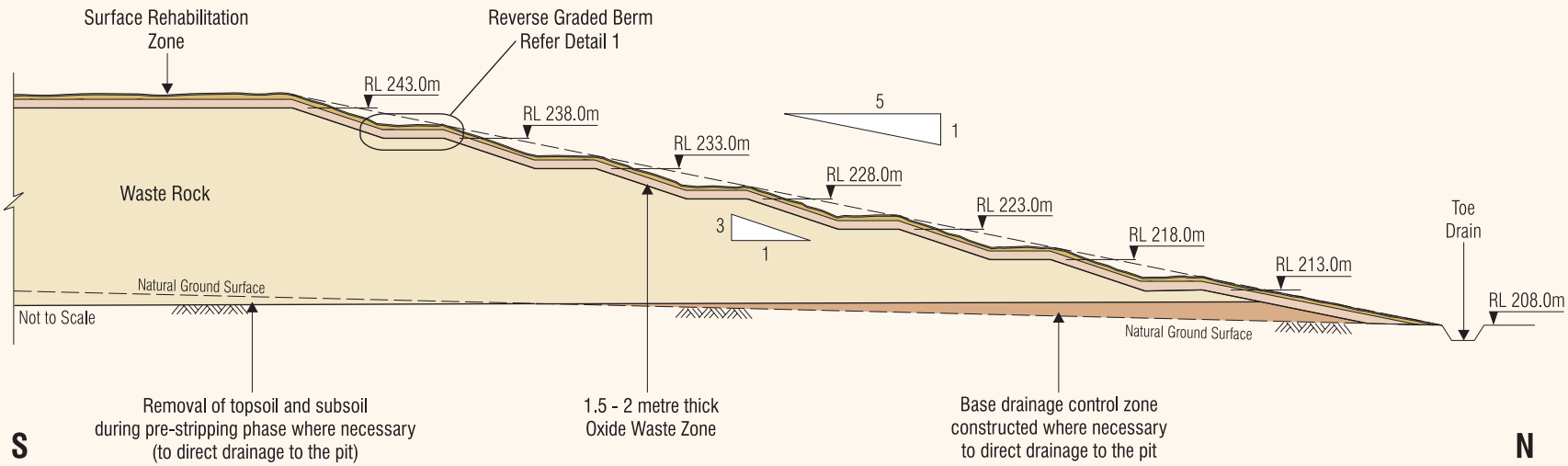
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DETAIL 1



PLAN



TYPICAL NORTH - SOUTH SECTION

FIGURE 5-5
Waste Rock Emplacement
Rehabilitation Cover Concepts

Cowal Gold Project

ResourceStrategies

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A typical section through the waste emplacement covers is shown in Figure 5-5.

Revegetation of Waste Emplacements

The revegetation proposals for waste emplacements aim to re-establish endemic woodland, shrub and grassland communities that can today be seen as remnants in the greater region (Sivertsen and Metcalfe, 1995, Section 3.4.2 and Plates 1-2, 1-3).

Nine main plant communities were identified in the Project area and regional surrounds (Section 3.4.2).

Figure 5-6 presents the observed relationships between topography, elevation and vegetative association on the Project area (and the new Project landforms).

The waste emplacements would range in elevation from about RL 208m to RL 243m (the Lake-full level is RL205.65m). The revegetation plan would endeavour to re-establish native endemic woodland and understorey and therefore recognises the alliances that naturally occur across the continuum of slope and elevation.

These alliances are described as follows:

Watercourse – Riverine Floodplain

River Red Gum (*Eucalyptus camaldulensis*) Woodland

This community type typically occurs on riverine floodplains in deep, heavy, grey alluvial soils where it often forms a monoculture woodland community.

Transitional or ecotonal associations with this community include:

- *E. melliodora* (Yellow box);
- *E. microcarpa* (Grey box);
- *Casuarina cristata* (Belah).

E. camaldulensis dominates the upper strata of this community type and understorey communities include *Chloris truncata* (Windmill Grass), *Alectryon oleifolius* (Rosewood), *Muehlenbeckia florulenta* (Lignum), *Baumea juncea* and *Sida intricata*.

Flat to Gently Undulating Slopes

Eucalypt (*Eucalyptus populnea, E. blakelyi, E. melliodora, E. microcarpa, E. conica*) Woodland (Alliance No. 1)

This alliance (and variations thereof) predominates on the agricultural lands of the western slopes, plateau country and granite basin. It is typically found on undulating, well-drained land.

Transitional or ecotonal associations with this alliance include:

- *E. melliodora* (Yellow box);
- *Callitris glaucophylla* (White Cypress Pine);
- *Casuarina cristata* (Belah).

The upper strata of this community is dominated by *Eucalyptus* spp with occasional *Callitris glaucophylla* (White Cypress Pine) and *Casuarina cristata* (Belah). A variety of large shrubs or small trees occur in the mid-storey including *Acacia pendula* (Myall), *A. stenophylla* (River Cooba), *Geijera parviflora* (Wilga) and *Alectryon oleifolius* (Rosewood).

Low Ridges and Hills

Eucalypt (*E. dealbata, E. sideroxylon*) Woodland (Alliance No. 2)

This alliance occurs mainly on the slopes of dry hills on skeletal well-drained soils, extending to the tops of rocky ridges where it associates with *Callitris endlicheri* (Black Cypress Pine) and *Acacia doratoxylon* (Lancewood).

Typically occurring as a tall woodland, community structure is characterised by a sclerophyll mid-understorey and a savannah understorey. Other major overstorey species include *E. macrorhyncha* (Red Stringy Bark), *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum). Understorey species include *Brachyloma daphnoides* (Daphne Heath), *Bursaria spinosa* (Sweet Bursaria), *Chloris truncata* (Windmill Grass) and *Bothriochloa macra* (Redleg Grass).

Hill Tops and Elevated Land

Eucalypt (*E. dealbata, E. sideroxylon, E. macrorhyncha, E. goniocalyx, E. polyanthemos*) Woodland (Alliance No. 3)

This alliance dominates dry hill tops on poorer, skeletal soils typical of the rocky (primarily uncleared), elevated areas in the region.

Other overstorey species in this woodland alliance include *E. blakelyi* (Blakely's Red Gum) and *E. melliodora* (Yellow Box). Understorey species composition is similar to that found on the low ridges and hills.

Seed stock would be collected locally and grown and maintained by contracted nurseries in central west NSW, a similar arrangement with local landowners or interest groups.

5.3.3 Final Void

Characteristics

At the completion of mining, the final void would comprise a landform that is some 1,000 m long, 850 m wide and 325 m deep. Set back from the void on three sides would be the revegetated slopes of the waste emplacements, gradually rising some 15 m above the surrounds of the void (to RL 223). The volume of the void would be about 80,000 ML.

A detailed report on void hydrology and filling is presented in Appendix F (Water Management). Appendix N (Compatibility) also presents the results of the long term compatibility study, including void limnology and water quality.

Groundwater inflows from the three aquifers, rainfall, and site runoff are expected to slowly increase the level of water in the void over a period of about 100 years. After this period, the void water level would reach equilibrium at a level approximately 25 m below the pit rim (or 22-24 m below the Lake full storage water level and would fluctuate

SHALLOW LAKE	WATERCOURSES - RIVER FLOODPLAIN	FLAT - GENTLY UNDULATING SLOPES	LOW RIDGES - HILLS	HILLTOPS - ELEVATED LAND
EXAMPLE OF LANDFORM: Lake Cowal and new lake foreshore	EXAMPLE OF LANDFORM: Fringing lake vegetation and drainage line vegetation	EXAMPLE OF LANDFORM: Footslopes below Cowal West; waste emplacement batters and surrounds	EXAMPLE OF LANDFORM: Cowal West tops and upper slopes of new landforms	EXAMPLE OF LANDFORM: Tailings and waste emplacements top surfaces
VEGETATION ASSOCIATION: Freshwater Plants	VEGETATION ASSOCIATION: River Red Gum Woodland	VEGETATION ASSOCIATION: Eucalypt Woodland Alliance No.1	VEGETATION ASSOCATION: Eucalypt Woodland Alliance No. 2	VEGETATION ASSOCIATION: Eucalypt Woodland Alliance No.3
TYPICAL SPECIES: Refer Figure 5-3	TYPICAL SPECIES: Windmill Grass Lignum River Red Gum Yellow Box Grey Box Belah Rosewood Blackbox	TYPICAL SPECIES: Poplar Box Yellow Box Fuzzy Box Grey Box Blakely's Red Gum White Cypress Pine Belah Myall River Cooba Wilga Rosewood	TYPICAL SPECIES: Windmill Grass Redleg Grass Daphne Heath Red Stringybark Mugga Ironbark Tumble-down Red Gum Black Cypress Pine Lancewood	TYPICAL SPECIES: Windmill Grass Redleg Grass Daphne Heath Mugga Ironbark Yellow/Red Box Long-leaved Box Black Cypress Pine Lancewood



Source: Adapted from Braithwaite (1975), Briggs & Thorton (1995), Bower (1997), Bower & Semple (1993), DLWC (1996), Goldney & Bowie (1990), Sivertsen & Metcalfe (1995).

Not to Scale

RL ~205m	RL ~206-220m	RL ~210-225m	RL ~220-230m	RL ~230-245m

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FIGURE 5-6
Conceptual Revegetation Strategy
Proposed Vegetative
Successional Communities

NORTH
Cowal Gold Project

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± 1 to 2 m) (Appendix F). The void water would not spill and is hydrogeologically isolated from and lower than the Lake water (Appendix N).

Void Water Quality and Stratigraphy

Geochemical studies (Appendix C) have concluded that the void water quality would not be acid due to the characteristics of the wall rocks and would be dominated by the overriding influence of saline groundwater to the void. Oxidation of any wall rock sulphide minerals effectively ceases as the rocks are progressively covered by water. The geochemical study (Appendix C) and the void stratigraphy and water quality study (Appendix N) indicate the following:

- During the filling stage the Cowal void would exhibit a steady progression toward seasonal stratification. After filling, the long-term scenario would include a trend in deep water toward hyper-salinity. In the surface mixed layer there would be a mid-year (approximately June - August) seasonal increase in salinity from that approximating sea-water to a level approaching twice that of sea-water. During the summer months the concentration of salinity would return to about sea-water levels.
- Due to the length of this filling time (>100 years) some of the biological and chemical features of the void would be well advanced prior to complete filling. Nonetheless the void would continue to evolve after it has filled, with changes in its biological and chemical characteristics. These would in turn have a significant influence on its seasonal physical behaviour.
- With respect to biological status and salinity, Australia is well-endowed with species tolerant of high salinity waters, with fauna displaying many adaptations to cope with salinity-associated stress. These species are particularly prevalent in the Lake Eyre basin and other Australian inland lakes. It is likely that the final void would support salt tolerant species of phytoplankton.
- Metal solubility in the void is expected to remain low and at levels that do not pose a threat to water quality (EGi, 1997).

The conclusions of the studies presented in Appendices C and N, coupled with the Species Impact Statement findings (Appendix A) suggest that:

- with respect to water quality, the void waters would not pose a threat to animals, notably avifauna;
- it could be expected that birds and perhaps bat species would utilise the void for refuge and perhaps feeding (eg. waterfowl species more adapted to deep water);
- the shallow surrounds of the void waterline could be rehabilitated in such a manner to enhance seasonal habitat opportunities for water birds.

These aspects are discussed below.

Void Rehabilitation Concepts

Objectives

The objectives of void rehabilitation are:

(i) to leave the void surrounds safe (for humans and stray stock) and revegetated in a manner consistent with the overall Project rehabilitation philosophy and objectives (Section 5.1);

(ii) where feasible, create habitat opportunities for waterbirds at the approximate level at which void water would reach equilibrium.

Concepts

The void surrounds would be fenced upon completion of mining. Signposted warnings to the public would be placed along the fence. Bunding is not considered of benefit given the close proximity of the waste emplacement batters. Specific details would be confirmed in the Mining Rehabilitation and Environmental Management Process (MREMP) conducted annually with the key stakeholders.

The top batter of the void, which would extend almost to the expected final equilibrium water level, would be left at the constructed angle (approximately 1:2). The first berm (at approximately RL 185) would be planted with understorey of the River Red Gum woodland alliance (Windmill Grass, Rosewood, Birdwood) and the batter and berm surfaces left in a roughened state to encourage succession and to provide micro-habitat. In the longer term, there may be opportunities to develop habitat for waterfowl and other species on the seasonally inundated berm.

These concepts, which serve to maximise the limited opportunities for batter habitat re-establishment that would occur over a long period of time, are shown in Figure 5-7.

Climate Change

The potential effects of climate change on void hydrology are addressed in Appendix F (Water Management). From the research information accessed for this study, a high degree of predictive uncertainty is evident, making it unrealistic to factor climate change into rehabilitation design until more accurate predictive data is available (anticipated within the next five years). Notwithstanding, the results of the analysis suggest that under enhanced greenhouse conditions, average rainfall in the Cowal area is likely to decrease, whilst rainfall intensities would increase. This would have the effect of a slightly lower overall final water level.

For the modelled scenario of increased rainfall (now considered by researchers as unlikely to occur – Appendix F), the void would take a similar period to establish an equilibrium water level which would fluctuate some 4-5 m higher than the base (present) case.

5.3.4 Tailings Storages

Rehabilitation Objectives

Tailings storage rehabilitation objectives are:

(i) to establish permanently stable landforms;

(ii) during operations, to stabilise batters so that they provide minimal habitat value for bird life (ie. pasture cover);

(iii) post-operations, to establish vegetative communities which are endemic to the region and which enhance remnant habitat extension opportunities;

(iv) to exclude widespread grazing and primary production.

Rehabilitation of the storage batters can be progressive as the storages are lifted by upstream methods. Rehabilitation

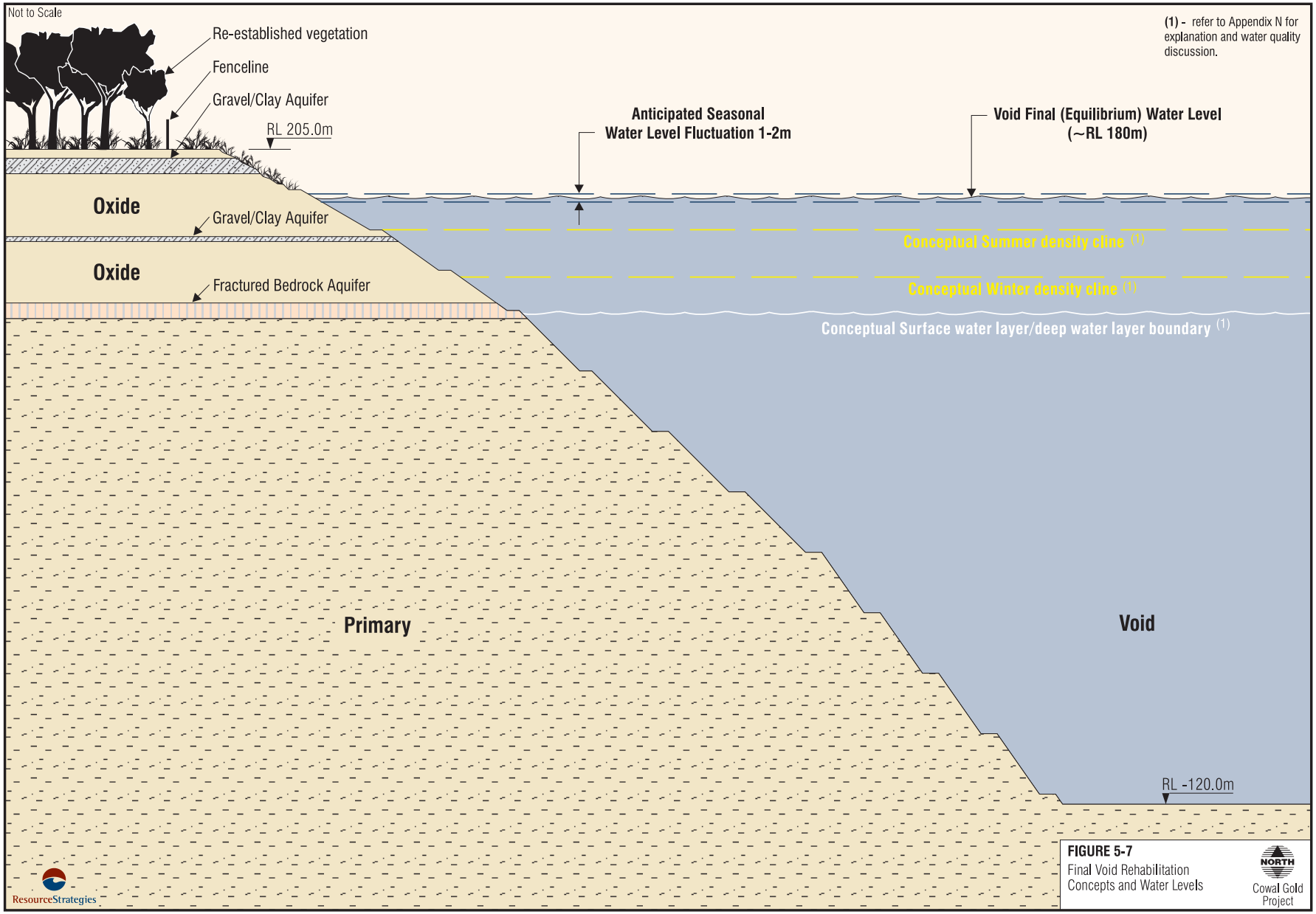
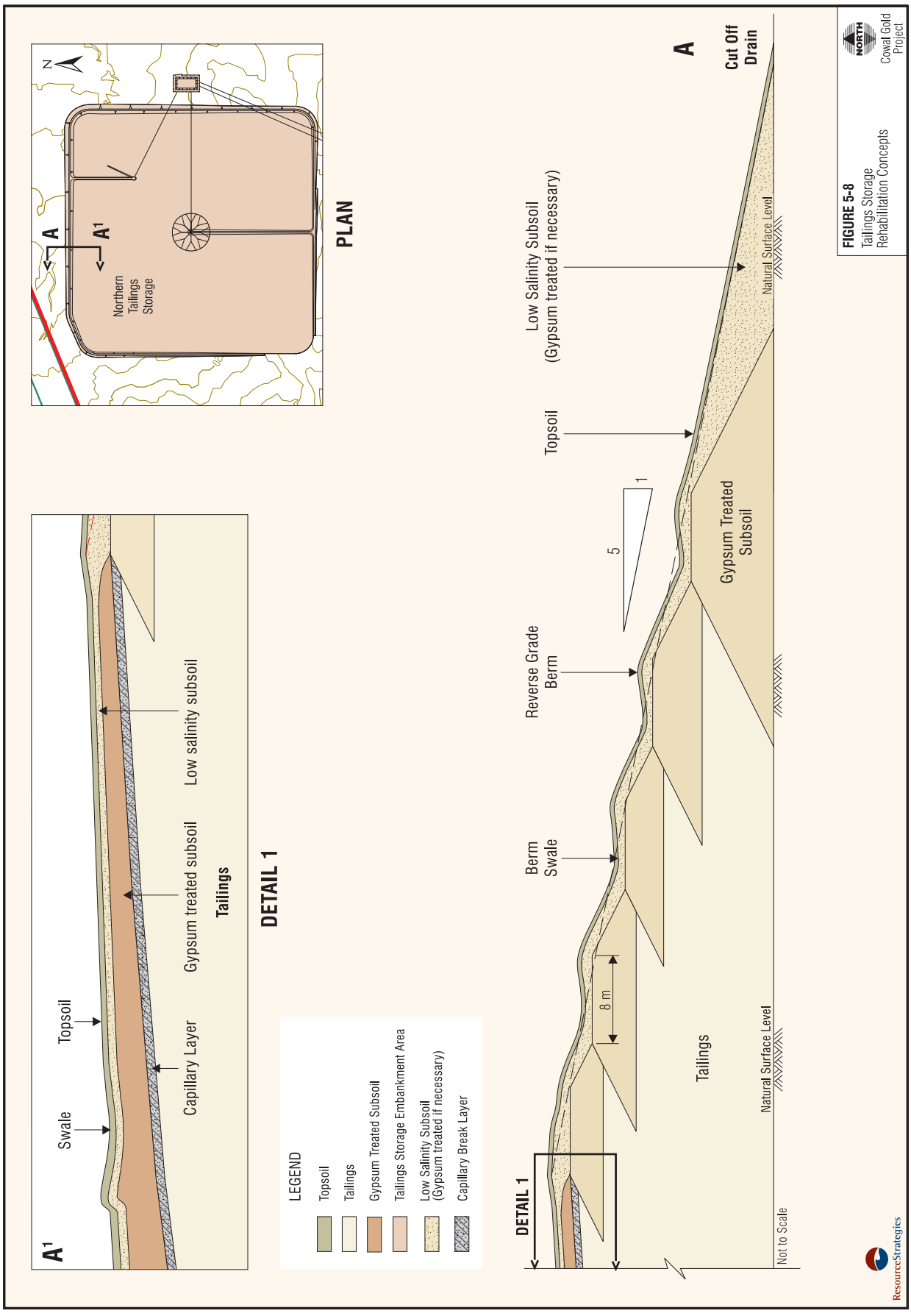


FIGURE 5-7
Final Void Rehabilitation
Concepts and Water Levels

NORTH
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PLAN
N
A
A1
Northern Tailings Storage
A1
Swale
Topsoil
Capillary Layer
Gypsum treated subsoil
Low salinity subsoil
Tailings
DETAIL 1
LEGEND
Topsoil
Tailings
Gypsum Treated Subsoil
Tailings Storage Embankment Area
Low Salinity Subsoil (Gypsum treated if necessary)
Capillary Break Layer
A
Cut Off Drain
Low Salinity Subsoil (Gypsum treated if necessary)
Topsoil
Reverse Grade Berm
Berm
Swale
5
1
Gypsum Treated Subsoil
8 m
Tailings
Natural Surface Level
Natural Surface Level
DETAIL 1
Not to Scale
NORTH
Cowal Gold Project
FIGURE 5-8
Tailings Storage
Rehabilitation Concepts
ResourceStrategies
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of the storage top surfaces can only be undertaken at the completion of milling (Year 12 onwards).

Surface Rehabilitation Zone

The cover system selected for the tailings storages is similar in intent and design to the waste emplacement in that it is designed to:

(i) absorb the rainfall that falls on the surface;

(ii) support a woodland ecosystem.

Rehabilitation Concepts

Batters

Figure 5-8 shows the rehabilitation concepts for the storage batters. The rehabilitation procedures and features of the covers are:

(i) Progressive rehabilitation of the batters can commence following the placement over the structural zone of low salinity subsoil (gypsum-treated if necessary, followed by topsoil.

(ii) Drainage on the batters follows the same principles as the waste emplacements, ie. the berms would be constructed to reverse grade, and be left rough to enhance absorption. The berms would longitudinally fall to low depressions constructed every 50 - 100 m along the berm to cater for extreme events.

(iii) Ripping to create surface roughness and absorption prior to revegetation operations would be undertaken.

(iv) Revegetation using native and introduced grasses during operational years.

(v) Post-mining revegetation using the communities detailed in Figure 5-6 and Section 5.3.2, planted as tubestock and seed, would be undertaken. The elevations of the storage batters would range from RL 215 to about RL 241.5 m.

Tailings Storage Top Surfaces

The cover, drainage and revegetation concepts for the tailings top surfaces follow similar principles to the waste emplacement concepts:

(i) A rough, deep cover system is proposed, to allow infiltration to be absorbed and stored by the covers. This provides a degree of saturation to the covers, to be stored for use by woodland vegetation with a comparatively high water demand.

(ii) At the completion of milling, the tailings surfaces would form a low, internally draining landform. With controlled placement of covers, the surfaces would drain via a number of shallow swales as described for the waste emplacements. The storage surfaces would form contained catchments (ie. would not spill over the batters) and would be able to retain all but the unlikely event of a probable maximum precipitation (which can be conveyed to ground surface via a rock drain in the south western corner of each storage). As with the waste emplacements, surface materials and revegetation would maximise water absorption and storage or evapo-transpiration.

(iii) The surface cover system would comprise:

- a capillary-breaking layer of select rock placed over tailings to restrict the upwards migration of tailings salts under periods of negative pore pressure (eg. during periods of prolonged drought);
- about a 1 - 1.5 m thick layer of gypsum-treated subsoil to provide for moisture absorption and storage, and a plant rooting medium;
- about a 0.5 - 1 m thick layer of low salinity subsoil (gypsum treated if necessary) to provide for moisture absorption and plant water storage;
- about a ± 0.2 m thick layer of topsoil for initial germination and provision of soil fungi and bacteria.

Revegetation communities would include the following:

- In the central, occasionally wet area, species selected from the Riverine Woodland alliance, comprising River Red Gum (*E. camaldulensis*) and understorey species from the freshwater communities such as *Typha domingensis* (*Cumbungi*) and Rush (*Eleocharis* sp.).
- On the remainder of the covered storage surface, species representative of the low ridges alliance depicted in Figure 5-6 (representing those species that occur on low ridges to elevations of around RL 225 m).

Figures 5-9, 5-10 and 5-11 depict the progressive rehabilitation concepts for the Project area, including the tailings storages, waste emplacements and void for Year 1, Year 8 and end of life, respectively.

Plate 5-1 presents a conceptual aerial view of the Project area following the exclusion of primary production (grazing and cropping) and following the establishment of vegetation communities.

Tailings Infrastructure

At the completion of milling, tailings disposal infrastructure would be rehabilitated as follows:

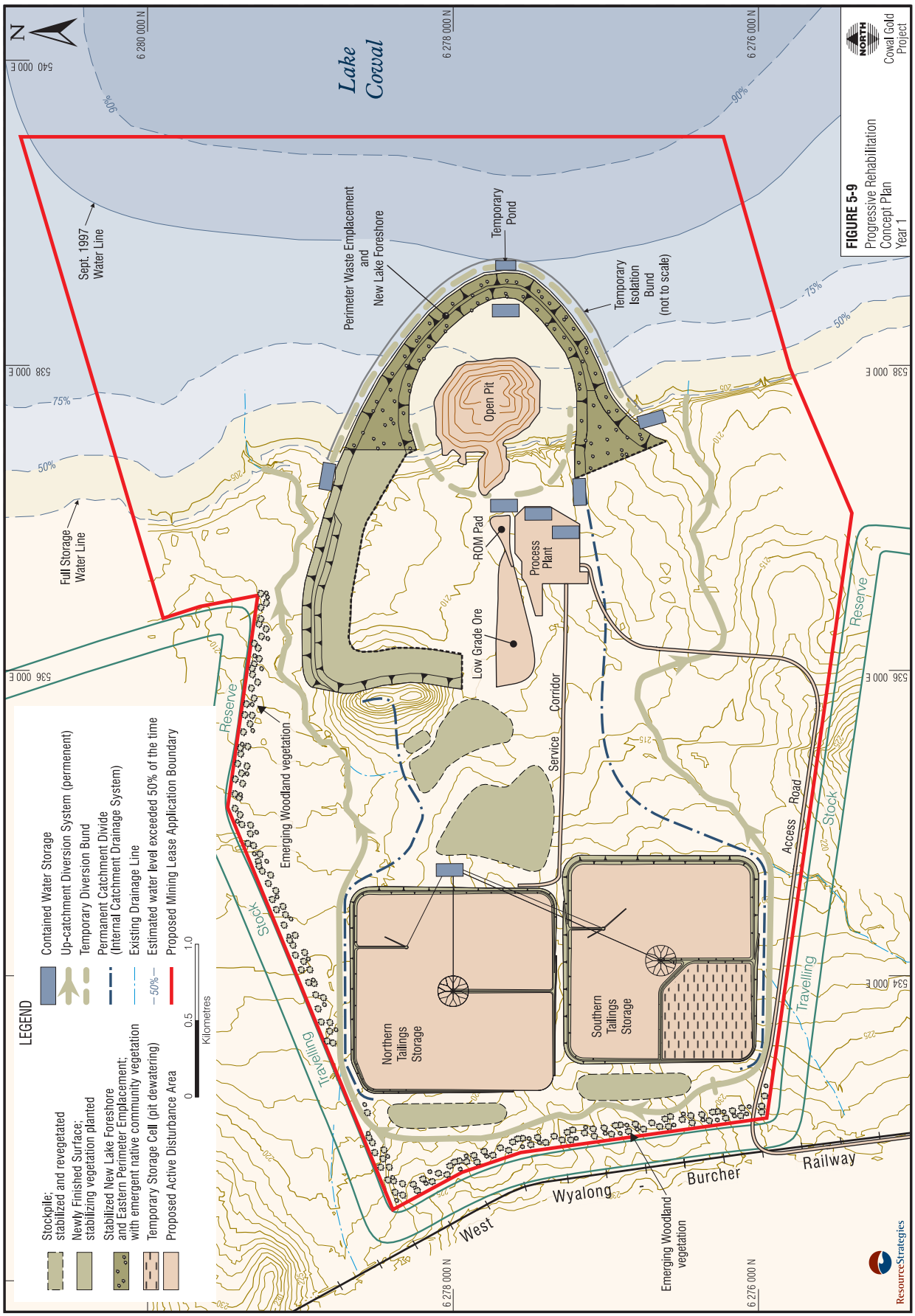
- The decant area would be allowed to dry and the decant tower would be permanently capped with fill and/or a concrete plug.
- The underdrains (which previously conveyed decanted water to the reclaim dam) would be grouted.
- The reclaim dam would be pumped dry (or allowed to evaporate), the liner excavated and the pond filled with earthfill and revegetated.
- The tailings discharge pipes, cyanide destruction plant and monitoring systems would be dismantled for reuse or disposal with the bulk of Project infrastructure.
- The tailings storages would be fenced.

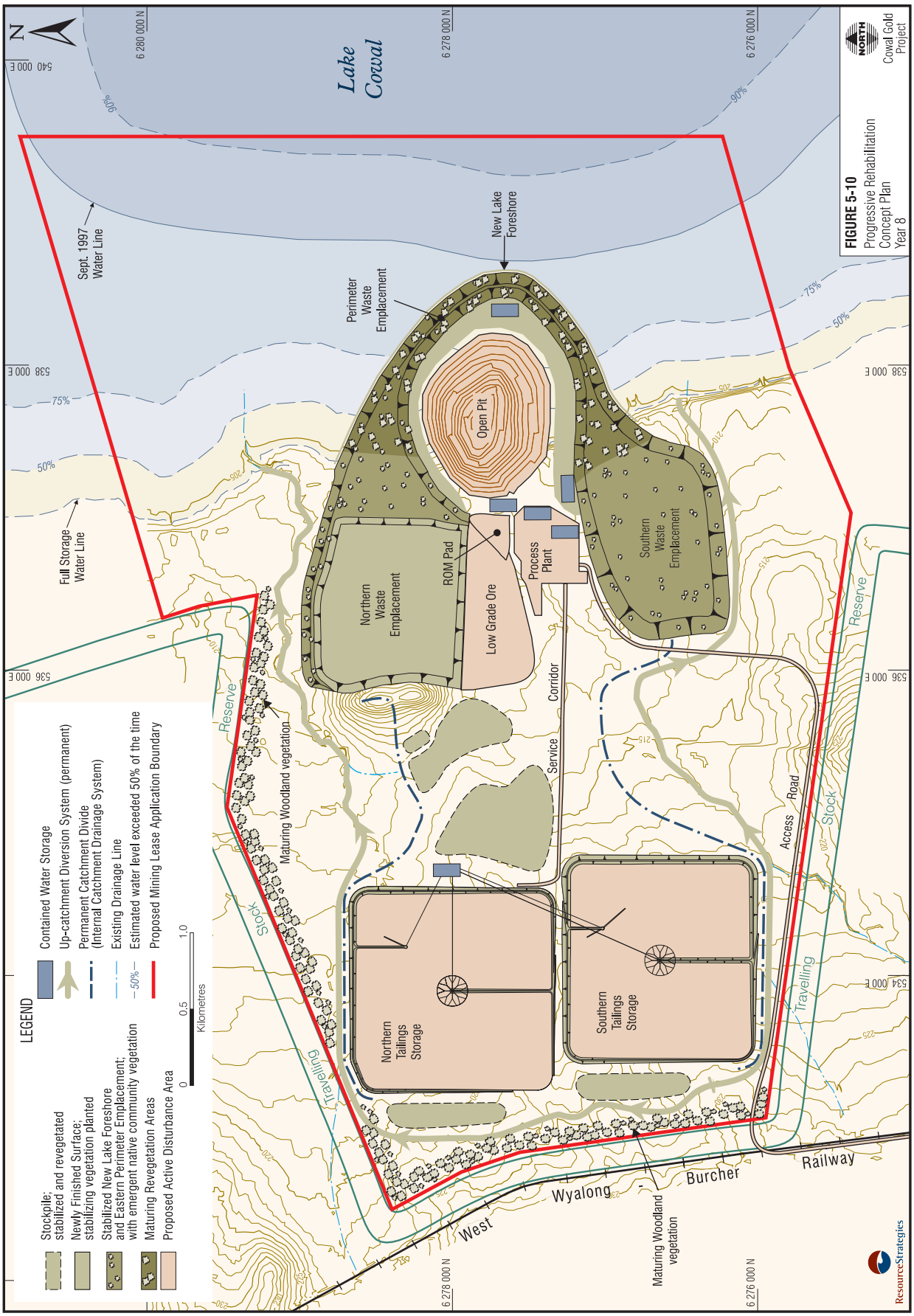
5.3.5 Infrastructure Areas

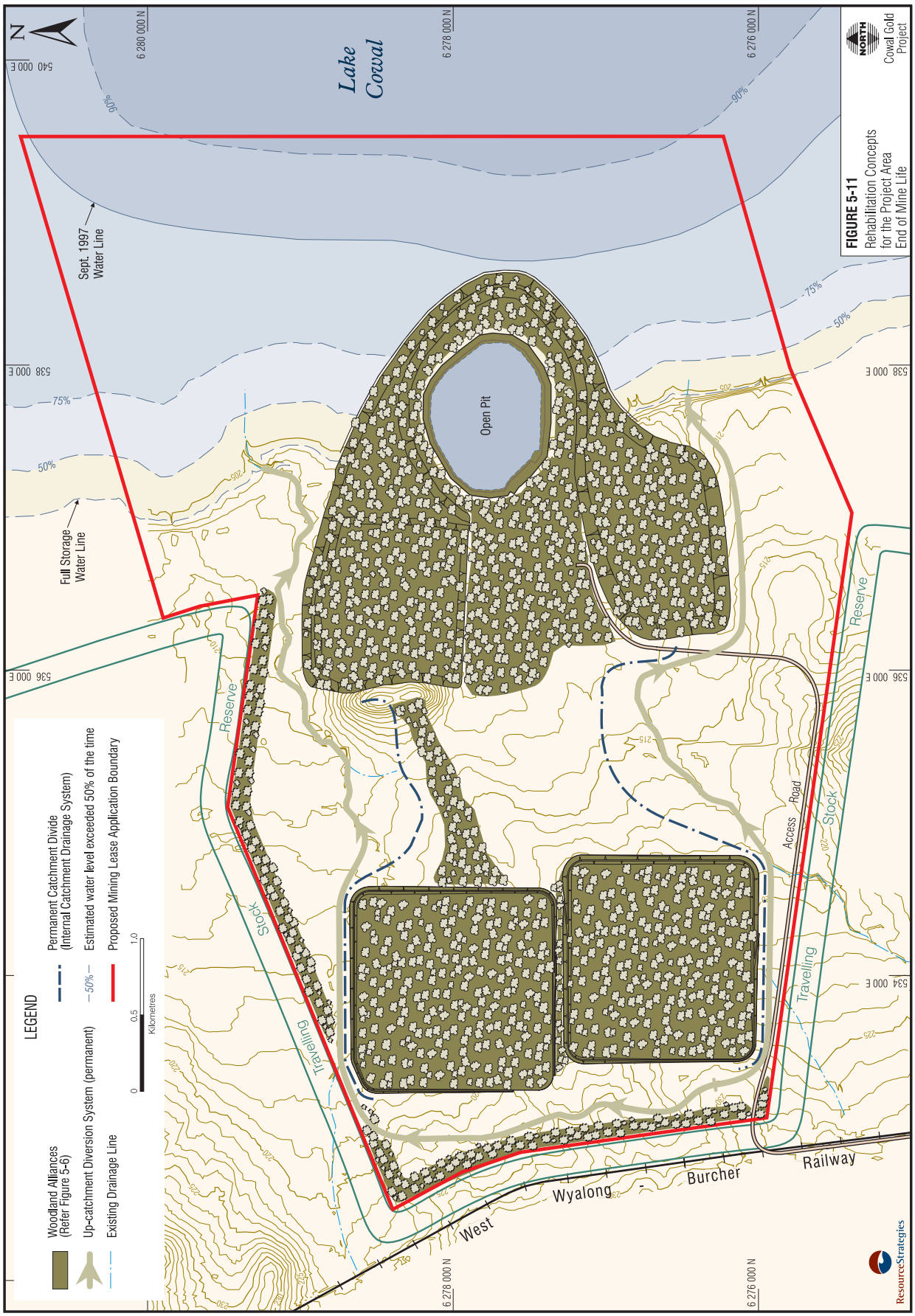
These include the processing mill, administration areas, workshops, ancillary roads and explosives storage areas.

Mine Fleet and Workshop

At the completion of mining (end Year 8) the mine fleet would be demobilised from site and the contractors' workshop dismantled. The footprint area would be tested


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Perimeter Waste Emplacement and New Lake Foreshore
Temporary Pond
Temporary Isolation Bund (not to scale)
Open Pit
ROM Pad
Process Plant
Low Grade Ore
Service Corridor
Access Road
Northern Tailings Storage
Southern Tailings Storage
Emerging Woodland vegetation
Reserve
Stock
Travelling
Railway
Burcher
Wyalong
West
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
LEGEND
Contained Water Storage
Up-catchment Diversion System (permenent)
Temporary Diversion Bund
Permanent Catchment Divide (Internal Catchment Drainage System)
Existing Drainage Line
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
Stockpile; stabilized and revegetated
Newly Finished Surface; stabilizing vegetation planted
Stabilized New Lake Foreshore and Eastern Perimeter Emplacement; with emergent native community vegetation
Temporary Storage Cell (pit dewatering)
Proposed Active Disturbance Area
0
0.5
1.0
Kilometres
FIGURE 5-9
Progressive Rehabilitation
Concept Plan
Year 1
Cowal Gold Project
ResourceStrategies
NOC-97-03_S5-021D.CDR


N
Lake Cowal
Cowal Gold Project
FIGURE 5-10
Progressive Rehabilitation
Concept Plan
Year 8
Sept. 1997 Water Line
New Lake Foreshore
Perimeter Waste Emplacement
Full Storage Water Line
Open Pit
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Process Plant
Southern Waste Emplacement
Northern Tailings Storage
Southern Tailings Storage
Service Corridor
Access Road
Maturing Woodland vegetation
Reserve
Stock
Travelling
Railway
Burcher
Wyalong
West
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
LEGEND
Contained Water Storage
Up-catchment Diversion System (permanent)
Permanent Catchment Divide (Internal Catchment Drainage System)
Existing Drainage Line
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
Stockpile; stabilized and revegetated
Newly Finished Surface; stabilizing vegetation planted
Stabilized New Lake Foreshore and Eastern Perimeter Emplacement; with emergent native community vegetation
Maturing Revegetation Areas
Proposed Active Disturbance Area
0
0.5
1.0
Kilometres
ResourceStrategies
NOC-97-03_S5-024D.CDR


N
Lake Cowal
Sept. 1997 Water Line
Full Storage Water Line
Open Pit
Reserve
Stock
Travelling
Access Road
Wyalong West
Burcher
Railway
6 280 000 N
6 278 000 N
6 276 000 N
540 000 E
538 000 E
536 000 E
534 000 E
90%
75%
50%
LEGEND
Woodland Alliances (Refer Figure 5-6)
Up-catchment Diversion System (permanent)
Existing Drainage Line
Permanent Catchment Divide (Internal Catchment Drainage System)
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
NORTH
Cowal Gold Project
FIGURE 5-11
Rehabilitation Concepts for the Project Area End of Mine Life
ResourceStrategies
NOC-97-03_S5-022E.CDR

for contamination from fuels and lubricants and any contaminated soils removed for proper disposal in accordance with EPA requirements. The area would then be contour ripped, topsoiled and revegetated with endemic seed and tubestock.

Reagents and Fuels
Unused reagents and fuels at the completion of milling would be returned to the supplier in accordance with all relevant safety and handling procedures.

Mill, Administration Area
These buildings would be dismantled and completely removed from the Project site.

The foundations and floors would be retained if a suitable alternative use is agreed in the MREMP process. Alternatively, they would be excavated for disposal at the base of the void or as buried landfill in an approved manner.

Internal powerlines, pipelines and the explosive magazine would be dismantled and removed.

Transmission Line and Substations
At the end of the Project, the transmission line from Temora would be the property of the electricity utility and as a piece of infrastructure is likely to remain in place up to the Project substation.

Bland Creek Borefield
The bores and associated pump stations may be transferred to regional landholders or, alternatively, dismantled and the bores plugged and capped.

The pipeline would either be raised and dismantled for recycling or kept in place if required for local use. If dismantled, the section of pipeline in the bed of Lake Cowal would be raised when the Lake is dry. If this is not possible due to successive high rainfall seasons, any decision to remove the pipeline under strict environmental management procedures would be discussed with the authorities. Given the maintenance period for Cowal Project rehabilitation it is likely, however, that the Lake would be sufficiently dry at some stage in this period.

5.3.6 Exploration Areas
All open drillholes would be backfilled and tracks revegetated in accordance with the procedures adopted for waste emplacements and site roads.

5.4 Seed and Plant Stock
The access to a large reserve and wide variety of endemic seed stock is fundamental to the success of the rehabilitation programme.

It is proposed that regional seed collecting programmes (perhaps involving local community groups, Landcare Groups, as well as contracted professional teams) would commence in the construction phase, to allow sufficient time to commence rehabilitation of the new Lake foreshore at the completion of foreshore reconstruction activities.

North have previously engaged local landowners to collect, germinate and maintain tree and shrub stock and may elect to continue this practice. Alternatively, a professional nursery or a site-based nursery (or regionally based Landcare facility) may be established, particularly focussing on the freshwater community plants and woodland understorey species required for revegetation works.

Contemporary seed treatment technology, particularly with woodland eucalypt species would also be undertaken (eg. smoking, scouring) to enhance germination rates and establishment success.

5.5 Maintenance and Monitoring
It is proposed that by the second annual MREMP meeting, a detailed Rehabilitation Procedures and Maintenance Plan (RPMP) would be prepared in consultation with government agencies and other stakeholders. This document is pivotal to the success of the rehabilitation proposals at the Project site, and in particular, the intention to enhance the depauperate status of endemic remnant vegetation in the region. The RPMP would be updated annually as part of the MREMP process.

It would be expected that the RPMP would cover:

- seed collection protocols;
- seed germination and maintenance procedures;
- tubestock maintenance;
- soil moisture and compaction requirements prior to planting;
- topsoil storage and maintenance;
- seeding rates and scouring methods;
- tubestock planting procedures;
- freshwater plant handling and planting procedures;
- erosion control procedures;
- access and fencing of germinating areas;
- criteria for measuring revegetation success;
- erosion control on newly planted surfaces;
- weed control and herbicide protocols in the Project catchment;
- criteria for assessing rehabilitation standards and completion status.
- contingency estimates of the total expenditure required to fully rehabilitate the Project area (assuming unforeseen closure of the Project) in any given year.

5.6 Lease Relinquishment
Upon the cessation of mining operations, tenure of the mining lease would be maintained by North until such time as lease relinquishment criteria (determined by DMR and DLWC) are satisfied. It is anticipated that lease relinquishment criteria would include (but not necessarily be limited to):

- landform stability;
- maintenance of downstream water quality;

- establishment of self-sustaining revegetation;
- satisfaction of all lease conditions; and
- removal of hard-stand areas and infrastructure.

Section 6

Section 6
Environmental Management and Monitoring Programmes

6.0 ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAMMES

6.1 Introduction

This section discusses the objectives and broad details of the environmental management and monitoring programmes proposed for the Project. The proposed programmes have been formulated from the results of baseline studies and from discussions with stakeholders. They should however be viewed as provisional, pending detailed discussion and stakeholder input during the assessment phase of the EIS.

6.2 Environmental Management

The environmental management of the Project would encompass a range of management plans and monitoring systems overseen by statutory planning provisions and North's company-wide Environmental, Safety and Health Management System (ESHMS). The relationship between these various components is shown in Table 6-1. Individual components are listed below and detailed in subsequent sections.

- Mining, Rehabilitation and Environmental Management Process (MREMP – Section 6.4.5). The environmental

Table 6-1 Project Environmental Management and Monitoring Process

Mine Phase	Environmental Management		Monitoring Programme
	Regulatory Requirements	Other Requirements	
Pre-Construction	• Formulation of Mining Operations Plan (MOP) • Fulfillment of Consent Condition requirements	Formulation of: • Project Environment Safety and Health Management System (ESHMS) in accordance with North ESH standards • Construction Environmental Management Plan (CEMP) • Integrated Erosion and Sediment Control Plan (IESCP) • Feral Pest Management Plan (FPMP) • Land Management Plan (LMP) • Site Water Management Plan (SWMP) • Soil and Stripping Management Plan (SSMP) • Hazardous Waste and Chemical Management Plan (HWCMP) • Monitoring and management protocols for Aboriginal Heritage sites • Bushfire Management Plan (BMP) • Autopsy procedures and mortality reporting and response procedures • Community consultation programme	Baseline monitoring: • Hydrology including water levels, stream flow, rainfall, etc. • Biology including waterbirds • Air quality subsequent to a complete review of the existing baseline dust monitoring programme • Meteorology • Water Quality
Construction	• Implementation of MOP and continuous update in accordance with current mine planning decisions • First Annual Environmental Management Report (AEMR) • Fulfillment of Consent Condition requirements	• Implementation of the Project EMS including the Project environmental management plans (CEMP, IESCP, LMP, SWMP, SSMP, FPMP, HWCMP, BMP) • Implementation of soil management and aboriginal heritage mitigation strategies • Autopsy procedures and mortality reporting and response procedures • Annual internal ESH performance review • Maintenance of the community consultation programme	• Ongoing baseline monitoring • Implementation of water management procedures including surface and groundwater • Noise and blast monitoring • Electricity transmission line biological monitoring component
Operations	• Fulfilment of MOP requirements and continuous update in accordance with current mine planning decisions • AEMR's • Fulfillment of Consent Condition requirements	• Ongoing administration of the Project ESHMS including the Project environmental management plans (IESCP, SWMP, FPMP, LMP, SSMP, HWCMP, BMP) • Annual internal ESH performance review • Maintenance of the community consultation programme • Final Rehabilitation Plan, close out objectives and monitoring programme	• Ongoing baseline monitoring • Water management procedures including surface and groundwater • Noise and blast monitoring • Electricity transmission line biological monitoring • Cyanide monitoring • Soil fertility and structure • Bird and bat usage of tailings storages • Rehabilitation performance (erosion, revegetation, landform stability, fauna usage)
Post-Operations	AEMR up until lease relinquishment	• Demonstration of landform stability • Ongoing internal annual environmental performance review up until lease relinquishment • Ongoing administration of the BMP, FPMP, SWMP, LMP, and IESCP	Rehabilitation performance (especially landform stability)

management of the site would be conducted in accordance with the MREMP. The MREMP is a statutory requirement required by the NSW DMR for the operation of a mine. The process comprises two forms of statutory documentation; the Mining Operations Plan (MOP) and the Annual Environmental Management Report (AEMR). The requirements of these MREMP components are detailed in Section 6.4.5.

- Construction Environmental Management Plan (CEMP – Section 6.3). The construction phase encompasses all works associated with the preparation of the site and installation of infrastructure for mining and processing. The construction management plan addresses environmental management during this phase of the Project life. The Integrated Erosion and Sediment Control Plan (IESCP) would be implemented as part of the CEMP. The IESCP would address all environmental management issues related to sediment movement and erosion control related to mine activities. The IESCP would have an ongoing environmental management role throughout the life of the Project.
- Hazardous Waste and Chemical Management Plan (HWCMP – Section 6.4.1). The HWCMP would provide detail on the appropriate transport, handling, disposal and recycling procedures for wastes generated at the Project site as well as appropriate emergency response procedures in the event of spillages.
- Bushfire Management Plan (BMP – Section 6.4.4). The BMP would be established in order to reduce fire risk to the immediate rural area.
- Land Management Plan (LMP – Section 6.4.2). The LMP would be produced to establish general property management practices which conform with sustainable landuse targets for both the immediate Project area as well as North optioned land surrounding the Project area.
- Site Water Management Plan (SWMP – Section 6.4.3). The SWMP would provide measures for the mitigation of potential water quality and quantity (surface and groundwater) impacts as detailed in Section 4.2.

The integration of Project environmental management with regional environmental management plans (e.g. Jemalong Land and Water Management Plan, Lake Cowal Management Plan and the Mid Lachlan Pilot Project for Regional Vegetation Management Plan) is recognised as important. All regional plans are currently in preparation, with finalisation expected by June 1998. The operation of the proposed mine including associated rehabilitation strategies would, as appropriate, incorporate land management principles presented in these plans once finalised.

Environmental management and monitoring programmes developed prior to construction and implemented during construction and operation are integral to the Project's aims of minimising environmental impacts and maximising the efficiency of rehabilitation strategies. The implementation of these programmes would verify performance and would also provide for rapid detection and remedy of potential impacts which could result.

The environmental monitoring programme is summarised on Figure 6-1 and further detailed in Section 6.5.

The site environmental management and monitoring programmes would also provide the information requirements for the process of improving performance. Performance improvement would also involve reviewing operations against the North Environment Safety and Health (ESH) Management System. North's internal performance review process is detailed in Table 6.2.

The environmental management of the Project site would include the following:

- Controls used for minimising environmental impact with respect to water, air, fauna, flora, noise and blast;
- Internal auditing;
- Waste management procedures;
- Environmental reporting requirements including operational consent conditions and MREMP requirements;
- Continuous improvement; and
- A commitment to reporting to the community.

Additionally, the following specific environmental objectives are to be incorporated in the environmental management and monitoring programmes:

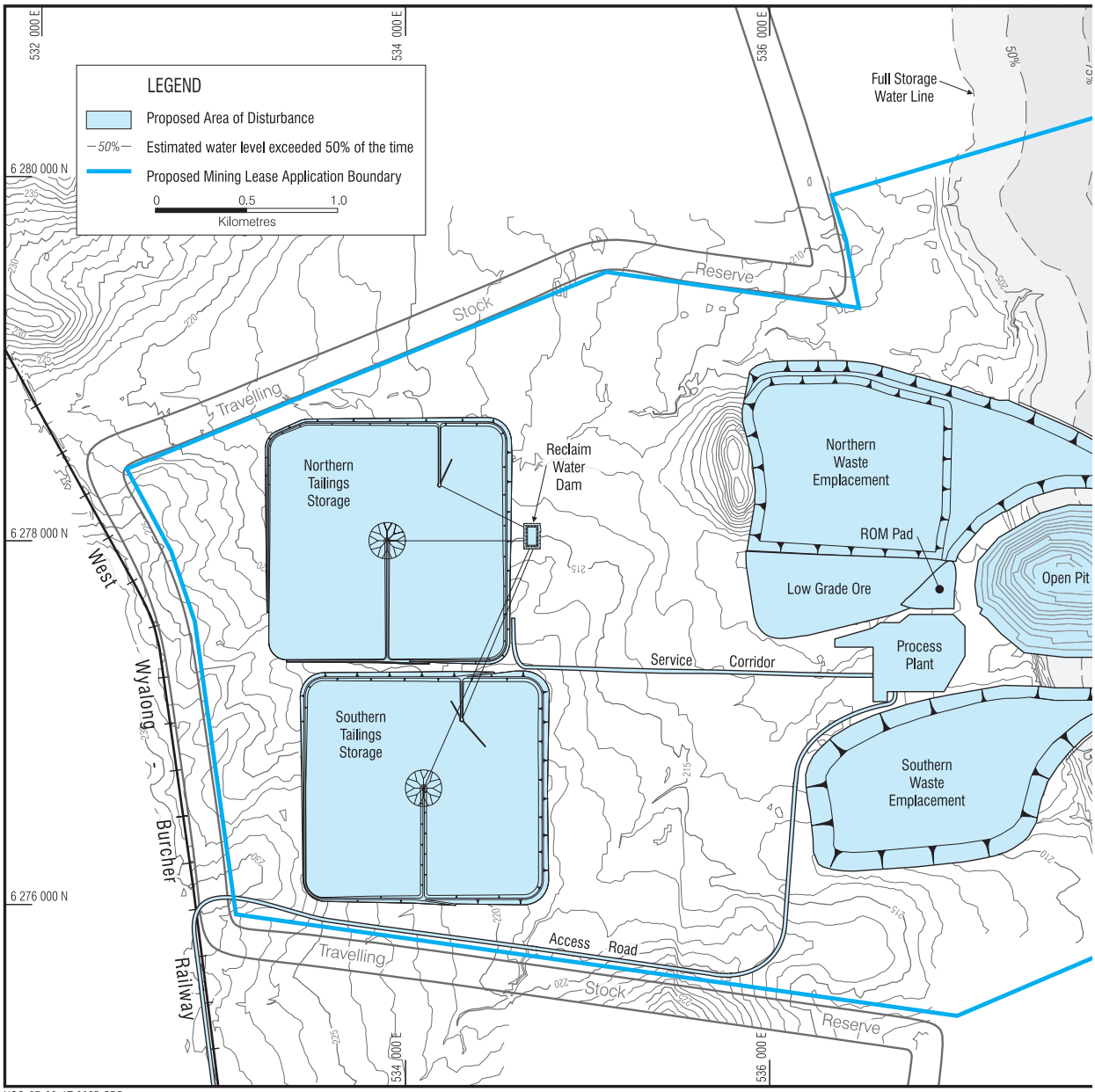
- undertake to ensure bird breeding areas at the north of Lake Cowal remain undisturbed by the mine;
- undertake to ensure that the quality of water in Lake Cowal is not detrimentally affected by the mine;
- the various monitoring programmes addressed in this section would provide the means by which environmental performance is measured (qualified and/or quantified). This includes a community consultation component which would contain avenues for receiving complaints;
- the on-going monitoring programme would undergo continuous improvement through both a statutory and internal annual environmental review programme.

6.2.1 Environmental Management System

North's co-ordination of the environmental monitoring and management plans, as well as health and safety issues, would be specified in an Environment, Safety and Health Management System (ESHMS). The ESHMS would define the organisational structure, responsibilities, practices, processes and resources for implementing and maintaining environmental objectives, and is prepared in line with North's ESH targets (Section 6.1). As outlined in Table 6-1, the ESHMS would be formulated in the pre-construction phase in preparation for implementation during construction.

The core environmental elements of the ESHMS would be:

- Environmental policy;
- Planning;
- Implementation and operation;
- Checking and corrective action; and
- Management review.


LEGEND
Proposed Area of Disturbance
50%
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
532 000 E
534 000 E
536 000 E
6 280 000 N
6 278 000 N
6 276 000 N
Full Storage Water Line
Reserve
Stock
Travelling
Northern Tailings Storage
Reclaim Water Dam
Northern Waste Emplacement
ROM Pad
Low Grade Ore
Open Pit
Process Plant
Service
Corridor
Southern Tailings Storage
Southern Waste Emplacement
West
Wyalong
Burcher
Railway
Access Road
Travelling
Stock
Reserve
NOC-97-03_LT-002B.CDR

The Project's environmental policy would comply with the principles of North's overall environmental policy which commits the Project to continual improvement in line with best practice management and compliance with relevant legislation and statutory requirements.

The planning component would review all environmental aspects of the operation, identify and evaluate legal requirements, establish environmental targets and objectives, and formalise the Environmental Management Programme.

The implementation and operation phase of the ESHMS would comprise the following:

- Establishment of structure and delegation of responsibility;
- Implementation of training and awareness programmes and improving competence;
- Establishment of communication channels;
- Establishment of a document control system; and
- Preparation of emergency contingencies and response plans.

The checking and corrective action phase would involve the review of environmental records and subsequent assessment of the Project's performance in relation to the environmental objectives. These monitoring records would be reported in the AEMR and would be used to demonstrate compliance with the requirements of the system. Audits of this process would be conducted to review and check the efficiency of the system.

Table 6-2 North ESH Management System Structure

Performance Improvement Process	ESH Element	ESH Element Objective
Policy	1. Environment, safety and health policies.	Statement of intent, commitment and principles in relation to ESH management.
Planning	2. Identifying and managing ESH effects and hazards.	Ensure ESH hazards and their effects on people, the environment and assets are identified, evaluated and managed over operation life.
	3. Compliance	Establish and maintain procedures to record and monitor compliance to statutory and policy requirements.
	4. ESH management and improvement programme	Ensure planned measurable and achievable approach to managing and improving ESH performance is adopted.
Implementation and Operation	5. Roles and responsibilities	Ensure ESH management roles and responsibilities are allocated and that accountability for ESH maintenance and continual improvement is established.
	6. Employee selection, training and competence	Ensure that all personnel involved in operations are competent.
	7. Communication, involvement and motivation	Involve all employees and contractors in the management of ESH issues.
	8. Document control	Develop and maintain a document system that meets ESH management systems expectations.
	9. Operational control	Control potentially hazardous tasks by the application of standard procedures.
	10. Emergency response	Ensure effective plans, procedures and trained personnel identify potential scenarios and plan appropriate response.
	11. Contractor management	Ensure low risk to personnel, the environment and assets arising from contracting arrangements.
	12. Health system	Ensure health risks are identified and controlled.
	13. System and human resource changes	Ensure non-engineering changes do not adversely effect ESH critical values or positions.
	14. Design, construction and commissioning	Ensure major hazards and risks are identified and that controls are implemented that verify safe design, construction and operation.
Checking and Corrective Action	15. Monitoring, reporting and corrective action	Ensure a reporting and analysis system for incidents and corrective action status.
	16. Records	Establish and maintain system of records which demonstrate ESH Management System compliance and to record status of environmental objectives and targets.
	17. Performance system review	Ensure effective review, inspection and monitoring processes.

The management review phase would include regular reviews of the system with respect to the requirements of ISO 14001 to ensure continual improvement in environmental performance of the company.

6.3 Construction Environmental Management Plan

Environmental management during the construction phase is addressed as a separate element of the site's overall environmental management due to the distinct differences in the types of activities conducted during the Project's construction phase. A Construction Management Plan would be formulated in consultation with key stakeholders prior to the start of works.

The construction phase encompasses all works associated with the preparation of the site and installation of infrastructure for mining and processing.

The aims for the construction environmental management programme include:

- Minimisation of disturbance area;
- Protection of identified environmentally sensitive areas (eg. Lake foreshore, remnant vegetation);
- Recovery and management of soil resources from disturbance areas;
- Minimisation of dust and noise impacts;
- Water management and surface hydrology;
- Aboriginal heritage issues (monitoring and salvage);
- Control of erosion and sediment migration to the Lake (via an Integrated Erosion and Sediment Control Plan [IESCP] prepared in close consultation with DLWC); and
- Characterisation of construction material and establishment of a set of suitability criteria (to be conducted in consultation with the DLWC).

6.4 Operational Environmental Management Plan

Environmental management during the operational phase would include the on-going administration of the Project ESHMS which encompasses all Project environmental management plans, as well as the fulfilment of MREMP requirements and the maintenance of the community consultation programme. Detail of the component environmental management plans is outlined in Sections 6.4.1 to 6.4.5. Environmental monitoring programmes intended for implementation and operation during both the construction and operational phases of the Project are outlined in Section 6.5.

6.4.1 Hazardous Waste and Chemical Management Plan

Chemical, reagent and fuel requirements during mineral processing are listed in Section 2.6.12. As discussed in Section 4.1.7, a preliminary risk assessment has been completed (Appendix L) which identifies risks to the public, public property and the environment (both on and off-site). The safeguards and contingency plans discussed in the assessment would be integral to the hazardous waste and chemical management plan. The plan would provide detail on the appropriate transport, handling, disposal and recycling procedures for wastes generated at the Project site as well as appropriate emergency response procedures in the event of spillages. The plan would be in accordance with relevant statutory considerations and Australian Standards.

The plan would also include the regular maintenance of both a hazardous substances and fuel and oil register. The purpose of these registers would be to facilitate efficient audit functions as well as conform with best practice environmental management.

The register of hazardous substances and dangerous goods used on site would comprise the following:

- Regularly updated medical/environmental safety data in accordance with Section 42 of the Mines Inspection General Rule (1994);
- A regularly updated list of the chemicals on site with details of quantities and storage locations;
- Auditing and review procedures;
- Safety and hazard management procedures for potential incidents;
- Personnel training procedures; and
- Contingency, cleanup and disposal procedures.

The fuel and oil register would include:

- The types and volumes of fuel and oils;
- Location of storage facilities, storage methods, bunding and secondary containment;
- Pumping, piping, transfer and separation procedures;
- Fire protection;
- Spill containment and cleanup procedures;
- Maintenance, testing and audit procedures;
- Waste oil collection, treatment and disposal procedures.

6.4.2 Land Management Plan

A Land Management Plan would be produced to establish general property management practices which conform with sustainable landuse targets for the immediate Project area. The Plan would be prepared in consultation with NSW Ag, DLWC, neighbouring landholders and NPWS and will take into consideration catchment management plans operating in the area.

The Plan would address:

- grazing and pasture management (including grazing management strategies during the progressive exclusion of stock from within the MLA area);

- weed management;
- remnant vegetation management (including vegetation clearance control during construction); and
- feral animal control.

6.4.3 Site Water Management Plan

The Site Water Management Plan would be formulated to provide measures for the mitigation of potential water quality and quantity (surface and groundwater) impacts as detailed in Section 4.2.

The Plan would be formulated in consultation with DLWC, and would aim to integrate with the Lake Cowal Management Plan and Jemalong Land and Water Management Plan, both of which are in preparation. The timing of the formulation and implementation of the Plan during the Project life is outlined in Table 6-1.

The key management components of the site water management strategy are detailed in Appendix F. They are:

- construction water management;
- operational water management; and
- post-closure water management.

Brief descriptions of these components are detailed below.

Construction Water Management

The construction water management system would comprise the following:

- Up-catchment Diversion System which permanently diverts runoff from catchment areas upslope of the mine site;
- Internal Catchment Drainage System which isolates the mine site hydrological cycle from the external environment; and
- Integrated Erosion and Sediment Control System (for both construction and operational phases as detailed in Section 6.5.11).

The system would also address water management of advanced pit dewatering and the development of the Bland Creek Palaeochannel borefield and associated water pipeline.

Operational Water Management

Operational water management issues and requirements are:

- the provision of secure and adequate water supplies (including surface and groundwater) for ore processing and potable requirements;
- the water supply for processing plant water requirements from on-going open pit dewatering and in-pit pumping of incident rainfall over the pit and runoff from catchment areas adjacent to the pit;
- on-site retention of potential saline seepage from the waste emplacements and ore stockpile, runoff from the processing plant and any accidental spills;
- contingency water management measures to prevent migration of potential contaminants, off-site and into Lake Cowal, as a result of accidental spillages and/or climatic extremes;
- contingency water management measures to mitigate regional groundwater effects resulting from make-up water supplied from the Bland Creek Palaeochannel borefield.

Post-Closure Water Management

The post-closure water management system would provide means for addressing the following:

- permanent isolation of the mine site (including runoff and void water) from Lake Cowal;
- long-term void water quality and void hydrology; and
- long-term stability of the permanent Up-catchment Diversion System and Internal Catchment Drainage System after mine closure.

6.4.4 Bushfire Management Plan

A Bushfire Management Plan would be established in order to reduce fire risk to the immediate rural area. The Plan would be formulated in consultation with the bushfire control officer at the Bland Shire Council and other relevant government authorities. The Plan would include aspects relating to fuel management and fire incident control, namely:

- identification of bushfire threat and assets at risk;
- identification of areas within the MLA requiring fuel management;
- description of fuel management strategies;
- planning and implementation procedures for hazard reduction;
- detection, reconnaissance and reporting of fires; and
- fire fighting activities.

North proposes to consult and comply with the requirements of the Bland Shire Council concerning the prevention and control of bushfires including the provision of:

- adequate fire breaks;
- provision of appropriate and well maintained fire fighting equipment on-site; and
- appropriate staff training.

No grass or vegetation would be burned off on the proposed MLA without the consent of the owner or occupier and the local fire authority.

6.4.5 Mining Operations Plan (MOP) and Annual Environmental Management Report (AEMR)

These documents would typically be required as a lease condition. Their aim is to:

"...ensure that any adverse effects of mining and processing are minimised and that a consistently high standard of environmental protection, pollution control and rehabilitation is practiced..." (DMR, 1996).

Accordingly, the MOP would be produced to give a detailed "on-the-ground" account of the proposed mine site activities for a nominated term. It would include all mining and rehabilitation operations and relevant environmental controls and procedures necessary for compliance with lease conditions. It would be produced prior to mining commencing. This would be followed up by the AEMR which would annually verify the environmental performance of the site both in a statutory and forward planning sense. Both forms of documentation would provide a means by which compliance with lease conditions and licenses is demonstrated. The environmental monitoring programmes would provide data for the measurement of compliance.

6.5 Operational Environmental Monitoring Programmes

Detailed Project environmental monitoring programmes (including parameters, frequencies and analytical procedures) would be specified in the first MOP, and following detailed discussions with regulators during the setting of Project consent conditions. The results of these programmes would be presented annually within the AEMR. The following components would be included within the monitoring programmes (Figure 6-2):

- Hydrology (including surface water flows and lake levels and surface water quality);
- Hydrogeology (including groundwater levels and quality);
- Cyanide monitoring (at plant site, destruction plants, point of disposal, storage decant ponds);
- Climate (temperature, wind direction, wind speed, humidity, solar radiation, rainfall, evaporation);
- Fauna (including bird usage of tailings storages, bird numbers and species diversity at bird breeding sites, autopsy procedures for on-site fatalities);
- Air quality at neighbouring properties and bird breeding areas (eg. suspended particles and metals);
- Noise and blasting (including real time monitoring of bird breeding colonies during blasting);
- Waste rock emplacements (including assessment of rehabilitation performance [ie. revegetation, landform stability]);
- New lake foreshore (including assessment of rehabilitation performance [ie. revegetation, landform stability];
- Tailings storages (for water levels, progressive batter rehabilitation);
- Soil management and topsoil stockpile management (for soil fertility and structural characteristics);
- Erosion and sediment (in order to assess landform stability);
- Rehabilitation (erosion, vegetation, land capability/suitability and land use monitoring); and
- Landholder and community consultation.

The programme would be subject to approval by relevant regulatory bodies including State and Local authorities. The design of the programme would also be dependent on the requirements of any environmental licenses issued by the EPA and any mining lease consent conditions.

The AEMR would present the results and findings of the monitoring programmes. Accordingly, the programme would be subject to annual review and continuous improvement as a result of stakeholder input.

6.5.1 Water Monitoring Programme

The water monitoring programme would comprise the following components:

- surface water flows;
- lake levels;
- rainfall and evaporation;
- surface water quality; and
- groundwater levels and quality.

Data collected during the programme would be applied to the following:

- review of on site water management structures and their effectiveness; and
- the biological components of the monitoring programme for establishing degrees of flux in the Lake habitat.

Surface water flow data is continuously recorded by automatic stream gauges on the Lachlan River (at Jemalong Weir), Manna Creek (at Glencoe Station) and the mid-reaches of Bland Creek (at Morangarell) and collected by DLWC. The flow data from these stations would be accessed to:

- determine the event frequencies of various rainfall events and subsequently review the performance of site water management structures (eg. sediment dams, diversion channels);
- establish the Lake catchment characteristics to provide an holistic appraisal of the Lake and the processes which alter its hydrology and water quality; and
- gauge the effects of surface water flows in Bland Creek on Lake water levels.

Lake levels would continue to be monitored at those locations established by North. These locations are shown on Figure 6-2.

Rainfall and evaporation measurements are currently recorded by the automatic weather station located on site (Figure 6-2). These measurements would provide Lake and site-specific climatic data as well as for the on-going assessment of the site's water balance. The results would also be integrated into the monitoring programme's biological monitoring components.

The surface water quality monitoring programme would include a baseline (or control) component which is targetted

at monitoring the dynamic nature of water quality in the Lake itself, while concurrently determining the degree to which potential site runoff effects alter these baseline levels. Water quality would provisionally be monitored at those sites shown on Figures 6-2 and 6-3 (including contained water storages). Monitoring results from the contained water storages would determine the requirement for amelioration of turbidity effects (eg. implication of flocculants). Water quality considerations would also be targetted within the cyanide destruction process. Accordingly, the monitoring programme to be implemented would include sampling of CN_{WAD} at the tailings storage discharge point and the tailings storages, and the measurement of CN_{FREE} at the cyanide destruction points.

Surface water quality would be monitored at those points marked on Figures 6-2 and 6-3 (including all baseline sites). Surface water quality assessment would include parameters agreed upon in consultation with DMR, NPWS, EPA and DLWC. Typically, those parameters would include pH, electrical conductivity (EC), total suspended solids (TSS), cations, anions, alkalinity, temperature, depth, turbidity, dissolved oxygen and select metals. Groundwater quality would also be assessed within the Project area. Analytical parameters would be agreed upon in a similar manner as those for surface water quality and would typically include pH, EC, TSS, cations, anions, alkalinity, total and filterable, arsenic (As), antimony (Sb), copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), selenium (Se), and silver (Ag).

Lake water quality would be sampled at all sample points (where possible) throughout filling and drying cycles (Figure 6-3).

Water quality would also be sampled at the proposed sewage treatment facility at a frequency to be determined by EPA.

Water quality sampling would be an integral component of the Integrated Sediment and Erosion Control Plan. This plan would be produced in close consultation with DLWC prior to commencement of construction and would be updated as new work areas are opened and/or as new work phases commence.

Both groundwater quality and levels would be monitored throughout the Project life. Groundwater levels would be monitored in the vicinity of the open pit and tailings storages, at the Bland palaeochannel borefield and at regional piezometers (the locations of which, would be agreed upon with DLWC and local landholders). Monitoring of potential seepage from the tailings storages is addressed in Section 6.5.9. Groundwater monitoring would provide the means by which potential impacts such as drawdown effects from groundwater extraction and groundwater quality effects from seepage may be assessed. The locations of all proposed monitoring bores are shown on Figures 6-2 and 6-4. Groundwater quality parameters would be measured at six-monthly intervals at one site within the MLA and one site in the vicinity of the palaeochannel borefield.

All programme components and schedules would be reviewed by relevant authorities prior to their implementation.

6.5.2 Climate

An automatic weather station has been installed on site to record air temperature, relative humidity, wind speed, wind direction, rainfall and solar radiation. These measurements are used to automatically calculate evaporation which is also recorded. The data is collected and collated within the meteorological database. It provides information for the understanding of Lake hydrological and meteorological processes, verifying parameters relevant to potential noise and/or air quality issues, reviewing the site water balance, design criteria of water management structures and rehabilitation design criteria, and refining the baseline environmental database.

6.5.3 Biological Monitoring

Due to the levels of fauna usage (particularly waterbirds) of Lake Cowal and its associated conservation status, the biological monitoring programme would play a key role in the overall programme.

The two main components of the biological monitoring programme would be:

- Continued baseline monitoring within the Lake; and
- Project-specific monitoring, notably tailings storages.

The continued baseline monitoring programme aims to establish the control by which to compare Project-specific monitoring results and, therefore, assess potential or measured impacts. This component programme would target the receiving environment and would include but not necessarily be restricted to the Lake ecosystem. The importance of this monitoring programme component is demonstrated when considering the dynamic nature of the Lake ecosystem. As the Lake is influenced by many other natural fluctuations and anthropogenic influences, the ability to characterise the Lake's ecosystem at any one time and to attribute various influences to Project related impacts would be the key function of the ongoing baseline monitoring programme.

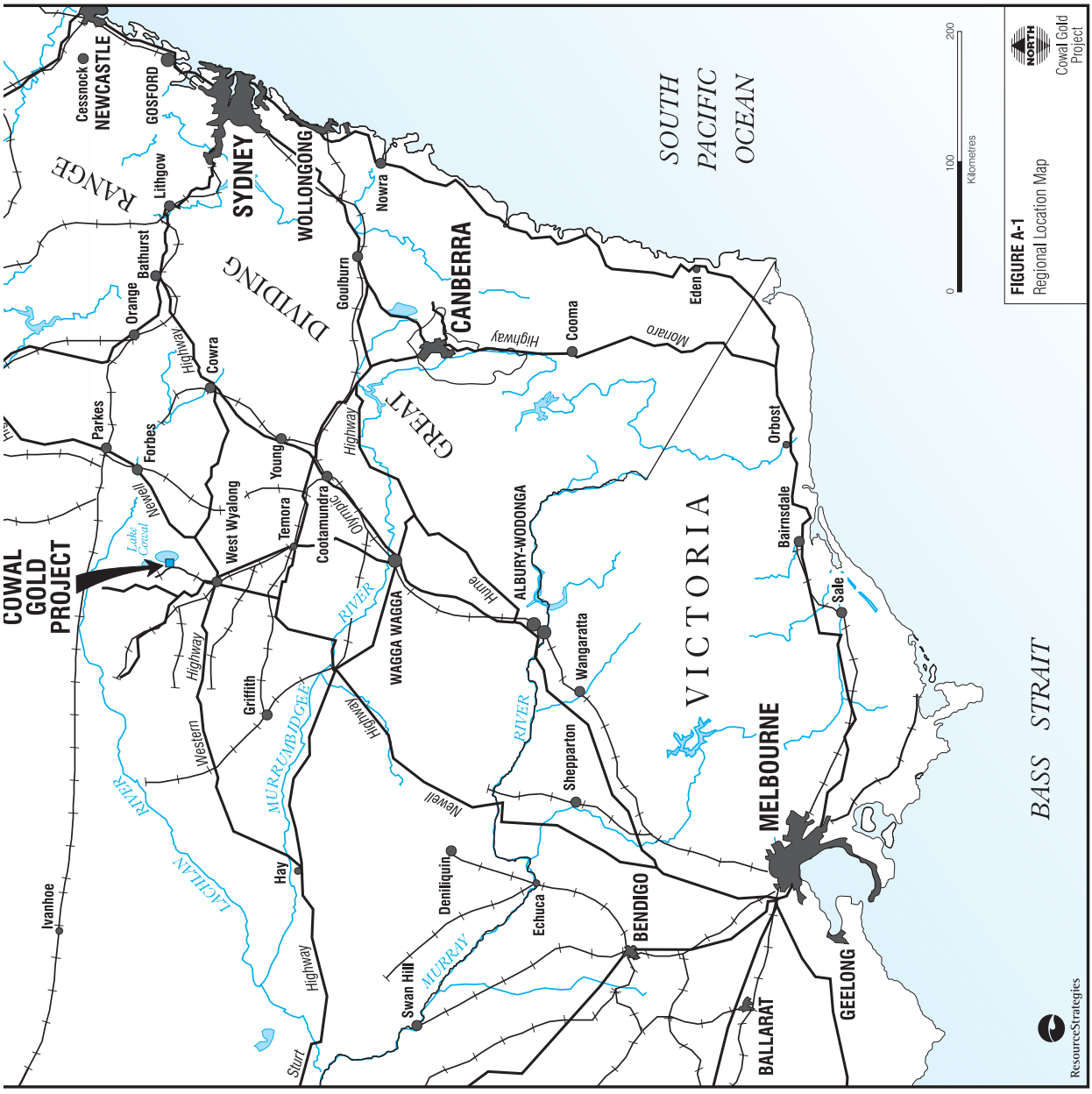
The baseline monitoring programme would be established by combination of:

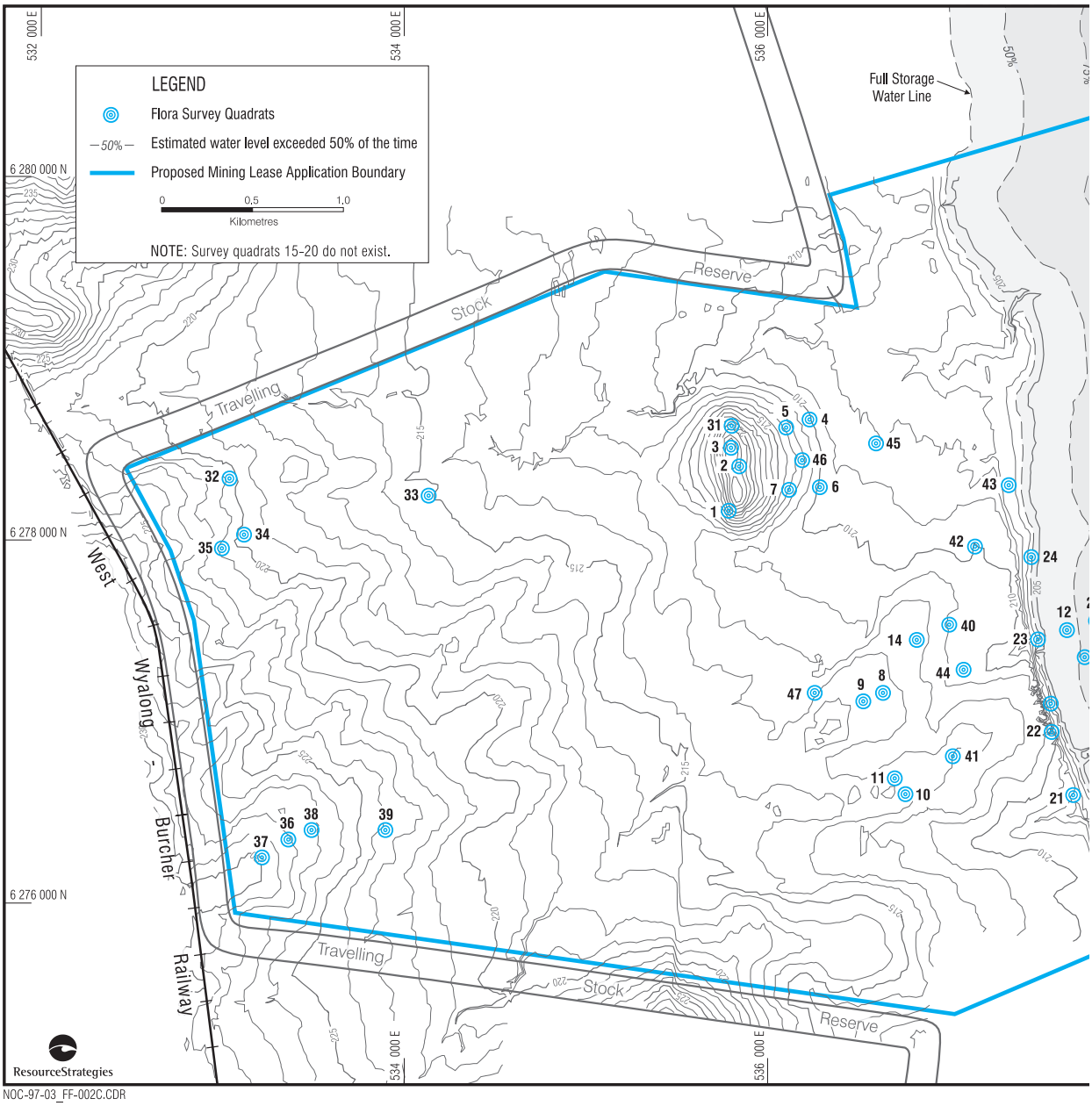
(i) the principles and guidelines for the biological monitoring programme (Humphries *et al.* (1991)); and

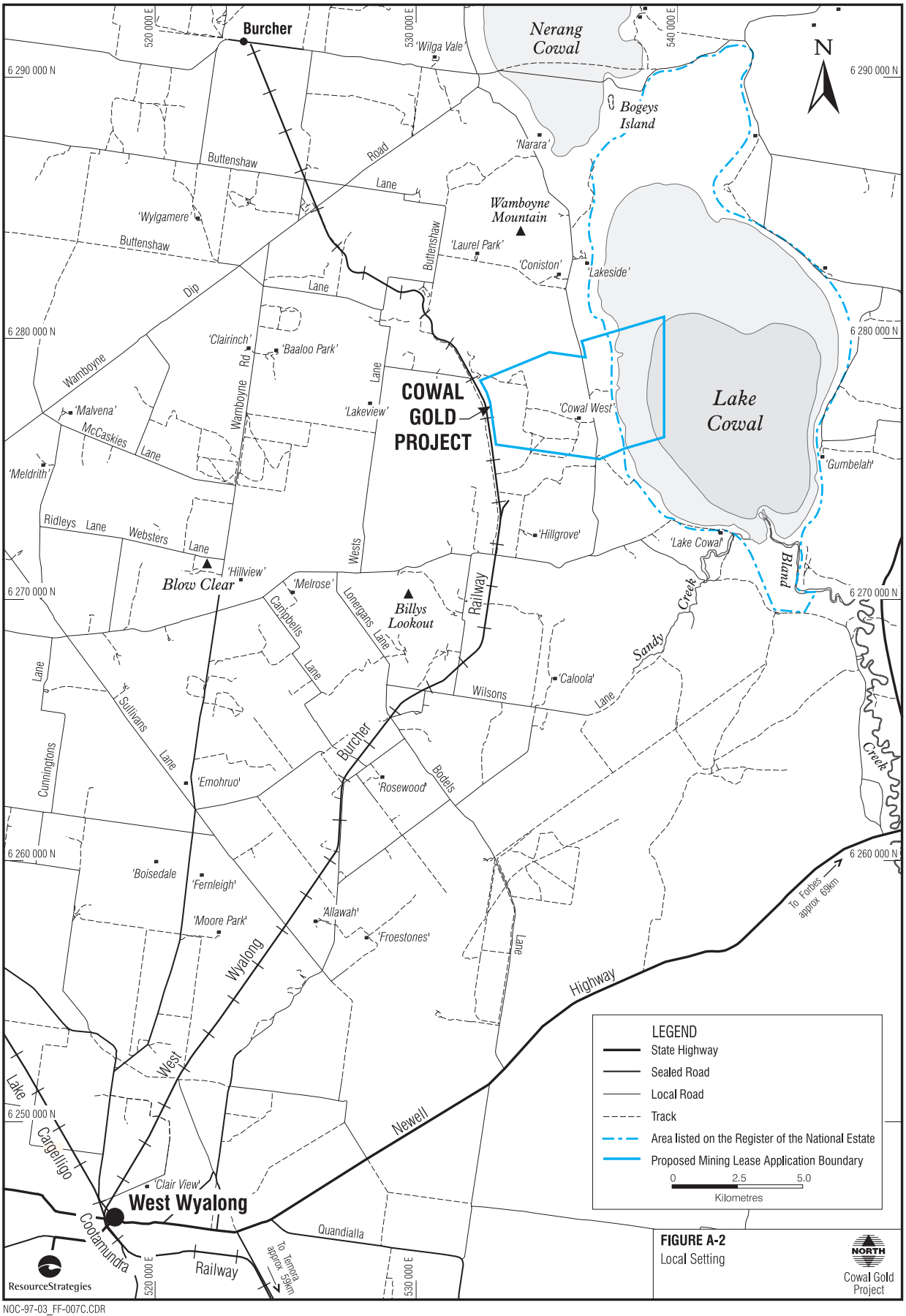
(ii) the implications and recommendations of Goldney *et al.*, 1997 (Appendix N).

The technical objectives of the programme are to:

- Characterise the natural fluctuations of the aquatic ecosystem;
- Identify existing anthropogenic influences on the Lake;
- Apply long term monitoring programme results to enable the detection of significant changes in the Lake ecosystem and the identification of the mining operation's role in such changes;


COWAL GOLD PROJECT
Lake Cowal
Parkes
Forbes
Newell
West Wyalong
Temora
Young
Cowra
Orange
Bathurst
Lithgow
Cessnock
NEWCASTLE
GOSFORD
SYDNEY
WOLLONGONG
Nowra
Goulburn
CANBERRA
Cooma
Eden
Moruya
Highway
Coolamundra
Ovmple
Griffith
Western
Highway
Hay
Ivanhoe
Sturt
Highway
Swan Hill
Deniliquin
Echuca
Newell
Highway
WAGGA WAGGA
Hume
ALBURY-WODONGA
Wangaratta
Shepparton
BENDIGO
MELBOURNE
BALLARAT
GEELONG
Orbost
Bairnsdale
Sale
RANGE
DIVIDING
GREAT
VICTORIA
SOUTH PACIFIC OCEAN
BASS STRAIT
MURRUMBIDGEE RIVER
MURRAY RIVER
LACHLAN RIVER
0
100
200
Kilometres
FIGURE A-1
Regional Location Map
Cowal Gold Project
ResourceStrategies
N0C-97-03_FF-023A.CDR


LEGEND
Flora Survey Quadrats
50%
Estimated water level exceeded 50% of the time
Proposed Mining Lease Application Boundary
0
0.5
1.0
Kilometres
NOTE: Survey quadrats 15-20 do not exist.
532 000 E
534 000 E
536 000 E
6 280 000 N
6 278 000 N
6 276 000 N
Full Storage Water Line
Travelling Stock Reserve
West Wyalong - Burcher Railway
ResourceStrategies
NOC-97-03_FF-002C.CDR



NOC-97-03_FF-007C.CDR

- Establish the basis from which any short term effects (eg. an accident at the mine, or elsewhere in the catchment), or any mortality of birds or fish for whatever reason, could be immediately investigated and assessed in terms of prior conditions.

The baseline biological monitoring programme would, therefore, adopt the same strategies and would include monitoring and/or assessment of the parameters necessary to achieve the aim of the programme.

Details would be confirmed in consultation with the relevant agencies, but are likely to include:

- noise and dust monitoring (at Project and external to Project);
- Lake sediment, water levels and biological diversity;
- water quality (groundwater and surface water in local and regional catchment);
- bird usage and diversity trends;
- regional landuse development patterns.

The existing waterbird monitoring programme would also be continued throughout the Project unless the results of the programme suggest revision or review. The waterbird monitoring programme involves survey of waterbird abundance, diversity and breeding activity at the Lake every August, October and January.

Full programme details would be confirmed with the relevant stakeholders subsequent to EIS lodgement, in accordance with normal procedures in NSW.

Occurrences of wildlife mortality have been recorded over the years at Lake Cowal (eg. when the Lake dries out completely, substantial fish and some waterbird mortalities occur). Notwithstanding the mitigation measures proposed to protect wildlife in the Project area (eg. the destruction of cyanide to meet EPA limits in the tailings storages) some potential for wildlife mortalities to occur within the Project area would still exist. Such mortalities could result from a range of events which may or may not be associated with activities on the mine site itself (eg. fauna mortalities in the Project area could result from changes in the Lake as discussed above or as a result of an accidental strike by a mine vehicle).

Any incidents of vertebrate fauna mortality which may occur within the Project area and in the immediate vicinity would be recorded and procedures for establishing the cause of death (where possible) would be implemented and include (but not necessarily be restricted to):

- prompt reporting of mortalities to NPWS and EPA;
- immediate removal and freezing of tissue samples and whole blood;
- prompt processing of samples for quantitative analyses (including cytochrome oxidase activity and cyanide bio-assays) and qualitative examinations (including bacteriology, gross pathology and histopathology); and
- an immediate review with NPWS/EPA of the 30/20 CN_{WAD} discharge levels in the event that the above analyses indicated cyanide toxicity.

This procedure would be finalised in consultation with relevant authorities, eg. NSW Ag and NPWS and would be detailed in the first Mining Operations Plan.

Project-specific biological monitoring would include the following monitoring programme components:

- Fauna (including birds and microchiropteran bats) usage of the tailings storages (qualitative and quantitative records);
- Fauna usage of the open pit area including pit walls and final void water body (qualitative records);
- Fauna (particularly terrestrial and avifauna) usage of the rehabilitated new lake foreshore, waste emplacements and tailings storages (qualitative records); and
- Monitoring of the electricity transmission line corridor for bird strike incidence (quantitative records).

All biological monitoring procedures and methodologies would be formulated in accordance with NPWS and NSW Ag and other relevant stakeholders.

A Feral Pest Management Plan would also be prepared in accordance with the best practice guidelines and recommendations of the Australian Nature and Conservation Agency – Vertebrate Pests Committee Working Group (1995) and the NPWS.

6.5.4 Air Quality

The proposed dust monitoring programme would be used to assess compliance of the operating mine with the air quality objectives and licence conditions. Figure 6-3 shows the locations of the dust gauges which comprise the existing air quality (dust) monitoring programme. Samples are currently analysed for total insoluble fraction as well as aluminium, arsenic, cadmium, lead, selenium, zinc and copper.

The proposed monitoring programme would be expanded to include those sites shown on Figure 6-3. Dust deposition would be calculated monthly and metals analyses would be conducted every six months.

6.5.5 Noise and Blasting

The proposed noise and blast monitoring programme would be used to assess the predictions of negligible adverse noise and blast impacts concluded by the noise and blast assessment completed for the Project. Noise and blasting would be randomly monitored at those residences shown on Figure 6-3 and listed below:

- Coniston;
- Lakeside;
- Lake Cowal; and
- Gumbelah.

Results of this monitoring would be used to verify those predictions made for the increase in the level of noise at bird breeding areas as well as compliance with EPA criteria.

Results of the noise and blasting monitoring programme would also be used to verify potential complaints received through the public consultation process.

Noise monitoring (ie. ambient noise levels and blasting vibration levels) would also be conducted at select, known bird breeding areas on the Lake and, as rehabilitation proceeds, at the new Lake foreshore to assess any impacts on bird behaviour at variance to the EIS predictions.

6.5.6 Aboriginal Heritage

The management of the site's aboriginal heritage would be directed towards protecting/ salvaging archaeological sites as well as enhancing local knowledge and the appreciation of the cultural heritage of Lake Cowal.

The management of archaeological sites in the Project area is detailed in Section 4.8.1. Management procedures to be implemented by North include the display of salvaged items at the West Wyalong Aboriginal Land Council museum and the production of a written account of Aboriginal heritage and history at Lake Cowal and West Wyalong. North also propose to sponsor a Land Council position as required specifically for the purpose of cultural heritage management during construction. Management of possible burial sites would also be included within the management protocols and would entail supervision of earthworks in the vicinity of small sand bodies that occur on-site (Appendix E).

6.5.7 Waste Rock Emplacements

The environmental management and monitoring programme for the waste rock emplacements would comprise the following studies:

- Assessment of the performance of soil covers as suitable plant growth medium including fertility and physical characterisation;
- Geochemical characterisation of waste rock including SAR, EC, pH, and trace elements;
- Assessment of the influence of edaphic (soil forming) processes on mined waste rock;
- Determination of drainage and seepage characteristics and the performance of the absorption systems on the top surfaces of emplacements. This would include water quality monitoring from the toe drain shown on Figure 5-5. The results of these assessments would be incorporated within the continuous improvement of the site's environmental management programme (eg. results would be used to refine soil erosion and drainage control);
- Determination of the moisture retention capacity of rehabilitation substrate; and
- Assessment of the revegetation success on the emplacements and the species suitability as revegetation succession takes place.

The programme would be reviewed annually. The review process would include input from DMR, NSW Ag, NPWS and DLWC.

Rehabilitation trials would be conducted on the waste rock emplacements (Section 6.5.12).

6.5.8 New Lake Foreshore

The new Lake foreshore is comprised of the following landforms (Section 5.3.1):

- the temporary isolation bund;
- the lake protection bund and the lower batter of the perimeter waste emplacement; and
- the intervening section of lakebed between the temporary isolation bund and the lake protection bund.

The following studies would be conducted as components of the environmental management and monitoring programme for the new Lake foreshore area:

- Water quality monitoring as detailed in Section 6.5.1 during construction and operation development phases;
- Assessment of the containment success of the temporary isolation bund during operation stages prior to breaching;
- Assessment of the constructed and final landform stability with particular focus on those foreshore landform components exposed to wave action;
- Determination of revegetation success on the New Lake Foreshore landform components;
- Assessment of the landforms' substrate suitability as revegetation media;
- Geochemical characterisation of material including SAR, EC, pH, and trace elements for stability and fertility investigations; and
- Determination of fauna activity (with emphasis on waterfowl, native fish and European carp) within the rehabilitated area.

6.5.9 Tailings Storages

The environmental management and monitoring programme for the tailings storages would include the following:

- Automated monitoring of cyanide concentration and pH in the tailings discharge water;
- Automated monitoring of cyanide concentration and pH in the decant pond water;
- Inspection of the tailings storages twice daily for bird usage and patterns of bird usage over time;
- Inspection of the tailings slurry pipeline for physical integrity;
- Inspection of the tailings water return pipeline for physical integrity;
- Fauna activity levels on and in the vicinity of the tailings storages (Section 6.5.3);
- Hydrological monitoring of the constructed and rehabilitated landforms. This would include assessment of the performance of the proposed surface water containment system and associated runoff control structures, the water holding capacity of rehabilitation cover material and degree of potential seepage from the storages. Monitoring procedures associated with these assessments would include:

  - the installation of piezometers on each of the tailings storages for the purpose of monitoring groundwater levels, embankment and foundation stability and verifying groundwater modelling predictions;
  - regular water quality sampling of the water collected in the seepage cutoff drain (Section 6.5.1); and
  - groundwater level monitoring at piezometers within the MLA (Figures 6-2 and 6-4), which are currently part of the baseline groundwater monitoring programme for groundwater level monitoring, embankment and foundation stability and verifying groundwater modelling predictions;
- Geotechnical stability of the tailings storage through measurements of phreatic surface and levels of embankment saturation;
- Assessment of the performance of soil covers as suitable plant growth medium including fertility and physical characterisation;
- Assessment of the influence of edaphic processes on tailings; and
- Assessment of the revegetation success on batters and surfaces of the storages and the species suitability.

The plan would be annually reviewed.

Rehabilitation trials would be conducted on the tailings storages. Details of these trials are outlined in Section 6.5.12.

6.5.10 Soil Management

Appendix B details the soil resource characteristics of the proposed development areas within the MLA. Soil management practices have been defined in accordance with the recommendations outlined in Appendix B.

As detailed in Section 5.2.3, topsoil and subsoil stockpiling protocols would be observed in accordance with soil resource management objectives. Soil management strategies would determine quantities of topsoil and subsoil for rehabilitation, suitable soil stripping, handling and storage procedures, and appropriate resource rejuvenation procedures.

The soil management strategy would include the formulation of a Soil Stripping Management Plan which would be completed prior to construction commencing. The plan would aim to refine the current assessment of the soil resource in terms of:

- soil depth;
- suitability for rehabilitation purposes;
- management of topsoil; and
- management of subsoil.

6.5.11 Erosion and Sediment Control

Operational and erosion sediment control proposals are detailed in Appendix F and Section 2.9.

The primary objective of erosion and sediment control on-site is the protection of Lake water quality (via the separation of flows into the Internal Containment System and the Up-catchment Diversion System). Erosion and sediment control strategies include surface drainage techniques such as crowning, infall and outfall techniques, and the construction of waterways, graded banks, detention banks and sediment traps. In addition to these strategies, an Integrated Erosion and Sediment Control Plan would be formulated prior to operations commencing (typically in accordance with Project consent conditions). This plan would address the progressive development of the site, providing design standards for specific erosion and sediment control measures. The objectives of this plan would be to:

- Control movement of sediment from areas disturbed by mine related activities; and
- Maintain downstream (Lake) water quality.

Water quality monitoring aspects associated with runoff events are detailed in Section 6.5.1.

Erosion control structures would be inspected after runoff events in order to assess structural integrity and effectiveness of control structures. Results of this monitoring would be used to evaluate necessary ameliorative responses.

6.5.12 Rehabilitation Performance

Rehabilitation performance would be assessed using the monitoring results from the above programmes in concert with the revegetation monitoring results.

Monitoring of the revegetation programme would commence with the start of revegetation activities. The components of the revegetation monitoring programme are as follows:

- Documentation of the cover treatment of various rehabilitated areas including recording seeding type and rate, date completed and fertiliser treatment (if required);
- Assessment of the establishment success of various fast-growing erosion control ground cover species;
- Establishment of vegetation transects for ongoing monitoring of endemic species diversity and abundance;
- Assessment of the level of fauna utilisation of rehabilitated areas; and
- Assessment of the establishment success of the species used in the various vegetation alliances planned for different landform types.

The rehabilitation monitoring programme and methodology would be determined in consultation with NPWS, DLWC, NSW Ag and DMR.

Monitoring results would be presented within the AEMR.

The details of rehabilitation strategies would be determined by the findings of proposed rehabilitation trials. Trials would be conducted on the tailings storages, waste rock emplacements and new lake foreshore landforms. Trials would aim to determine optimum revegetation species rates and treatment methods through trials on varying rehabilitation cover thicknesses along with various establishment procedures (eg. varying starter fertiliser rates).

Trials would be conducted on dedicated areas, which would not be disturbed subsequent to establishment. Monitoring of vegetation establishment would be conducted seasonally.

The trials would be designed in consultation with NPWS, DLWC, NSW Ag and DMR.

The design and results of these trials would be incorporated in the MREMP and would be detailed in the MOP.

A detailed set of close-out criteria for post operations monitoring would be developed through the MREMP in line with the final Rehabilitation Plan.

6.5.13 Post-Operations Monitoring

Monitoring programmes would be maintained for periods and at frequencies to be established in consultation with key agencies, until all mine related disturbance areas are rehabilitated to stable landforms. Determination of landform stability criteria and close-out criteria would be agreed in consultation with these agencies principally through the MREMP.

As noted in the ecological study (Goldney et al., 1997) conducted as a component of the Long Term Compatibility Assessment (Appendix N), most long-term ecological risks associated with the Cowal Gold Project can be managed in a manner that would result in either a minimal impact on Lake Cowal's critical conservation values, complete removal of a risk or in some cases may even enhance these values. The creation of the final void with its long-term highly saline waters, adjacent to Lake Cowal, provides a minimal potential ecological risk. Long term conservation of the Lake's CCVs with or without the Project needs to encompass:

- The development of a Lake Cowal Whole of Catchment Management Plan to enable the optimisation of nature conservation and agricultural outcomes within the catchment, including strategies to mitigate critical land degradation processes, based on a systems approach. The development of such a strategy implemented over a ten year period is considered to be the most important offset that can occur in the catchment and needs to be developed co-operatively with all stakeholders. It is noted that the Lake Cowal Management Plan is currently being compiled as part of the Jemalong Land and Water Management Plan. These plans are recognised as integral components to a Lake Cowal Whole of Catchment Management Plan;
- Development of at least one farm as a working model of the integration of nature conservation and sustainable agriculture that all sustainable farm systems need to achieve if the Whole of Catchment Management Plan were to be implemented. Linkage of this development with a research program to monitor outcomes (economic, rehabilitation and productivity);
- Development of individual farm plans for all other properties owned/managed by North Ltd in the Lake Cowal system, in keeping with the Catchment Management Plan;
- Progressive preservation of a selection of the lakebed properties with at least a 100 m terrestrial buffer zone and conversion to Nature Reserve status; and
- Provision of research scholarships on critical management areas over a decade including:
  - waterbird population dynamics;
  - key species ecology;
  - optimal riparian regeneration-rehabilitation strategies;
  - optimal lakebed rehabilitation strategies;
  - optimising lakebed farming and nature conservation outcomes;
  - oral history of Lake Cowal with emphasis on natural history of the system; and
  - optimal placement of sustainable synthetic native plant communities on farm land for agriculture and nature conservation outcomes.

The authors of the long-term compatibility ecological study consider that the Cowal Gold Project could operate as a catalyst to initiate and support these measures.

6.6 Landholder Consultation/Involvement

A committee of local stakeholders comprising landholders and relevant interest groups would be invited to participate in a forum to disseminate environmental performance information and Project development updates.

Section 7

Section 7

References

7.0 REFERENCES

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- *Bland Shire Council Local Environmental Plan 1993*
- *Clean Air Act 1961*
- *Clean Waters Act 1970*
- *Commonwealth Australian Heritage Commission Act 1975*
- *Commonwealth Endangered Species Protection Act 1992*
- *Crown Lands Act 1989*
- *Dangerous Goods Act 1975*
- *Forbes Shire Council Local Environmental Plan 1986*
- *Heritage Act 1977*
- *Local Government Act 1993*
- *Mines Inspection Act 1901*
- *Mines Inspection General Rule 1994*
- *Mining Act 1992*
- *National Parks and Wildlife Act 1974*
- *National Trust of Australia (New South Wales) Act 1990*
- *Native Vegetation Conservation Act 1998*
- *Native Title Act 1993*
- New South Wales *Environmental Planning and Assessment Act 1979*
- New South Wales *Fisheries Management Act 1994*
- New South Wales *Threatened Species Conservation Act 1995*
- *Noise Control Act 1975*
- *NSW Aboriginal Land Rights Act 1983*
- *Pipelines Act 1967*
- *Pollution Control Act 1970*
- *Rivers and Foreshores Improvement Act 1948*
- *Roads Act 1993*
- *State Environmental Planning Policy 11 – Traffic Generating Developments*
- *State Environmental Planning Policy 33 – Hazardous and Offensive Development*
- *State Environmental Planning Policy 34 – Major Employment Generating Industrial Development*
- *State Environmental Planning Policy 44 – Koala Habitat Protection*
- *State Environmental Planning Policy 45 – Permissibility of Mining*
- *Water Act 1912*

Section 8

Section 8

Abbreviations and Acronyms

8.0 ABBREVIATIONS AND ACRONMYS

AEMR	Annual Environmental Monitoring Report
Ag	Silver
ARI	Average recurrence interval
As	Arsenic
BMP	Bushfire Management Plan
CAMBA	China-Australia Migratory Bird Agreement
Cd	Cadmium
CEMP	Construction Environmental Management Plan
CIL	Carbon in leach
CO_2	Carbon dioxide
CN	Cyanide
CN_{WAD}	Weak acid dissociable cyanide
Cu	Copper
DA	Development Application
dBA	"A"-weighted decibels
DLWC	Department of Land and Water Conservation
DMR	Department of Mineral Resources
DUAP	Department of Urban Affairs & Planning
EC	Electrical conductivity
EIS	Environmental Impact Statement
EL	Exploration lease
EPA	Environment Protection Authority
ESD	Ecologically Sustainable Development
ESHMS	Environment, Safety and Health Management System
FPMP	Feral Pest Management Plan
g/t	grams per tonne
g/m²/month	grams per square metre per month
GSE	Great Southern Energy
ha	hectare
HWCMP	Hazardous Waste and Chemical Management Plan
HCN	Hydrogen cyanide
IESCP	Integrated Erosion and Sediment Control Plan
Hg	Mercury
JAMBA	Japan-Australia Migratory Bird Agreement
kg	kilogram
kV	kilovolt
L_{A10}	Noise level exceeded 10% of the time with "A"-weighting
L_{A90}	Noise level exceeded 90% of the time or background with "A"-weighting
LEP	Local Environmental Plan
LGA	Local Government Area
LMP	Land Management Plan
mg/L	milligrams per litre
ML	megalitres (million litres)
MLA	Mining Lease Application
m^3/hr	cubic metres per hour
MOP	Mining Operations Plan
mm	millimetres
Mm^3	mega (million) cubic metres
MREMP	Mining Rehabilitation and Environmental Management Process
Mt	mega tonnes (million tonnes)
Mtpa	mega (million) tonnes per annum
MW	megawatt
NPWS	National Parks & Wildlife Service
NSW Ag	NSW Agriculture
O_2	Oxygen
Pb	Lead
PM10	Particulate matter with diameter <10 µm
ppm	parts per million
PVC	Polyvinyl chloride
RL	Relative level
ROM	Run-of-Mine
ROTAP	Rare or Threatened Australian Plants
RTA	Roads and Traffic Authority
SAG	Semi-autogenous grinding
SAR	Sodium adsorption ratio
Se	Selenium
Sb	Antimony
SEPP	State Environmental Planning Policy
SIS	Species Impact Statement
SS	Suspended solids
SSMP	Soil and Stripping Management Plan
SWMP	Site Water Management Plan
t	tonne
t/m^3	tonnes per cubic metre
tpa	tonnes per annum
tph	tonnes per hour
TSP	Total suspended particulates
TSR	Travelling Stock Reserve
TSS	Total suspended solids
WW ALC	West Wyalong Aboriginal Land Council
Zn	Zinc
°C	degrees Celsius
$\mu g/m^3$	micrograms per cubic metre
µm	micrometres
µS/cm	micro siemens per centimetre

Section 9

Section 9
Glossary

9.0 GLOSSARY OF TERMS

Acid rock drainage (ARD)
Drainage of less than neutral pH emanating from mine workings or waste emplacements.

Activated carbon
Granular carbon that has been treated to improve its ability to adsorb a particular substance (eg. the gold-cyanide complex formed during cyanide leaching).

Adsorption
The adhesion of a molecule or particle to a surface.

Alluvium
A general term for stream-deposited sediment (sand, silt, gravel, etc.) within stream beds or on flood plains or alluvial fans.

Ambient air quality
Quality of the outdoor air to which people, structures, plants and animals are exposed.

Anthropogenic
Affected by, or relating to, human beings.

Aquatic
Living in or on water, or concerning water.

Aquifer
A sub-surface water-bearing layer of sediment or rock.

Average recurrence interval
The expected value or average value of the periods between exceedances of a given event magnitude. A term used in water engineering. Also known as "return period".

Background
The condition (eg. noise levels, bird populations) already present in an area before the commencement of a specific activity (eg. a mining operation).

Barren slurry (tailings)
Liquid, ground, ore following removal of precious metal.

Baseline Data
A body of information collected over time to define specific, characteristics of an area (eg. species occurrence or noise levels) prior to the commencement of an activity (eg. a mining operation).

Basement Rock
Unweathered rock lying below the soil and weathering profile.

Batter
An engineered slope of soil or rock fill on either side upslope or downslope of a road, embankment or mine waste storage; the sloping banks of cut earth separating different levels in an open-cut pit.

Beach
A deposit of tailings solids lying exposed to the atmosphere in a tailings storage.

Benthic
Relating to or living on the bottom of a body of water.

Berm
A low bank or steep slope built onto a slope to improve its structural stability and reduce erosion.

Biological diversity
The diversity of different species of plants, animals and micro-organisms, including the genes they contain, in the ecosystem of which they are part.

Borax
Sodium tetraborate, $Na_2B_4O_7.10H_2O$.

Breeding population
That proportion of the population of a species that is mature enough to breed.

Breeding range
The geographical distribution of habitat suitable for a particular faunal species to breed in.

Bund
An earth, rock or concrete wall or mound constructed to restrict the inflow or outflow of liquids or noise.

Calcium oxide
Quicklime, CaO.

CAMBA
China-Australia Migratory Bird Agreement.

Capillary breaking layer
A layer of material placed specifically on a surface to intercept the upwards migration of moisture.

Carbon-in-leach (CIL) process
Process of gold extraction where gold is leached from ore and adsorbed onto carbon in the same tanks.

Carbon-in-pulp (CIP) process
Process of gold extraction involving cyanide leaching followed by the adsorption of the gold onto activated carbon particles in separate tanks.

Catchment
The entire land area from which water (eg. rainfall) drains to a specific watercourse or waterbody.

Caustic soda
Sodium hydroxide, NaOH.

Chalcopyrite
Copper-iron sulfide, $CuFeS_2$.

Chemically inert
A chemical substance that does not easily react with other substances.

Chemically stable
A chemical substance that does not readily decompose.

Chronic effects
The effect on an organism of a continuous abnormal condition applied over 10% or more of its lifespan.

CIL
See carbon-in-leach process.

CIP
See carbon-in-pulp process.

CN_{FREE}
Free cyanide, generally includes the cyanide ion (CN^-) and hydrogen cyanide (HCN).

CN_{TOT}
Total cyanide; the total amount of all cyanide whether free, weak acid dissociable, or bound in a stable complex.

CN_{WAD}
Weak acid dissociable cyanide; cyanide existing in complexes, generally with metal ions, which break up (dissociate) in the presence of weak acid; includes free cyanide.

Concentration
The amount of a substance per unit of mass or volume of the medium in which it occurs.

Conductivity
The measurement of the ability of a substance (either a measure of solid, liquid or gas) to transmit electricity; used to determine the amount of salt in a soil sample.

Confined aquifer
A saturated aquifer, overlain by a relatively impervious formation in which the pressure of the water at the top of the aquifer is greater than atmospheric pressure.

Confluence
Junction of two streams.

Conglomerate
Sedimentary rock consisting of poorly sorted grains (typically pebbles surrounded by finer material, such as sand or silt).

Contained gold
Total mass of gold contained within the ore to be mined.

Copper sulphate
Cupric sulfate, $CuSO_4 . 5H_2O$.

Cross-section
A two-dimensional diagram of an object presented as if the object had been cut along its length.

Crusher
That part of an ore-processing plant where the ore is mechanically crushed into smaller pieces.

Culvert
Large pipe or channel carrying water underneath a structure (eg. a road or railway track) or underneath the ground.

Cut-off grade
Metal grade below which mining becomes uneconomic.

Cut-off trench
Trench placed underneath and parallel to an embankment or dam wall and filled with material of low permeability (eg. compacted clay) to prevent seepage underneath the embankment or wall.

Cyanate
A chemical species (CNO^-) formed by the oxidation of cyanide.

Cyanide
A chemical (CN^-) capable of dissolving gold and used in the extraction of gold from ore.

Cyanide decay
The chemical and physical processes by which cyanide is degraded and lost from a system (eg. a tailings storages).

Cyanide detoxification
Any chemical process that renders cyanide non-poisonous (eg. the addition of sulfur dioxide and air).

Cyanide leach feed
Crushed, ground, and slurried ore to be fed into the cyanide leach tanks.

Cyanide-leached
Removed from ore by dissolution in cyanide solution.

Cyclone
A device that generates a vortex to clear particulate matter from air or water.

dB
Decibel; unit used to express sound intensity.

dBA
Decibels, A-weighted scale; unit used for most measurements of environmental noise; the scale is based upon typical responses of the human ear to sounds of different frequencies.

Decant pond
A central pond, formed in a tailings storage by runoff of tailings supernatant liquor, from which water is pumped (decanted) from the pond and fed back to the processing plant as process water.

Decant riser pipe
Vertical pipe placed in tailings storage decant pond to enable removal of pond water by pumping.

Decant water
Water available to be decanted (by gravity, or pumped from a tailings pond).

Decommissioning
Removal or reuse of infrastructure.

Drawdown
The localised lowering of groundwater level as a result of water extraction.

dS/m
Decisiemens per metre; a measure of conductivity.

Dump operations
The deposition of waste rock or soil on a waste emplacement.

Dumping face
The face of a waste emplacement currently being used for waste rock deposition; the face of an embankment currently being used for construction material deposition.

$EC_{1:5}$
The electrical conductivity of a 1:5 soil:water extract.

$EC_e (dSm^{-1})$
Electricity conductivity of water measured in decisiemens.

Ecologically sustainable development (ESD)
Development that improves the quality of life, in a way that maintains the ecological processes on which life depends.

Ecosystem
An interacting system of animals, plants, other organisms and non-living parts of the environment.

Ecotone
A region of transition between two plant communities, characterised by a transition between either the floristic components of the communities or the structures of the communities.

Edaphic
Pertaining to ecological formations or effects resulting from or influenced by local conditions of the soil or substrate; also an old term applied to any soil characteristic that affects plant growth.

Electrical conductivity (EC)
The ability of a substance (either solid, liquid or gas) to transmit electricity.

Electro-winning
The recovery of gold dissolved in cyanide solution by passing an electric current through the solution (electrolysis) to cause gold deposition on steel-wool cathodes.

Embankment lifts
An embankment is constructed by the placement of a series of progressively higher and narrower earth or rock layers; each separate layer is called a lift.

Emission
A discharge of a substance (eg. dust) into the environment.

Employment multiplier
The effect whereby employment created by a new business or industry in turn leads to the creation of further jobs (such as in the building or retail industries as the result of increases in local population).

Endemic
Native plant or animal restricted to a specific locality or geographic region.

Fault
Major fracture of the earth's crust caused by the relative movement of the rock masses on either side.

Final void
A completed (mined-out) mine pit.

Flocculation
The water treatment process by which suspended colloidal or very fine particles are aggregated into larger masses (as a result of the addition of coagulant chemicals), which eventually settle out of suspension.

Flotation
The separation of a mixture (eg. sulfide minerals and waste material) in water, often by the addition of chemicals that carry one component (eg. sulfides) to the surface as a froth.

Flotation concentrate
Material (eg. sulfide minerals) that has been concentrated by the removal of impurities (eg. silicate minerals) during flotation.

Freeboard
Excess water storage capacity (usually designed to contain rainwaters).

Gabion rock basket
Wire baskets filled with rock material used to protect loose surfaces from erosion by flowing water.

Grade
The concentration of gold either in an individual rock sample or averaged over a specified volume of rock; gold grade is usually given in grams per tonne.

Gravity decant
A decant system that uses gravity to remove water.

Groundwater
All waters occurring below the land surface; the upper surface of the soils saturated by groundwater in any particular area is called the water table.

Habitat
The particular local environment occupied by an organism.

Hydraulic boundary
Structural feature of a rock mass (eg. a fault) that impedes the movement of groundwater.

Hydraulic gradient
The change in static head (ie. elevation and pressure) per unit of distance in a given direction. (Units: dimension less)

Hydraulically separate
Where no transfer of water is possible between two surface water or groundwater bodies.

Infrastructure
The supporting installations and services that supply the needs of the Project.

In-situ
A term used to distinguish material (eg. rocks, minerals, fossils, etc.) found in its original position of formation, deposition, or growth, as opposed to transported material.

JAMBA
Japan-Australia Migratory Bird Agreement

L_{A10}
The noise exceeded by 10% of the measurement period. Commonly referred to as the average maximum.

L_{A90}
The noise exceeded by 90% of the measurement period. Commonly referred to as the average minimum or background noise level.

$L_{Aeq\ (1\ hour)}$
The steady sound level that contains the same amount of acoustical energy as a given time-varying sound.

Lacustrine
Pertaining to lakes.

Land capability
A method of landuse assessment used to estimate the ability of the land to support a particular landuse. Classification is based on an assessment of the land's biophysical characteristics.

Leach
Dissolution and removal of a soluble substance from a soil or a rock, eg. the leaching of salt (by water) from a soil or the leaching of gold (by cyanide) from a rock.

Limnology
The scientific study of lakes.

Macroinvertebrate
Larger invertebrates (animals without backbones) which can be studied without using a microscope.

Mine aquifer
An aquifer intercepted by the mine pit.

Mine waste
By-products of mining operations with no economic value.

Mine water
All water used in mining and processing (for dust suppression, in leach tanks, etc.).

National Estate
Places defined and registered under the *Australian Heritage Commission Act 1975* as having aesthetic, historic, scientific, or social significance or other special value for present and future generations.

Noise contours
Theoretical lines connecting points of equal noise value.

Northing
A map grid line that runs east-west and is used in conjunction with an easting to record position.

Noxious plants
Plants that are considered or declared a pest in a Shire or region.

Observation bore
A bore or piezometer tapping a selected aquifer to allow monitoring of its water level or water quality variations.

Order of magnitude
An approximate 10-fold difference between two numbers (eg. 21 and 230) is one order of magnitude; an approximate 100-fold difference is two orders of magnitude (eg. 21 and 2,150), etc.

Orebody
A solid mass of ore (both high and low grade) that is geologically distinct from the rock that surrounds it and that is commercially extractable.

Overburden
Material that overlies a deposit of ore.

Oxidation
The process by which an element or compound undergoes a chemical reaction involving the removal of electrons; often involves reaction with oxygen to form an oxide (eg. the rusting of iron).

Oxide ore
That component of the ore reserve composed of weathered (oxidised) rock.

Palaeochannel
An ancient stream channel that is now buried.

PAX
Potassium amyl xanthate.

Permeability
The ability of a rock or soil to allow fluid to pass through it.

pH
A measure of the degree of acidity or alkalinity of a solution; expressed numerically (logarithmically) on a scale of 1 to 14, on which 1 is most acid, 7 is neutral acid, and 14 is most basic (alkaline).

Pit water
Water inflow into the pit from incident rainfall or groundwater seepage from pit walls.

Porphyry copper-gold system
A relatively common gold-bearing mineralisation where the copper is widely and finely disseminated throughout the host rock.

Potable water
Water of quality suitable for human consumption.

Pre-stripping
The removal of waste or overburden, before mining, to expose an orebody.

Primary crusher
The machine that crushes the excavated ore feed.

Primary ore
Unweathered mineralised rock.

Process aeration
The bubbling of air through a process to improve its effectiveness.

Process make-up water
Process water sourced from outside the Project area to replenish supplies.

Process method
The method used to extract gold from the ore.

Process plant
The place where the extraction of the gold from the mined ore occurs.

Process reagents
The chemicals and solutions used in the process method.

Pyrite
A common, yellow, sulfide, mineral, FeS_2.

Ramsar
Convention on Wetlands of International Importance Especially as Waterfowl Habitat.

Reagents
Chemicals used as part of an industrial process.

Receptor
A designated place at which an impact may occur (eg. a dwelling).

Recharge
The addition of water to an aquifer, directly from the surface, indirectly from the unsaturated zone, or by discharge from overlying or underlying aquifer systems.

Reclaim dam
A dam containing water reclaimed from the tailings storage prior to its recirculation back to the process plant.

Recoverable gold
Amount of gold that can be extracted from the ore by normal processing methods.

Rehabilitation
The restoration of a landscape and especially the vegetation following its disturbance.

Relative humidity
The ratio of actual moisture in the air to the amount the air could hold if saturated, at a given temperature.

Remnant vegetation
Native vegetation remaining after widespread clearing has taken place.

Riparian
Pertaining to, or situated on, the bank of a body of water, especially a watercourse such as a river.

ROM
Run-of-mine; see run-of-mine ore stockpile.

ROTAP
Rare or threatened Australian plant (species)

Run-of-mine (ROM) ore stockpile
The stockpile of freshly mined ore used to feed the mill and process plant.

Runoff
That portion of precipitation (rain, hail and snow) that flows across the ground surface as water.

Salinisation
The accumulation of soluble salts in soil.

Salinity
The total content of dissolved solids in groundwater, commonly expressed as parts of dissolved solids per million parts of solution, or milligrams of dissolved solids per litre of solution (mg/L); the significance of salinity depends on the nature as well as the amount of the dissolved solids.

Sediment flux
The flow of sediments into and out of a system (eg. a lake or river).

Seepage
Liquid or fluid such as water, seeping or flowing from beneath the ground to the surface.

Semi-autogenous grinding (SAG) mill
A revolving mill where coarse rock fragments are ground partly under their own weight and partly with the aid of stainless steel balls.

Silt jetty
Bank of silt extending out into a lake, formed when a stream deposits its suspended sediment into a lake.

Sphalerite
Zinc-containing ore, ZnS (zinc sulfide).

Spigot offtakes
The discharge lines from the tailings slurry pipe around a tailings storage.

Stream gauging
Determination of water level and velocity in a stream or river for the purpose of calculating the volume of flow.

Sub-aerial tailings depositional technique
Method of tailings deposition involving progressive peripheral discharge of tailings slurry around the storage (typically via a spigotted ring main) with thin-layer beaching resulting.

Substrate
An underlying layer (eg. of sediment under water).

Sulfate sulfur
Sulfur contained in the sulfate ion (SO_4^{2-}).

Supernatant
The layer of water above settled solids.

Tailings
Finely ground residue from processing and extraction of product from ore.

Tailings liquor
Moisture held in tailings.

Temperature gradient
The rate that temperature changes with distance, expressed in degrees per unit length (eg. °C/100 m).

Temperature inversion
An atmospheric phenomenon in which air temperature increases with height over a particular interval.

Total suspended particulate matter (TSP)
The mass of all particulate matter suspended in a solution.

Total suspended solids
A common measure used to determine suspended solids concentrations in a waterbody and expressed in terms of mass per unit of volume (eg. milligrams per litre).

Toxic
Poisonous to a specific organism, sometimes resulting in death.

Transmissivity
The rate at which groundwater is transmitted at a specified hydraulic gradient through rock of a specified width.

Turbidity
The optical property of water that prevents light from being transmitted, turbidity or muddiness is caused by the presence of very fine suspended matter such as clay or organic matter.

Underdrainage
Artificial drainage that removes infiltration or seepage water from underneath a structure (eg. a tailings storage or a stockpile).

Vagrant
Wandering, not local.

WAD
Weak acid dissociable.

Waders
Long-legged waterbirds that inhibit shallow areas of water.

Waste rock
Uneconomic rock extracted from the ground during a mining operation to gain access to the ore.

Units

The prefixes for units used are as follows:

G	giga	10^9	1 000 000 000
M	mega	10^6	1 000 000
k	kilo	10^3	1 000
m	milli	10^{-3}	0.000 1
µ	micro	10^{-6}	0.000 000 1

The units of measurement are:

a	annum
°C	degrees Celsius
d	day
h	hour
ha	hectare
l	litre
min	minute
mm	millimetre
m	metre
m^2	square metre
m^3	cubic metre
mg/l	milligram per litre
µg/l	microgram per litre
%	per cent
pH	measure of acid/alkaline condition
s	second
t	tonne