BLACK RANGE
MINERALS

SYERSTON NICKEL COBALT PROJECT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 4 – APPENDICES K TO O

October 2000

ResourceStrategies

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 4

CONTENTS OVERVIEW

REPORT 10-1034-R1
APPENDIX K-K.DOC

Construction, Operation and Transportation Noise and Blasting Impact Assessment Syerston Nickel-Cobalt Project

Prepared for

Black Range Minerals Ltd

18 September 2000

RICHARD HEGGIE
A S S O C I A T E S
ABN 29 001 584 612

Marton House, 142 Union Street The Junction NSW 2291
Telephone 02 4969 8751 Facsimile 02 4961 6530 newcastle@heggies.com.au

Construction, Operation and Transportation Noise and Blasting Impact Assessment Syerston Nickel-Cobalt Project

Quality System
Quality Endorsed Company
ISO 9001 Lic 3236
Standards Australia

Richard Heggie Associates Pty Ltd operates under a Quality System which has been certified by Quality Assurance Services Pty Limited to comply with all the requirements of ISO 9001:1994 "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing" (Licence No 3236).

This document has been prepared in accordance with the requirements of that System.

AAAC
MEMBER FIRM OF THE ASSOCIATION OF AUSTRALIAN ACOUSTICAL CONSULTANTS

Richard Heggie Associates Pty Ltd is a Member Firm of the Association of Australian Acoustical Consultants.

EXECUTIVE SUMMARY

Black Range Minerals Ltd (Black Range) is proposing to mine an average of 2 million tonnes per annum (tpa) of nickel laterite ore and establish a nickel and cobalt extraction plant at Syerston, 45 km northeast of Condobolin and 80 km north-west of Parkes in the Central West of New South Wales.

An average of approximately 20,000 tpa of metal or up to 42,000 tpa of mixed nickel-cobalt sulphide precipitate products would be produced for sale to international markets. Annual metals production would peak at approximately 20,000 tonnes of nickel and 5,000 tonnes of cobalt.

In addition to the proposed mine site, Black Range propose a number of components which when combined make up the Syerston Nickel Cobalt Project (the Project). In summary, the Project would involve:

- The mine site including ore processing, gas, acid and power and steam plants, open pit mining areas and mine waste disposal facilities (eg waste emplacements, tailings dams and evaporation ponds).
- Raw water supply borefields some 60 km to the south of the mine site.
- A 65 km long water pipeline from the borefield to the mine site.
- A 90 km long natural gas pipeline from the existing Sydney-Moomba gas-line approximately 80 km south southwest of the mine site.
- Quarrying, crushing and transport of limestone from a quarry approximately 20 km southeast of the mine site.
- A rail siding on the Bogan Gate-Tottenham Railway approximately 25 km to the southeast of the mine site.
- Road and access upgrades and construction of a road bypass.

Locations of the Project components are shown in the figure contained in **Appendix A**.

An Environment Impact Statement (EIS) for the proposed Project is required under the NSW Environmental Planning and Assessment Act (1979). The Project has mineral resources adequate for a mine life of over thirty years. In accordance with regulatory requirements, the EIS assesses the potential environmental impacts of the Project for a term of 21 years.

This report is an assessment of the potential noise and blasting impacts of the above Project components for the EIS term and has been prepared as EIS supporting information, in accordance with the Director General Requirements.

EXECUTIVE SUMMARY

Mine and Quarry Noise Impact Assessment and Proposed Actions

In summary, given that compliance with the EPA's nominated noise criteria has to be demonstrated under **prevailing** meteorological conditions (refer to **Section 8**), the only predicted noise level exceedance is:

- Evening Mine Operations Year 5:
  Marginal 1 dBA/2 dBA exceedances at Currajong Park only, for an autumn/winter 2 m/s south-southeasterly wind.

- Night-time Mine Operations Year 5:
  Marginal/moderate 1 dBA/3 dBA exceedances at Currajong Park only, for a winter 2 m/s southeasterly wind and a temperature inversion together with a 2 m/s southeasterly wind respectively.

- Evening Mine Operations Year 20:
  Moderate 3 dBA/4 dBA exceedances at Currajong Park only for an autumn/winter 2 m/s south-southeasterly wind.

- Night-time Mine Operations Year 20:
  Moderate 3 dBA/5 dBA exceedances at Currajong Park only, for a Winter 2 m/s southeasterly wind and a temperature inversion together with a 2 m/s southeasterly wind respectively.

- Daytime Quarry Operations Year 5:
  Marginal 2 dBA exceedances at Lesbina and Eastbourne and a moderate 5 dBA exceedance at Moorelands under calm meteorological conditions.

With respect to potential mitigative actions, Black Range advise the following:
For the quarry, the conduct of operational monitoring, and if then required the construction of additional bunding to mitigate predicted exceedances at Moorelands, supported by confirmatory monitoring of mitigative effects. Additional attenuation works/potential acquisition thereafter if necessary.

For the mine and plant, the conduct of confirmatory monitoring throughout operations (notably later in mine life when exceedances of 3-5 dBA at Currajong Park are currently predicted) followed by actions such as the modification of noise at source or receiver if exceedances are confirmed. Additional attenuation works/potential acquisition thereafter if necessary.

EXECUTIVE SUMMARY

Pipeline Construction Noise Impact Assessment

Noise emitting sources to be used for the construction of the pipelines include two backhoes and a crane. These items of mobile plant are not considered to be particularly noisy items of plant. It is unlikely that any residential receiver will be affected by pipeline construction noise emissions for more than several hours.

Road Upgrades and Fifield Bypass Construction Noise Impact Assessment

As with the pipeline construction works described above, it is unlikely that any residential receiver will be affected by roadworks necessary for the road upgrades and construction of the Fifield Bypass for more than several weeks. Roadworks associated with the upgrade of several roads and the construction of the Fifield Bypass are proposed to be conducted during daylight hours only.

Rail Siding Construction Noise Impact Assessment

The construction of the rail siding is expected to be undertaken within three months. Construction noise will include those associated with the construction of the rail spur line, installation of appropriate switching and rail signals, construction of loading and unloading facilities, hardstands, access road, rail crossing and administrative facilities.

For an expected construction period of three months, for the purposes of this assessment, a construction noise criterion for the period 4 to 26 weeks (in accordance with the EPA's ENCM) has been applied. Based on the daytime ambient background noise level of 32 dBA measured at "Reas Falls", a daytime construction noise criterion of 42 dBA (background plus 10 dBA) is applied to all construction activities when measured at the facade of nearest potentially affected residential receivers.

The nearest potentially affected receiver to the rail siding is "Glen Rock", approximately 750 metres from the siding. Therefore L_{A10} construction noise emission levels should remain below 83 dBA when measured 7 metres from the noise source. Based on previous measurement data, it is unlikely that the construction equipment likely to be used at the rail siding would exceed these noise levels, hence construction of the rail siding is likely to comply with the nominated criterion.

EXECUTIVE SUMMARY

Road Traffic Noise Impact Assessment

Mine Operations Road Traffic

Review of the road traffic level predictions given in **Table 10.1.1** indicates that all future peak hour noise levels are lower than both the daytime and night-time traffic noise criteria (of $L_{Aeq(1hour)}$ 60 dBA and 55 dBA respectively) presented in **Table 7.4.1**.

Construction Road Traffic

Review of the predicted $L_{Aeq(1hour)}$ mine construction plus existing traffic noise levels presented in **Table 10.2.1** indicates that all the levels are lower than both the daytime and night-time traffic noise criteria (of $L_{Aeq(1hour)}$ 60 dBA and 55 dBA respectively) given in **Table 7.4.1**.

In terms of noise sensitive receivers situated adjacent to MR350 and State Road 90 between the rail siding and Parks based on a speed of 100 km/hr for all the peak level construction traffic along SR90, compliance with the daytime $L_{Aeq(1hour)}$ 60 dBA criteria would be met at offset distances of 20 m and more.

Rail Traffic Noise Impact Assessment

The results presented in **Table 11.1.1** indicate that the predicted noise levels comply with the recommended EPA's criteria at the nearest potentially affected properties.

Use of Explosives

The following assessments are derived from the predicted levels of blast emissions given in **Table 12.2.1** and the recommended structural damage and human comfort criteria presented in **Section 7.6**.

- The predicted levels of ground vibration at all residential properties comply with the structural damage criterion of 15 mm/s recommended for residential buildings in British Standard 7385:Part 2-1993.
- The predicted levels of ground vibration at all residential properties comply with the human comfort criterion of 5 mm/s for daytime blasting (Monday to Saturday 0900 hours to 1700 hours)

EXECUTIVE SUMMARY

- The predicted levels of peak airblast at all residential properties are well below the US Bureau of Mines' structural damage limit of 132 dB Linear
- The predicted levels of peak airblast at all residential properties comply with the human comfort criterion of 115 dB Linear for daytime blasting (Monday to Saturday 0900 hours to 1700 hours) recommended by the ANZECC.

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Overview

The Syerston Nickel Cobalt Project (the Project) is owned by Black Range Minerals Ltd (BRM).

The project area is located in the central western area of New South Wales, near the village of Fifield, approximately 80 km north-west of the regional centre of Parkes and 350 km west-north-west of Sydney.

An average of approximately 20,000 tpa of metal or up to 42,000 tpa of mixed nickel-cobalt sulphide precipitate products would be produced for sale to international markets. Annual metals production would peak at approximately 20,000 tonnes of nickel and 5,000 tonnes of cobalt.

In addition to the proposed mine site, Black Range propose a number of components which when combined make up the Project. In summary, the Project would involve:

- The mine site including ore processing, gas, acid and power and steam plants, open pit mining areas and mine waste disposal facilities (eg waste emplacements, tailings dams and evaporation ponds).
- Raw water supply borefields some 60 km to the south of the mine site.
- A 65 km long water pipeline from the borefield to the mine site.
- A 90 km long natural gas pipeline from the existing Sydney-Moomba gas-line approximately 80 km south southwest of the mine site.
- Quarrying, crushing and transport of limestone from a quarry approximately 20 km southeast of the mine site.
- A rail siding on the Bogan Gate-Tottenham Railway approximately 25 km to the southeast of the mine site.
- Road and access upgrades and construction of a road bypass.

Locations of the Project components are shown in the figure contained in **Appendix A**.

Richard Heggie Associates Pty Ltd (RHA) was engaged by Resource Strategies on behalf of Black Range Minerals to assess the noise and vibration impacts associated with the proposed development of the Project (including the possible cumulative impacts of construction, mine operation and transportation).

The preparation of this assessment has been guided by the NSW Department of Urban Affairs and Planning (DUAP) Director General's requirements (**Appendix B1**) and the DUAP EIS Guidelines with respect to Extractive Industries as well as the New South Wales Protection Authority's (EPA's) Requirements for the Environmental Impact Statement (EIS) dated 2 November 1998 attached as **Appendix B2**. their Environmental Noise Control Manual (ENCM) and Environmental Criteria for Road Traffic Noise.

The Assessment has been prepared in accordance with the Australian Standard 1055, 1997 *"Description and Measurement of Environmental Noise"* Parts 1, 2 and 3 and with reference to the EPA's'' Industrial Noise Policy, their Environmental Noise Control Manual (ENCM) and the Protection of the Environment Operation's Act.

1.2 Project Assessment

The major sources of noise and vibration emissions may be grouped into four distinct areas for the purpose of noise and vibration impact assessment:

Syerston Mine Construction and Operating Noise Emissions

- **Syerston Mine Construction -** construction equipment during the Syerston Mine surface infrastructure construction.
- **Syerston Mine Operation -** mobile and process plant equipment.

Limestone Quarry Operating Noise Emissions

- **Limestone Quarry Operation -** mobile equipment and fixed plant associated with limestone quarry operations (including excavators, haul trucks, dozers, graders, product trucks, Powergrid Scalping plant and a secondary crusher)

Limestone Quarry Blast Emissions

- **Limestone Quarry Blasting -** Ground-borne vibration and airblast emissions resulting from production blasting.

Syerston Mine Transportation Noise

Syerston Mine Road and Rail Transportation - vehicles on public roads during the construction and operating phases and rail traffic during the operating phases of the mine.

2 PROJECT DESCRIPTION

2.1 Plant and Process Description

The proposed processing plant will consist of the following major components:

- Ore preparation facilities
- Limestone slurry preparation facilities
- Acid pressure leaching
- Counter current decantation (CCD) washing
- Tailings neutralisation
- Solution neutralisation
- Sulphide precipitation
- Sulphide leaching and impurity removal
- Nickel, cobalt and zinc solvent extraction, and
- Nickel and cobalt electrowinning.

A full description of the proposal is presented in the EIS Volume 1 (Part A, Section A2).

Transport of Raw Materials and Product

The methods of transporting raw materials and product plus plant and equipment are summarised below.

- Sulphur - by rail from Newcastle. In the start up period sulphuric acid rather than sulphur would be transported from Newcastle by truck.
- Water - by pipeline.
- Natural gas - by pipeline.
- Caustic soda by rail/road from Sydney.
- Magnesia - by road from Young.
- Limestone - by road from limestone quarry near Trundle.
- Miscellaneous raw materials - by rail from Newcastle.
- Fuel - by road from Parkes/Sydney.
- Miscellaneous supplies and equipment - by road from various sources.
- Product - by rail to Newcastle.

2.2 Plant and Equipment

The major sources of noise associated with the project have been identified and include:

Mobile plant noise emission sources including:
Excavators and ore trucks associated with the mining activities.

Processing plant noise emission sources including the:
Ore Preparation Ball Mill.
Limestone Ball Mill.
Hydrogen Sulfide Flare.
Emergency pressure relief releases.
HPAL on/off valve actuations.
Power Plant.
Pumps, exhaust fans and conveyers.
Cutting and crushing of final products.

Standard noise reduction measures will include the installation where required of silencers on intake or outlet pipes and the application of insulation layers on fan housings. Further noise measures, such as the complete housing of equipment, use of noise-reduced gearboxes or noise protection at chutes, will be implemented if required.

Transportation noise emission sources including the:
Noise associated with import of raw materials and the export of the products and by-products.

2.3 Pipeline Construction

Water and gas pipelines to the mine site will to be constructed prior to the commissioning of the process plant. The construction of the pipelines will require several items of mobile plant including two backhoes/excavators and a crane.

2.4 Road Upgrades and Fifield Bypass Construction

Several existing roads require widening to provide 8.5 metres of pavement and 3 metres of gravel shoulder at each property accesses.

Construction of a bypass route to circumvent Fifield (the Fifield Bypass) would also be undertaken. Construction of the bypass will be carried out by Black Range Minerals (BRM).

It is anticipated that typical roadwork equipment would be required for the road upgrades and road constructions and roadworks would be completed within a period of three months. These roadworks are proposed to be conducted during daylight hours only.

2.5 Rail Siding Construction

The project also requires the construction of a rail siding for loading and unloading of bulk materials to be transported by rail. The construction of the rail siding would involve the use of items of mobile equipment such as a dozer, a cement mixer and a generator.

It is anticipated that the construction work would be completed within three months and that the works would be conducted during daylight hours only.

3 SURROUNDING PROPERTIES

The nearest potentially affected non-Black Range Minerals owned rural dwellings beyond the Syerston Mine and Limestone Quarry boundaries are shown in **Appendix C**. This assessment has evaluated and assessed predicted noise and blast (where applicable) emissions at these residences against relevant established criteria.

4 HOURS OF OPERATION

The proposed hours of operation for the various aspects of the Syerston Project are presented in **Table 4.1.1**.

Table 4.1.1 Hours of Operation

Phase	Location		Operating Hours (Hrs)
Construction Phase	Main Project Site	Maintenance, Process Plant Construction, and Testing	24 hours (Monday to Sunday)
		Construction Earthworks	0700-1800 (Monday to Sunday)
	Haul Road (Route 64)		Daytime (0700 - 1800 Monday to Sunday)
	Limestone Quarry		0700 – 1700 (Monday to Sunday)
	Rail Siding		0700 – 1800 (Monday to Sunday)
	Gas and Water Pipelines		0700 – 1800 (Monday to Sunday)
Operating Phase	Main Project Site		24 hours (Monday to Sunday)
	Haul Road (Route 64)		24 hours (Monday to Sunday)
	Limestone Quarry		0700 – 1700 (Monday to Sunday) (Truck loading is 24 hours if necessary)
	Rail Siding		24 hours (Monday to Sunday)

5 TRANSPORTATION

The following information has been sourced from Masson Wilson Twineys Transport Assessment, Proposed Syerston Nickel - Cobalt Project.

5.1 Road Transportation

The road system in the vicinity of the Syerston Project site that would be used by traffic generated by the project are described below.

State Route 90 connects Parkes and Condobolin through Bogan Gate and Ootha. The road has one lane in each direction and has a speed limit of 100 km/h.

Main Road 350 (Tullamore - Bogan Gate Road) from Bogan Gate to Tullamore. It has a two lane sealed carriageway and the speed limit is 100 km/h generally but 50 km/h through Trundle. There is a 40 km/h school zone for the school located on the southern side of Trundle. Residences in Trundle are set back 30 m to 40 m on either side of the road.

Shire Road 83 (Middle Trundle Road) runs north west from State Route 90 to intersect with MR350 just south of Trundle. The speed limit is 100 km/hr.

Shire Road 64 (Fifield -Trundle Road) intersects with the Road from Bogan Gate to Tullamore approximately 6 km north of Trundle. Shire Road 64 is generally around 4 m wide with about 1 m wide gravel shoulders.

Main Road 57 North runs north from State Route 90, east of Condobolin, though Fifield and Tullamore. The speed limit is generally 100 km/h. Shire Road 60 intersects with Main Road 57 North at an intersection. The road pavement ends to the north-east of this intersection and the road becomes a gravel road with an 8 m to 12 m wide formation. North of its intersection with Shire Road 64, Main Road 57 (North) is paved with a two lane seal. Approaching Fifield, the speed limit reduces to 50 km/h. The road doglegs through Fifield which has residences on either side of the road. About 1 kilometre north of Fifield, the road again becomes unpaved, with a formation width of about 12 m. South of Tullamore, the road is again paved.

Shire Road 44 (Melrose to Gillenbine Road) is an 8 m to 12 m wide unpaved road. The speed limit is 100 km/h.

Shire Road 34 (Fifield to Wilmatha Road) is an 8 m to 12 m wide unpaved road. The speed limit is 100 km/h.

Shire Road 60 (Springvale Road) is a sealed road approximately 6 m wide with a 100 km/h speed limit.

Existing Traffic Flows

Table 5.1.1 summarises the daily traffic volumes on roads leading to and from the Syerston Mine site. Proportions of heavy (large rigid vehicles and articulated) vehicles are also indicated at sites where this information is available.

Table 5.1.1 Existing Daily Traffic Volumes

Road	Location (Year of Count)	Daily Traffic Flow	Percent Heavy Vehicles	Carriageway Description
State Route 90	East of Bogan Gate (96)	792	-	2 lane seal
MR350	Bogan Gate to Trundle (96)	388	-	2 lane seal
MR350	North of Trundle (92)	339	-	2 lane seal
SR83	East of MR350 (96)	99	-	Gravel/2 lane seal
SR64	East of MR57 North (99)	52	17.1%	1 lane seal
MR57 North	North of State Route 90 (96)	216	-	2 lane seal
MR57 North	Northeast of SR60 (95)	87	10.6%	Gravel
MR57 North	South of Fifield (92)	63	-	2 lane seal
SR44	East of SR60	90	-	Gravel
SR34	South of SR44	90	-	Gravel
SR60	North of MR57 Nth (99)	90	12.6%	2 lane seal
MR57 North	South of Tullamore (96)	164	-	Gravel/2 lane seal
MR57 North	North of Tullamore (96)	98	17.4%	Gravel
MR354	Northwest of Tullamore (99)	69	-	Gravel
MR354	20 km Northwest of Tullamore (96)	373	-	Gravel

Source: Traffic Counts by Lachlan and Parkes Shire Councils and RTA

Table 5.1.2 presents typical hour by hour proportions for roads in the area. The table was produced from several counts conducted by Parkes and Lachlan Shire Councils in 1999.

Table 5.1.2 Typical Hourly Traffic Proportions Throughout the Day

Hour Period	Percent of Daily Flow
0000-0100	0.70
0100-0200	0.35
0200-0300	0.25
0300-0400	0.25
0400-0500	0.10
0500-0600	1.10
0600-0700	6.00
0700-0800	7.20
0800-0900	6.95
0900-1000	6.70
1000-1100	7.15
1100-1200	6.75
1200-1300	6.40
1300-1400	6.25
1400-1500	5.70
1500-1600	5.05
1600-1700	9.05
1700-1800	10.90
1800-1900	5.95
1900-2000	3.20
2000-2100	1.40
2100-2200	0.90
2200-2300	0.85
2300-2400	0.80

Source: 1999 Traffic Counts by Parkes and Lachlan Shire Councils

Table 5.1.3 presents indicative peak hour traffic flows for the mine's principal access routes derived using proportions indicated on **Table 5.1.2**.

Table 5.1.3 Existing Peak Hour Flows (vehicles/hour)

Road	Location	AM Peak	PM Peak
State Route 90	East of Bogan Gate	57	86
MR350	Bogan Gate to Trundle	28	42
MR350	North of Trundle	24	37
SR83	East of MR350	7	11
SR64	East of MR57 North	4	6
MR57 North	North of State Route 90	16	24
MR57 North	Northeast of SR60	6	10
MR57 North	South of Fifield	5	7
MR57 North	South of Tullamore	12	18
SR44	East of SR60(1)	6	10
SR60	North of MR57 North	6	10

(1) No traffic data available, assume similar volumes to SR60 for worst case

5.2 Rail Transportation

It is proposed to transport sulphur and some other bulk materials to the site from Newcastle by rail and to back load products from the Syerston Mine by rail. A new siding is proposed to be constructed north of Trundle on the existing Tottenham Bogan Gate railway near the intersection of MR350 and SR64. Rail transport from Sydney is also envisaged.

Sulphur

Sulphur will be shipped from sources overseas to Newcastle. Typical shipments will be 20,000 to 50,000 tonnes. Transport to the mine will be via a dedicated train that will typically make two round trips per week to the proposed new rail siding north of Trundle.

Each train is proposed to have 44 wagons, 39 of these will each carry two special 6m long tipper containers. The other five will carry conventional containers in which miscellaneous materials will be transported.

Containers will be offloaded from the train by forklift and placed into a temporary storage area. From this they will be loaded progressively onto a shuttle fleet of road train truck rigs that will transport the containers to the mine site via Shire Road 64 (SR64) and the proposed Fifield Bypass where they will be unloaded.

A fleet of five truck rigs is proposed including one B-double combination and four road train combinations. These will also carry limestone to the mine. Transport of the total annual load of 210,000 tonnes of sulphur from Newcastle will require on average about 12 deliveries per day. However, on some days the truck fleet will carry only sulphur and on other days only limestone so the actual number will vary considerably from day to day.

Caustic Soda

Caustic soda is proposed to be transported in containers by road or rail from Sydney. It is proposed that the containers be attached to an interstate train for transport to Parkes. It is possible that caustic soda would be trucked from Sydney, however for the purposes of this model it is assumed to be via rail.

Caustic soda containers would be offloaded by forklifts and trucked to the mine in the same way as sulphur. Transport of the caustic soda will require on average about 1 delivery every two days.

Magnesia

Magnesia will probably be sourced from Young. It is proposed to transport this by road in a bulk pressure tanker B-double truck that will make two round trips per day. The route to be followed will be Young, Grenfell, Forbes, Parkes, Bogan Gate, Trundle and the reverse. Typically, there will be 10 round trips per week. Normally these would occur on weekdays but weekend transport would occur as necessary.

Limestone

Limestone will be transported from the quarry to the mine using the same road trains that will be used for sulphur transport.

Road train combinations will operate two 12 hour shifts per day. There will be a maximum of 9 two-way vehicle movements per hour on SR64 between the quarry and the mine. On average there will be about 36 limestone deliveries per day but there would be less when sulphur was being transported and more when it was not.

Fuel and Lubricants

Fuel will be transported by 19m B-double tankers from Sydney or smaller tankers from Parkes. It is assumed that there will typically be about three such deliveries per week.

Miscellaneous Bulk Materials

It is proposed that miscellaneous bulk materials be transported to Newcastle and carried to the mine in containers on the sulphur transport trains. The transport of these materials will require on average 2 deliveries per day.

Other Materials and Equipment

These include foodstuffs and special equipment and supplies. It is anticipated that there will be around 10 of these deliveries per day. In addition, it is expected that there will likely be around 10 further light truck and van visits to the site per day relating to maintenance and on-going minor development works.

Mine Product

About 20,000 tonnes of product per annum will be produced, for export. This will be transported to Newcastle by backloading containers bringing sulphur to the mine. Thus delivery of product will involve no extra road or rail movements.

A summary of materials movement is presented in **Table 5.2.1**.

Table 5.2.1 Summary of Materials Movement

Product	Average Daily Truck Movements To or From					Train Movements on Branch Line Per Week
	Rail Siding	Limestone Quarry	Young	Local Sources	Sydney	
Sulphur	24	-	-	-	-	4
Caustic Soda	1	-	-	-	-	2
Magnesia	-	-	4	-	-	-
Limestone	-	72	-	-	-	-
Misc Bulk	4	-	-	-	-	-
Other	-	-	-	40	4	-
Fuel/Lubricants	-	-	-	1	-	-
Mine Product*	-	-	-	-	-	-

Note: Each return trip = two movements, average daily movements are shown.
* Backloaded on sulphur trucks/trains.

There will be typically 6 train movements per week on the rail branch line from Bogan Gate to the mine siding. Usually there will be no more than 2 rail movements per day, one each way.

5.3 Project Generated Road Traffic

Employee Traffic

It is expected that administration employees will typically work a five day week while miners and process employees will work a combination of five days out of any seven during the week or four days on/four days off with 12 hour shifts. The nominal shifts presented in **Table 5.3.1** are expected to operate on a weekday.

Table 5.3.1 Indicative Shift Start and Finish Times and Employee Numbers

Start	Employees In	Finish	Employees Out
6:00 am	33	6:00 am	10
6:30 am	1	7:00 pm	27
7:00 am	127	15:00 pm	14
7:30 am	1	15:30 pm	1
8:30 am	1	16:30 pm	15
18:00 pm	10	17:00 pm	10
19:00 pm	27	17:30 pm	1
-	-	18:00 pm	27
-	-	18:30 pm	8
-	-	19:00 pm	87
Total	**200**	**-**	**200**

For the Cadia Mine it was found that typical day shift employees travelled with an average of 1.4 persons per car while night shift persons travelled with 1.2 persons per car. It was also found that the daily work routine did not adhere strictly to nominal shift times. Using this information, the estimated employee traffic generation for the Syerston Project is as set out on **Table 5.3.2**.

Table 5.3.2 Estimated Daily Employee Traffic Generation

Start	Vehicles In	Vehicles Out
5:00 am	24	-
6:00 am	66	9
7:00 am	20	20
8:00 am	5	2
15:00 pm	-	11
16:00 pm	-	11
17:00 pm	9	8
18:00 pm	20	24
19:00 pm	3	61
20:00 pm	-	1
Total	**147**	**147**

The estimated employee distribution and consequential distribution of daily and peak hour employee traffic leading to and from these locations is set out on **Table 5.3.3**.

Table 5.3.3 Expected Distribution of Employees and Their Traffic

Location	Percent of Employee Homes	Employee Vehicles Travelling To and From Location		
		Weekday Vehicle/day(1)	Peak Hour (Vehicle/hr)	
			am	pm
Parkes	65.5%	192	49	41
Trundle	2.5%	8	2	2
Tullamore	2.0%	6	1	1
Condobolin	29.0%	84	21	18
Bogan Gate	0.5%	2	1	1
Ootha	0.5%	2	1	1
Total		**294**	**75**	**64**

(1) Adjusted to achieve even numbers as each car visit from home to work and back represents two vehicle trips.

Other Mine Traffic

Other traffic visiting the mine during its operational phase will include daily consumables, locally sourced spare parts and equipment, maintenance contractors, mine staff visiting off-site facilities, regulating inspectors and general visitors.

For the above assessment purposes it is considered reasonable to allow a further 100 vehicle movements per day with these being oriented 90 percent towards Parkes and 10 percent towards Condobolin. This traffic will occur mainly between 7:00 am and 6:00 pm with peak hourly traffic volumes being increased by perhaps 10 vehicle movements per hour.

Future Traffic Flows on Roads in the Area

In total the operational traffic generation of the mine is forecast to be about 550 vehicle movements per day comprising the following:

- About 300 employee vehicle movements per day.
- About 150 truck and van raw materials transport vehicle movements per day.
- About 100 other vehicle movements per day.

Table 5.3.4 adds the above estimated additional traffic movements to existing traffic levels on the respective roads to provide an estimate of likely future traffic levels when the mine is fully operational.

The use of SR83 by mine traffic will depend to a large extent on the condition of the unsealed section of it. With regular maintenance it would allow travel at around 80 km/h.

Heavy vehicles will be required to use the nominated route through Bogan Gate and the nominated heavy vehicle routes through Parkes.

Table 5.3.4 Existing and Future Daily Traffic Volumes on Affected Roads

Road	Location	Existing Daily Traffic Volume (Vehicles/Day)		Future Daily Traffic Volume (Vehicles/Day)	
		Total	Heavy(1)	Total	Heavy
State Road 90	East of Bogan Gate	792	95	887	190
MR350	Bogan Gate to Trundle	388	47	485	142
MR350	North of Trundle	339	41	685	136
SR83	East of MR350	99	12	340	12
SR64	East of MR57 Nth	52	9	499	205
Fifield Bypass	East of MR57 Nth	-	-	449	196
MR57 North	North of State Rd 90	216	26	305	29
MR57 North	North of Fifield Bypass	63	9	65	9
SR44	East of SR60	90	11	179	14
SR34	South of SR44	90	11	179	14
SR60	North of MR57 Nth	90	11	179	14
MR57 North	South of Tullamore	164	20	170	20

(1) Assumed at 12% of total when heavy vehicle count not available

Table 5.3.5 presents estimates of future peak hourly traffic flows.

Table 5.3.5 Existing and Future Peak Hourly Traffic Volumes on Affected Roads (vehicles/hour)

Road	Location	Existing Peak Hour Flows		Future Peak Hour Flows	
		am	pm	am	pm
State Road 90	East of Bogan Gate	57	86	68	97
MR350	Bogan Gate to Trundle	28	42	40	54
MR350	North of Trundle	24	37	92	97
SR83	East of MR350	7	11	61	57
SR64	East of MR57 Nth	4	6	76	70
Fifield Bypass	-	-	-	72	64
MR57 North	North of State Route 90	16	24	39	44
MR57 North	North of Fifield Bypass	5	7	5	7
SR60	North of MR57 N	6	10	29	30
MR57 North	South of Tullamore	12	18	14	20

5.4 Construction Transportation

Construction Workforce Traffic

It is proposed that the vast majority of the construction workforce live in a self-contained on site construction camp. A bus service is proposed to transport workers between Parkes airport and the camp.

The construction camp will accommodate workers during the 24 month construction period. During this period, numbers in the camp will fluctuate according to the activities occurring on the mine site.

Traffic generated by the construction workforce will include:

- Travel by employees resident off camp.
- Recreational travel by employees resident in the camp.
- Bus trips to/from the airport.
- Delivery of food and other consumable supplies to the camp.

Indicative daily estimates of this traffic are set out in **Table 5.4.1**.

Table 5.4.1 Estimate of Construction Workforce Traffic

	Average (vehicles/day)	Peak (vehicles/day)	Comment
Off camp employees	72	144	1.4 persons/vehicle
Recreational travel	34	68	3 persons/vehicle, 10% of camp go & return each day
Airport bus trip	2	4	-
Camp deliveries	20	30	-
Total	**128**	**246**	

Note: Each return trip = two movements

Major Equipment and Supplies

Based on a construction programming analysis provided by BRM it has been estimated that major equipment and supplies will peak at a monthly average of about 12 deliveries per day (24 vehicle trips per day). On average over the whole construction period it is expected that there will be about 6 or 7 major deliveries per day (12 to 14 vehicle trips per day).

Other Traffic

Other traffic generated during construction will include that due to visiting company, design and regulatory personnel, general equipment and consumables, local contractors, construction personnel moving to and from off site construction locations.

For planning purposes it is considered appropriate to make the following indicative allowances for other construction traffic travelling to and from the main mine site:

- Design, regulatory and general visitors to site - 35 to 50 trips/day
- Consumables and general equipment - 35 to 50 trips/day
- Trips between mine site and related off site construction areas (pipelines, siding) - 100 trips/day
- Limestone quarry development - 50 trips per day
- Railway siding development - 50 trips per day

These equate to a total number of other construction traffic trips of 270 to 300 trips per day.

It is noted that trips referred to are two way totals ie a visit to the mine generates two vehicle trips. About one third of these would be heavy vehicles.

Further traffic generated by construction by the gas and water pipelines will for the most part focus on the route of these and not on the mine site itself. Traffic generation associated with these will relate to:

- construction vehicles (eg. sideboom tractor).
- delivery of pipes, fittings and associated equipment.
- delivery of bedding material.
- daily employee travel.

Separate contractors with their own work compounds will be responsible for these. Indicatively, it is expected that these will total perhaps 50 vehicle trips per day each.

As discussed, the proposed gas and water pipelines will each be subject to their own Construction Management Plan which will deal with traffic effects separately.

Total Construction Traffic

Table 5.4.2 provides an estimate of the total daily traffic generation of construction activities.

Table 5.4.2 Combined Construction Traffic Estimate (vehicles/day)

	Average Period			Peak Period		
	Heavy	**Light**	**Total**	**Heavy**	**Light**	**Total**
Workforce	22	106	128	34	212	246
Major Equipment & Supplies	15	-	15	24	-	24
Other Traffic	90	180	270	100	200	300
Total (rounding)	**130**	**290**	**420**	**160**	**420**	**580**

Table 5.4.2 indicates an expectation that there will be a total of about 420 vehicle trips generated per day by the mine site on average throughout the construction period with some 580 vehicle trips per day during the peak construction month. By way of comparison a total traffic generation of the mine of about 550 vehicle trips per day is forecast for the operational phase.

Further construction activities will take place at the limestone quarry and railway siding site. These are each expected to involve a workforce of only about 15 to 20 persons and at this stage are expected to be undertaken separately over three monthly periods.

These could also generate up to about 50 vehicle trips per day. Some of these would be to and from the main mine site and have been allowed for above. The nett increase in traffic generation at any one time is expected to be about 30 vehicle trips per day at one or other but not both sites at once.

6 EXISTING ACOUSTICAL ENVIRONMENT

6.1 Unattended Background Noise Surveys

Unattended background noise monitoring was conducted between Thursday 11 November and Thursday 25 November 1999 at a number of residences representative of the areas in the vicinity of the Project. Environmental noise loggers were used to record noise levels continuously at the respective monitoring locations over the survey period. Noise data during periods of any rainfall and/or windspeeds in excess of 5 m/s (approximately 9 knots) were discarded.

A summary of the results of the background noise surveys are given in **Table 6.1.1** and presented graphically in **Appendices D** to **J** for the various hours of the construction and operational phases of the project.

Table 6.1.1 Summary of Existing L_{A90} Rating Background Noise Levels (RBL's) – dBA

Monitoring Locations	$L_{A90(15minute)}$ Rating Background Noise Level			
	Main Project Site, Haul Road and Rail Siding			Quarry
	Daytime 0700-1800 hrs	Evening 1800-2200 hrs	Night-time 2200-0700 hrs	Daytime 0700-1700 hrs
BG1 "Wanda Bye"	34	36	28	34
BG2 "Sunrise"	35	35	28	35
BG3 "Currajong Park"	35	28	27	34
BG4 "Warrawandi"	31	34	30	31
BG5 "Reas Falls"	32	30	26	32
BG6 "Danganmore"	31	31	26	31
BG7 Cnr Slee Street, Fifield	31	29	26	32

Note: The L_{A90} represents the level exceeded for 90% of the interval period and is referred to as the average minimum or background noise level.

Review of the data presented in **Table 6.1.1** indicates that the $L_{A90(15minute)}$ RBL's at the various monitoring locations ranged from 31 dBA to 35 dBA during the daytime, 28 dBA to 36 dBA during the evening and 26 dBA to 30 dBA during the night-time. The measured background noise levels are typical of those of a rural environment with little transportation noise and no industrial noise sources.

It is noteworthy that in their recently released Industrial Noise Policy, the EPA states that "where" the rating background noise level is found to be less than 30 dBA, then it is set to 30 dBA".

6.2 Operator-Attended Noise Surveys

At each monitoring location, night-time operator-attended noise surveys of 15 minutes duration were conducted during the deployment and collection of the noise loggers on Thursday 11 November and Wednesday/Thursday 24/25 November 1999 respectively.

The operator-attended noise measurements were conducted with a precision integrating sound level meter in order to qualify the results obtained with the unattended noise loggers. During attended noise surveys, the operator identified the character and duration of acoustically significant ambient noise sources. Wherever possible, the operator quantified local traffic flow and made a qualitative assessment of the prevailing weather conditions.

The operator-attended noise survey results are presented in **Table 6.2.1** and **Table 6.2.2** for 11 November and 24/25 November 1999 respectively.

Table 6.2.1 Operator-Attended Noise Survey Results – Thursday 11 November 1999

Location Start Time	Weather Conditions	Primary Noise Descriptor (dBA re 20 µPa)						Description of Noise Emission Sources
		L_{Aeq}	L_{A1}	L_{A10}	L_{A90}	L_{Amax}	L_{Amin}	
BG1 "Wanda Bye" 1.17 pm	Warm, sunny (24°C) 50% medium cloud, still periods with wind 1-2 m/s from SW	44	54	49	33	60	28	Insects, birds, wind in trees, chickens, sheep
BG2 "Sunrise" 12.30 pm	Warm, sunny (24°C) 50% medium cloud, still periods with wind 1-2 m/s from SW	41	51	44	35	63	32	Insects. Birds, wind in trees and grass, dogs, chickens, distant power line, distant wind in trees
BG3 "Currajong Park" 2.15 pm	As previous, but wind more often still and when blowing 1.5 m/s from SW	47	60	45	30	67	26	Aircraft, birds, insects, distant tractor spraying vehicle, pigs
BG4 "Warrawandi" 3.00 pm	Warm, sunny (24°C) 50% medium cloud, still periods with wind 1-2 m/s from SW	39	47	42	30	62	25	Wind in trees, insects, birds
BG5 "Reas Falls" 4.45 pm	Warm, sunny (24°C) 10% high cloud, still periods with wind 1-2 m/s from SW	46	56	45	34	77	30	Wind in trees, birds, insects, occasional traffic
BG6 "Danganmore" 5.30 pm	Warm, sunny (24°C) 10% high cloud, but more periods with wind 1-2 m/s from SW	41	52	44	29	68	26	Wind in trees, insects, birds, plane
BG7 Fifield	Warm, sunny (24°C) 50% medium cloud, still periods with wind 1-2 m/s from SW	49	64	47	30	72	27	Traffic wind in trees, insects, birds, distant music

Table 6.2.2 Operator-Attended Noise Survey Results Wednesday/Thursday 24/25 November 1999

Location Start Time	Weather Conditions	Primary Noise Descriptor (dBA re 20 µPa)						Description of Noise Emission Sources
		L_{Aeq}	L_{A1}	L_{A10}	L_{A90}	L_{Amax}	L_{Amin}	
BG1 "Wanda Bye" 2.30 pm 24.11.99	Wind 0-0.5 m/s from W	43	55	45	33	65	28	Roosters crowing, birds, flies, farm activities and car starting/moving off
2.25 am 25.11.99	Wind Calm	33	41	34	31	50	29	Dog barking (very distant) Cicadas/crickets Bird/bat flying away
BG2 "Sunrise" 2.00 pm 24.11.99	Wind 0-0.5 m/s from W	41	50	42	31	69	29	Birds, breeze, dogs
2.00 am 25.11.99	Wind Calm	29	41	26	21	56	20	Crickets/cicadas, occasional noise of breeze in trees
BG3 "Currajong Park" 1.15 pm 24.11.99	Breeze up to 51-53 dBA	48	57	51	40	69	34	Farming activities, birds and fruit flies
1.30 am 25.11.99	Wind Calm	33	44	34	21	56	20	Sheep, cicadas/crickets
BG4 "Warrawandi" 11.45 am 24.11.99	Wind 0-0.5 m/s from W	46	60	44	32	68	28	Birds, breeze in trees, very distant traffic, flies
1.10 am 25.11.99	Wind Calm	32	41	32	29	57	28	Crickets/cicadas, breeze in trees
BG5 "Reas Falls" 11.20 am 24.11.99	Wind 0-0.5 m/s	42	50	45	33	61	29	Birds, sheep, roosters, breeze in trees, very occasional farming activity
12.05 am 25.11.99	Wind Calm	43	53	47	28	60	25	Cicadas, frogs, crickets Dogs barking
BG6 "Danganmore" 12.00 noon 24.11.99	Wind 0-0.5 m/s from NW	44	55	45	35	71	33	Cicadas, birds, breeze in trees
12.30 am 25.11.99	Wind Calm to 0.5 m/s	35	41	38	25	51	23	Crickets, breeze in trees
BG7 Fifield 2.55 pm 24.11.99	Wind 0-0.5 m/s from W	42	52	44	36	64	33	Birds, breeze in trees, pool pump
12.45 am 25.11.99	Wind Calm	32	40	33	28	48	25	Cicadas/crickets

The operator-attended noise measurement results confirm the results obtained with unattended noise loggers and support the use of the noise levels in being representative of the background noise environment at the various residences in the vicinity of the Project.

7 IMPACT ASSESSMENT PROCEDURES

7.1 General Objectives

Residential Receiver

Responsibility for the control of noise emission in New South Wales is vested in Local Government and the EPA. The EPA has released an Industrial Noise Policy dated January 2000 that provides a framework and process for deriving noise criteria for consents and licences that will enable the EPA to regulate premises that are scheduled under the Protection of the Environment Operations Act 1997.

The specific policy objectives are:

- To establish noise criteria that would protect the community from excessive intrusive noise and preserve the amenity for specific land uses.
- To use the criteria as the basis for deriving project specific noise levels.
- To promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.
- To outline a range of mitigation measures that could be used to minimise noise impacts.
- To provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development.
- To carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the Act.

Assessing Intrusiveness

For assessing intrusiveness, the background noise needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than 5 decibels above the rating background level (L_{A90}).

Assessing Amenity

The amenity assessment is based on noise criteria specific to land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. The existing noise level from industry is measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion. The cumulative effect of noise from industrial sources needs to be considered in assessing impact.

An extract from the EPA Industrial Noise Policy that relates to the amenity criteria is given in **Table 7.1.1.**

Table 7.1.1 Amenity Criteria – Recommended L_{Aeq} Noise Levels from Industrial Noise Sources

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended $L_{Aeq\ (15\ minute)}$ Noise Level (dBA)	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
	Urban	Day	60	65
		Evening	50	55
		Night	45	50
	Urban/Industrial Interface – for existing situations only	Day	65	70
		Evening	55	60
		Night	50	55
School classrooms - internal	All	Noisiest 1-hour period when in use	35	40
Hospital ward				
- internal	All	Noisiest 1-hour period	35	40
- external	All	Noisiest 1-hour period	50	55
Place of worship - internal	All	When in use	40	45
Area specifically reserved for passive recreation (eg National Park)	All	When in use	50	55
Active recreation area (eg. school playground, golf course)	All	When in use	55	60
Commercial premises	All	When in use	65	70
Industrial premises	All	When in use	70	75

Notes For Monday to Saturday, Daytime 7.00 am – 6.00 pm; Evening 6.00 pm – 10.00 pm; Night-time 10.00 pm – 7.00 am

On Sundays and Public Holidays, Daytime 8.00 am – 6.00 pm; Evening 6.00 pm – 10.00 pm; Night-time 10.00 pm – 8.00 am

The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period

7.2 Construction Phase Noise Criteria

When dealing with construction noise, the EPA recognises that higher levels of noise than would apply to the long-term operational emissions for a development are likely to be tolerable to receptors in view of the relatively short duration of the works. As a result, the EPA has published guidelines in the ENCM for the control of construction site noise.

In summary, the EPA assess proposed construction works noise on a case by case basis and incorporate the nature of surrounding land use and potential cumulative noise impacts into guidelines for its control. The following outlines the EPA's typical approach toward the control of construction noise, however these are used as general guidelines only:

Level Restrictions

For a cumulative period of exposure to construction activity noise of up to 4 weeks, the $L_{A10(15minute)}$ emitted by the works to specific residences would not exceed the L_{A90} rating background level (RBL) by more than 20 dBA.

For a cumulative construction noise exposure period of between 4 weeks and 26 weeks, the emitted $L_{A10(15minute)}$ noise level would not exceed the L_{A90} RBL by more than 10 dBA.

For a cumulative construction noise exposure period of greater than 26 weeks, the emitted $L_{A10(15minute)}$ noise level would not exceed the L_{A90} RBL by more than 5 dBA.

Time Restrictions

The majority of the construction activities on the Syerston Project would be undertaken within the EPA's preferred daytime construction hours. Where it is necessary for construction works to be undertaken outside the EPA's preferred construction hours (eg at the main project site), the $L_{A10(15minute)}$ noise level emitted by the works should not exceed the relevant RBL during the period by a margin of more than 5 dBA, independent of the duration of the construction activity.

Silencing

All practical measures should be used to silence excavation and/or construction equipment, particularly in instances where extended hours of operation are required.

The construction noise criteria for the proposed hours of construction at the respective construction areas are presented in **Table 7.2.1**.

Table 7.2.1 $L_{A10(15minute)}$ Construction Noise Assessment Criteria – dBA

Receiver Location	Cumulative Period of Exposure/Noise Assessment Criterion $L_{A10(15minute)}$					
	<4 Weeks		4 to 26 Weeks		>26 Weeks	
	0700-1800 hrs	0700-1700 hrs	0700-1800 hrs	0700-1700 hrs	0700-1800 hrs	0700-1700 hrs
BG1	54	54	44	44	39	39
BG2	55	55	45	45	40	40
BG3	55	54	45	44	40	39
BG4	51	51	41	41	36	36
BG5	52	52	42	42	37	37
BG6	51	51	41	41	36	36
BG7	51	52	41	42	36	37

In order to minimise the risk of sleep disturbance during night-time construction activities, the EPA's ENCM recommends that the $L_{A1(60second)}$ noise level outside a bedroom window should not exceed the $L_{A90(15minute)}$ background noise level by more than 15 dBA. The $L_{A1(60second)}$ noise level may conservatively be estimated by the typical maximum level of noise emission.

7.3 Operational Phase Noise Criteria

The Project operational noise emission criteria have been set with reference to the EPA's Industrial Noise Policy, as outlined in **Section 7.1**. Establishing the operational noise criteria includes assessment of RBLs, intrusiveness criteria and amenity criteria.

The intrusiveness criteria have been set for hours of mine operation based on the RBLs (Table 6.1.1) at the surrounding residences.

The existing ambient L_{Aeq} in the area surrounding the project site was controlled by natural sources and traffic noise. There were no other industrial noise sources in the area. The residences in the vicinity of the Project are best described by the "rural" receiver type. The amenity criteria have been set using **Table 7.1.1**.

The amenity criteria noise levels are significantly higher than the intrusiveness criteria noise levels. Compliance with the intrusiveness criteria, therefore, will guarantee compliance with the amenity criteria. Accordingly, the following discussion presents the intrusiveness criteria as the controlling noise criteria.

The resulting operational noise emission criteria are given in **Table 7.3.1**.

Table 7.3.1 Mine, Quarry and Rail Siding Operational Noise Emission Criteria – dBA

Receiver Location	Period - Hours /Criteria			
	Intrusiveness Criteria $L_{Aeq(15minute)}$			
	Monday to Sunday			Monday to Sunday
	0700-1800	1800-2200	2200-0700	0700-1700
BG1	39	41	35	39
BG2	40	40	35	40
BG3	40	35	35	39
BG4	36	39	35	36
BG5	37	35	35	37
BG6	36	36	35	36
BG7	36	35	35	37

7.4 Road Transportation Noise Assessment Criteria

Whilst operating on the privately owned access road, the assessment procedure for vehicle noise is as previously outlined in **Section 7.1**. That is, road vehicle noise contributions are included in the overall predicted $L_{Aeq(15minute)}$ mine operating noise emissions. On public roads, different noise assessment criteria apply to the vehicles, which would be regarded as "traffic", rather than as part of the mine site noise sources.

In some instances, an intermediate approach between the "private" and "public" roadway assessment approaches may be appropriate. This could, for example, apply to the access roads well away from mining, quarrying and processing operations, where the vehicle noise would be clearly perceived as "traffic" noise, rather than as part of the operations.

In June 1999, the EPA issued a document entitled Environmental Criteria for Road Traffic Noise. In terms of the functional categories of roads, the EPA's document states that:

"It is noted that some industries (such as mines and extractive industries) are, by necessity, in locations that are often not served by arterial roads. Heavy vehicles must be able to get to their bases of operation, and this may mean travelling on local roads. Good planning practice recognises that we must acknowledge this type of road use and develop ways of managing any associated adverse impacts. To this end, the concept of 'principal haulage routes' has been endorsed by the Department of Urban Affairs and Planning's North Coast Extractive Industries Standing Committee. Ways of identifying 'principal haulage routes' and managing associated adverse impacts have not yet been fully defined. Where local authorities identify a 'principal haulage route', the noise criteria for the route should match those for collector roads, recognising the intent that they carry a different level and mix of traffic to local roads."

Based on the above, the relevant assessment criteria for the Project are presented in **Table 7.4.1**.

Table 7.4.1 New Land Use Road Traffic Noise Criteria

Type of Development	Criteria $L_{Aeq(1hour)}$ Daytime	Criteria $L_{Aeq(1hour)}$ Night-time	Where Criteria Are Already Exceeded
8. Land use developments with potential to create additional traffic on collector roads	60 dBA	55 dBA	Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using "quiet" vehicles; and using barriers and acoustic treatments. In all cases, traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dBA

Note: Total traffic noise contribution including existing and project related vehicle movements.
$L_{Aeq(1hour)}$ represents the highest L_{Aeq} noise level for any hour during daytime (0700 hrs to 2200 hrs) and night-time (2200 hrs to 0700 hrs).

The corresponding daytime criterion nominated by the EPA in their ECRTN for existing schools is an internal level of $L_{Aeq(1hour)}$ 45 dBA.

7.5 Rail Transportation Noise Assessment Criteria

The EPA's Rail Traffic Noise Guidelines are contained in the ENCM 1994 Chapter 163 and form the basis for the assessment of cumulative train noise emissions on the Tottenham Bogan Gate Line and those associated with the operation of the new rail siding.

The EPA's recommended $L_{Aeq(24hour)}$ and maximum (L_{Amax}) noise assessment criteria for residential receivers are presented in **Table 7.5.1**.

Table 7.5.1 Cumulative Train Noise Assessment Criteria

Receiver Area[1]	$L_{Aeq(24hour)}$	Maximum (L_{Amax})
Residential Boundary	60 dBA	85 dBA

Note 1: All dwellings not owned or optioned by BRM.

The philosophy behind applying a 24 hour equivalent continuous noise level criterion is that being "energy-averaged" throughout the day, it is sensitive to both the noise level of individual events and the number of noise events.

7.6 Blast Emissions Criteria

In terms of the most recent relevant blast vibration damage criteria, British Standard 7385:Part 2-1993 is a definitive standard against which the likelihood of building damage from ground vibration can been assessed.

Although there is a lack of reliable data on the threshold of vibration-induced damage in buildings both in countries where national standards already exist and in the UK, BS 7385:Part 2 has been developed from an extensive review of UK data, relevant national and international documents and other published data. The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extraction or construction excavation), demolition, piling, ground treatments (eg compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

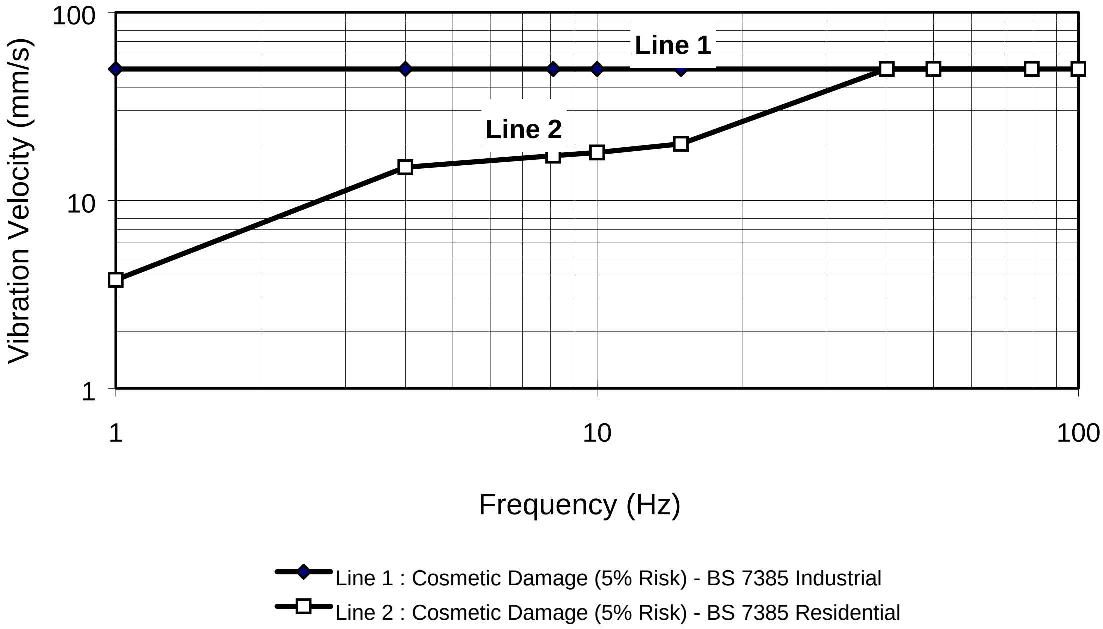
As the strain imposed on a building at foundation level is proportional to the peak particle velocity but is inversely proportional to the propagation velocity of the shear or compressional waves in the ground, this quantity (ie peak particle velocity) has been found to be the best single descriptor for correlating with case history data on the recurrence of vibration-induced damage.

The guide values from this standard for transient vibration judged to result in a minimal risk of cosmetic damage to residential buildings and industrial buildings are presented numerically in **Table 7.6.1.** and graphically in **Figure 7.6.1**.

Table 7.6.1 Transient Vibration Guide Values for Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Figure 7.6.1 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

In the absence of any site specific data on the dominant frequency of blast vibration signals at the Syerston Limestone Quarry, 4 Hz is considered a reasonable "limiting" frequency as this corresponds to the lowest natural frequency of buildings and building components. Reference to **Table 7.6.1**, therefore, indicates that the vibration criteria for the limestone quarry would be 15mm/s.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 7.6.1**, and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 7.6.1** should not be reduced for fatigue considerations.

It is noteworthy that extra to the guide values nominated in **Table 7.6.1**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Airblast - Structural Damage

Based largely on work carried out by the US Bureau of Mines, the US Office of Surface Mining has presented the following regulatory limits for airblast from blasting (depending on the low frequency limit of the measuring system):

Low Frequency Limit	Peak Airblast Level Limit
2 Hz or lower	132 dB Linear
6 Hz or lower	130 dB Linear

These levels are generally consistent with the level of 133 dB Linear nominated in AS 2187.2-1993.

The US criteria are structural damage limits based on relationships between the level of airblast and the probability of window breakage, and include a significant safety margin. It has been well documented that windows are the elements of residential buildings most at risk to damage from airblast from blasting.

While cracked plaster is the type of damage most frequently monitored in airblast complaints, research has shown that window panes fail before any other structural damage occurs (USBM, RI 8485-1980). The probabilities of damage to windows exposed to a single airblast event are as shown in **Table 7.6.2**.

Table 7.6.2 Probability of Window Damage from Airblast

Airblast dB Linear	Level kPa	Probability of Damage	Effects and Comments
140	0.2	0.01%	"No damage" - windows rattle
150	0.6	0.5%	Very occasional failure
160	2.0	20%	Substantial failures
180	20.0	95%	Almost all fail

Human Comfort and Disturbance Considerations

The ground vibration and airblast levels which cause concern or discomfort to residents are significantly lower than the damage limits. Humans are far more sensitive to some types of vibration than is commonly realised. They can detect and possibly even be annoyed at vibration levels which are well below those causing any risk of damage to a building or its contents.

The criteria normally recommended for blasting in NSW based on human discomfort are contained in the EPA's ENCM (Chapter 154). However, the EPA now advocate the use of the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines "*Technical Basis of Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*" dated September 1990. The ANZECC criteria for the control of blasting impact at residences are as follows:

- The recommended maximum level for airblast is 115 dB Linear.
- The level of 115 dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the level should not exceed 120 dB Linear at any time.
- The recommended maximum level for ground vibration is 5 mm/s (peak particle velocity (ppv)).
- The ppv level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s (ppv) at any time.
- Blasting should generally only be permitted during the hours of 0900 hours to 1700 hours Monday to Saturday. Blasting should not take place on Sundays and public holidays.

8 MINE NOISE MODELLING PROCEDURE

8.1 Prediction of Noise Emissions - General Discussion

In order to determine the acoustical impact of the construction phase, mine operation, and quarry operations, a computer model was developed of the Syerston Mine incorporating the significant noise sources, the surrounding terrain and nearby potentially affected residential properties.

The Syerston Mine computer model was prepared using RTA Software's Environmental Noise Model (ENM for Windows, Version 3.06), a commercial software system developed in conjunction with the NSW Environment Protection Authority. The acoustical algorithms utilised by this software have been endorsed by the Australian and New Zealand Environment Council and all State Environmental Authorities throughout Australia as representing one of the most appropriate predictive methodologies currently available.

The noise modelling takes into account source sound level emissions and locations, screening effects from buildings, receiver locations, meteorological effects, ground topography and noise attenuation due to spherical spreading and atmospheric absorption.

A reduction factor of 7 dBA has been applied to convert the predicted maximum overall noise emission to an L_{Aeq} level for mine operations and quarry operations. The corresponding reduction factor to convert the predicted maximum overall noise emission on L_{A10} Level for construction activities was 5 dBA.

The ENM Noise Model Data Sheets for the mine construction phase (Year -1), Years 5 and 20 of the mine operations and Year 5 of the quarry operations are attached as **Appendix K** and provide the following information:

- The schedule of plant and equipment.
- The maximum linear octave band sound power level (SWL) for each item.
- The maximum overall A-weighted SWL for each item.
- The local coordinates (X,Y,Z) for each item during each modelling scenario.
- The acoustical source height above ground level for each item.

It should be noted that the maximum sound power levels given for each item of mobile equipment do not include noise emissions which emanate from reversing alarms.

In the event that reversing alarm noise is considered to be a source of disturbance, the alarm noise level should be checked against the appropriate Department of Mineral Resource requirements and the necessary mitigating action taken to achieve an acceptable noise reduction without compromising safety standards.

8.2 Meteorological Parameters

EPA Assessment of Prevailing Weather Conditions

Wind

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the source of the noise. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind affects need to be considered when wind is a feature of the area. Wind is considered to be a feature where source to receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 percent of the time or more in any assessment period (day, evening, night) in any season. This differs from the procedure used with temperature inversions, in that the 30 percent occurrence applies to all seasons and each assessment period - and not just the winter season and night-time assessment period. There are two ways to assess wind effects:

- Use a wind rose to determine whether wind is a feature based on the frequency of occurrence and wind speed. In doing this, care is to be taken to assess the source-to-receiver components of wind that are relevant.
- Simply assume that wind is a feature of the area (foregoing the need to use a wind rose) and apply a "maximum impact" scenario.

The default wind speed proposed by the EPA in their Industrial Noise Policy is 3 m/s (source to receiver component).

In terms of measured meteorological data, where there is 30 percent or more occurrence of wind speeds below 3 m/s (source-to-receiver component), then use the highest wind speed (below 3 m/s) instead of the default.

Further, where there is less than a 30 percent occurrence of wind of up to 3 m/s (source-to-receiver component), wind is not included in the noise-prediction calculation.

Temperature Inversion

Temperature inversions, when they occur, have the ability to increase noise levels by focusing sound waves. Temperature inversions occur predominantly at night during the winter months. For a temperature inversion to be a significant characteristic of the area it needs to occur for approximately 30% of the total night-time during winter or about 2 nights per week.

The night-time period for determining inversion frequency is from 1 hour before sunset to 1 hour after sunrise (taken to be 6.00 pm to 7.00 am), which is the time period during which inversions are most likely. (This is different from the night noise assessment period over which inversions are to be assessed, which is from 10.00 pm to 7.00 am).

In the absence of any site specific data, default values for temperature inversions and associated drainage-flow wind speeds are provided by the EPA for use in assessing impacts where inversions are present for at least 30% of the total night-time during winter. These default values have been chosen based on the analysis of available field data. The following default parameters are specified for non-arid areas:

Moderate (F-class stability category) inversions

- 3°C/100 m temperature inversion strength for all receivers, plus a 2 m/s source-to-receiver component drainage-flow wind speed for those receivers where applicable.

Additional EPA Noise Assessment Information

The EPA's recommended noise assessment criteria is aimed to limit potential intrusive noise emissions and preserve noise amenity. In cases where the limiting noise assessment criterion (in this case $L_{Aeq(15minutes)}$) intrusiveness criterion) cannot be achieved, then practicable and economically feasible noise control measures should be applied. This usually requires demonstrations that Best Achievable Technology and Best Environmental Management Practices have been implemented to mitigate adverse acoustical impacts.

In the event that the lowest achievable noise emission levels remain above the noise assessment criteria, then the potential noise impact needs to be balanced and assessed against any economic and social benefits the project may bring to the community. It then follows that where the consenting authority may consider that the development does offer community benefits, then these may be grounds for permitting achievable noise emission levels as statutory compliance levels.

Prevailing Weather Conditions

An assessment of prevailing weather conditions has been prepared from data provided by Zib & Associates Pty Ltd for the period April 1999 to April 2000.

The prevailing wind speeds and direction throughout the year are summarised in **Table 8.2.1** for daytime, **Table 8.2.2** for evening and **Table 8.2.3** for night-time.

Table 8.2.1 Annual and Seasonal Frequency of Occurrence Wind Speed Intervals - Daytime

Period	Calm (<0.5 m/s)	Wind Direction	0.5 m/s to 2 m/s	2 m/s to 3 m/s	0.5 m/s to 3 m/s
Annual	4%	SSW (±45°)	7%	7%	14%
Summer	1%	ENE (±45°)	6%	7%	13%
Autumn	7%	SSW (±45°)	8%	8%	16%
Winter	4%	SSW (±45°)	11%	8%	19%
Spring	1%	ENE (±45°)	5%	7%	12%

Table 8.2.2 Annual and Seasonal Frequency of Occurrence Wind Speed Intervals - Evening

Period	Calm (<0.5 m/s)	Wind Direction	0.5 m/s to 2 m/s	2 m/s to 3 m/s	0.5 m/s to 3 m/s
Annual	13%	SSE (±45^o)	26%	9%	35%
Summer	12%	SSW (±45^o)	9%	11%	20%
Autumn	22%	SSE (±45^o)	28%	8%	36%
Winter	6%	SSE (±45^o)	44%	9%	53%
Spring	8%	SW (±45^o)	17%	9%	26%

Table 8.2.3 Annual and Seasonal Frequency of Occurrence Wind Speed Intervals – Night-time

Period	Calm (<0.5 m/s)	Wind Direction	0.5 m/s to 2 m/s	2 m/s to 3 m/s	0.5 m/s to 3 m/s
Annual	17%	ESE (±45^o)	15%	6%	21%
Summer	9%	ENE (±45^o)	10%	11%	21%
Autumn	25%	SE (±45^o)	22%	6%	28%
Winter	18%	SE (±45^o)	31%	5%	36%
Spring	13%	ENE (±45^o)	13%	10%	23%

The daytime seasonal and annual frequency of occurrence of the various atmospheric stability classes are presented in **Table 8.2.4**, together with the estimated Environmental Lapse Rate (ELR).

Table 8.2.4 Annual Frequency of Occurrence of Atmospheric Stability Classes - Daytime

Stability Class	Percentage Frequency					Estimated ELR ^{o}C/100 m	Qualitative Description
	Summer	Autumn	Winter	Spring	Annual		
A	21	8	3	11	9	<-1.9	Lapse
B	26	27	20	30	25	-1.9 to -1.7	Lapse
C	28	26	27	29	28	-1.7 to -1.5	Lapse
D	26	34	35	30	33	-1.5 to -0.5	Neutral
E	0	2	6	1	2	-0.5 to 1.5	Weak Inversion
F	0	3	9	1	4	1.5 to 4 (and >4)	Moderate Inversion

Note: ELR (Environmental Lapse Rate)

The night-time seasonal and annual frequency of occurrence of atmospheric stability classes are presented in **Table 8.2.5** together with the estimated Environmental Lapse Rate (ELR).

Table 8.2.5 Annual Frequency of Occurrence of Atmospheric Stability Classes - Night-time

Stability Class	Percentage Frequency					Estimated ELR ^{o}C/100 m	Qualitative Description
	Summer	Autumn	Winter	Spring	Annual		
A	0	0	0	0	0	<-1.9	Lapse
B	0	0	0	0	0	-1.9 to -1.7	Lapse
C	0	0	0	0	0	-1.7 to -1.5	Lapse
D	67	42	27	55	47	-1.5 to -0.5	Neutral
E	25	29	32	31	30	-0.5 to 1.5	Weak Inversion
F	11	31	41	19	26	1.5 to 4 (and >4)	Moderate Inversion

Note: ELR (Environmental Lapse Rate)

The evening/night-time seasonal and annual frequency of occurrence of atmospheric stability classes are presented in **Table 8.2.6** together with the estimated Environmental Lapse Rate (ELR).

Table 8.2.6 Annual Frequency of Occurrence of Atmospheric Stability Classes – Evening/Night-time

Stability Class	Percentage Frequency					Estimated ELR ^{o}C/100 m	Qualitative Description
	Summer	Autumn	Winter	Spring	Annual		
A	0	0	0	0	0	<-1.9	Lapse
B	0	0	0	0	0	-1.9 to -1.7	Lapse
C	1	0	1	1	0	-1.7 to -1.5	Lapse
D	69	42	26	54	46	-1.5 to -0.5	Neutral
E	22	24	26	26	26	-0.5 to 1.5	Weak Inversion
F	11	35	49	22	29	1.5 to 4 (and >4)	Moderate Inversion

Note: ELR (Environmental Lapse Rate)

Definition of Prevailing Weather Conditions

Based on the available meteorological information assessed in accordance with the EPA's INP, the prevailing weather conditions for the Syerston Mine site are summarised as follows:

Seasonal Wind Speed and Direction - Evening

Autumn

- 36% south-southeast (±45^{0}) 0.5 m/s to 3 m/s.

Winter

- 53% south-southeast (±45^{o}) 0.5 m/s to 3 m/s.

Seasonal Wind Speed and Direction – Night-time

Winter

- 36% southeast (±45) 0.5m/s to 3m/s.

Temperature Gradients

- Neutral conditions approximately 33% of the annual daytime period (Table 8.2.4).
- Moderate inversion conditions approximately 49% of the winter night-time period (Table 8.2.6).

Noise Modelling Meteorology

The contributed noise emissions for the proposed operating scenarios to the nearest potentially affected residential properties have been calculated with the following meteorological parameters:

Prevailing Calm - Daytime

- During "calm" daytime conditions (ie 19^{o}C air temperature, 58% relative humidity, 0 m/s wind speed and -1^{o}C/100 m temperature gradient).

Prevailing Wind

- Prevailing autumn/winter south-southeasterly evening wind conditions (ie 17^{o}C/11^{o}C air temperature, 78%/86% relative humidity, 2 m/s wind speed and 0^{o}C/100 m temperature gradient).
- Prevailing winter southeasterly night-time wind conditions (ie 11^{o}C air temperature, 86% relative humidity, 2 m/s wind speed and 0^{o}C/100 m temperature gradient).

Temperature Inversion

- Moderate winter temperature inversion conditions (ie 11^{o}C air temperature, 86% relative humidity, 2 m/s southeasterly wind speed and 3^{o}C/100 m temperature gradient) during night-time.

Predicted Noise Emission levels

The predicted $L_{A10(15minute)}$ noise emission levels during the mine construction phase (Year -1) and the $L_{Aeq(15minute)}$ noise emission levels during Years 5 and 20 of mine operations and Year 5 of the quarry operations are presented in **Section 9**.

9 MINE AND QUARRY NOISE IMPACT ASSESSMENT

9.1 Mine Construction Phase

Emissions during the construction phase would be dominated by noise from mobile plant associated with earthworks conducted during daylight hours. Maintenance and process facility construction and testing activities could occur outside daylight hours, however, noise contributions would be minor and of short duration.

The predicted contributed $L_{A10(15minute)}$ daytime (0700 hours to 1800 hours) noise emissions for the proposed construction phase of the mine during Year -1 to the surrounding residential assessment areas are presented in **Table 9.1.1** under prevailing calm meteorological conditions.

Table 9.1.1 Predicted $L_{A10(15minute)}$ Mine Construction Phase Noise Emissions Year -1 - dBA

No	Location	Predicted $L_{A10(15minute)}$ Noise Emission	$L_{A10(15minute)}$ Noise Criteria Daytime (0700 hrs to 1800 hrs)		
		Calm	<4 weeks(1)	4-26 weeks(1)	>26 weeks(1)
13	Brooklyn	11	55	45	40
14	Currajong Park (BG3)	15	55	45	40
15	Rosehill	7	55	45	40
18	Flemington	2	55	45	40
20	Sunrise (BG2)	17	55	45	40
21	Wanda Bye (BG1)	8	54	44	39
22	Glenburn	16	54	44	39
23	Fifield (BG7)	8	51	41	36
26	Warrawandi (BG4)	2	51	41	36
27	Slapdown	16	51	41	36

Note 1: Durations shown (ie <4 weeks, 4 to 26 weeks, >26 weeks) refer to cumulative period of noise exposure.

Impact Assessment

The following is derived from the data presented in **Table 9.1.1**, for a construction period of greater than 6 months (refer to **Table 7.2.1**) conducted between 0700 hours and 1800 hours.

- The $L_{A10(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria under prevailing calm meteorological conditions.

Conclusion

Noise impacts arising from the Syerston Mine construction works are acceptable at all assessment locations.

9.2 Mine Operations - Daytime - Year 5

The predicted contributed $L_{Aeq(15minute)}$ noise emissions for the proposed mine operations during Year 5 to the surrounding residential assessment areas are presented in **Table 9.2.1** under prevailing calm meteorological conditions.

Table 9.2.1 Predicted Daytime $L_{Aeq(15minute)}$ Mine Operating Noise Emissions - Year 5 - dBA

No	Location	$L_{Aeq (15minute)}$ Noise Emission	$L_{Aeq(15minute)}$ Noise Criteria
		Calm	Daytime (0700 hrs to 1800 hrs)
13	Brooklyn	24	40
14	Currajong Park (BG3)	31	40
15	Rosehill	22	40
18	Flemington	13	36
20	Sunrise (BG2)	22	40
21	Wanda Bye (BG1)	13	39
22	Glenburn	19	39
23	Fifield (BG7)	16	36
26	Warrawandi (BG4)	16	36
27	Slapdown	24	36

Impact Assessment

The following is derived from the data presented in **Table 9.2.1** for daytime mine operations.

- The daytime $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria under prevailing calm meteorological conditions.

Conclusion

Noise impacts arising from the Syerston Mine daytime Year 5 operations are acceptable at all assessment locations.

9.3 Mine Operations - Evening - Year 5

The predicted contributed evening $L_{Aeq(15minute)}$ noise emissions for the proposed mine operations during Year 5 to the surrounding residential assessment areas are presented in **Table 9.3.1** under prevailing adverse wind conditions.

Table 9.3.1 Predicted Evening $L_{Aeq(15minute)}$ Mine Operation Noise Emissions - Year 5 - dBA

No	Location	$L_{Aeq(15minute)}$ Noise Emission		$L_{Aeq(15minute)}$ Noise Criteria
		SSE Wind (2 m/s)		Evening (1800 hrs to 2200 hrs)
		Autumn	Winter	
13	Brooklyn	25	26	35
14	Currajong Park (BG3)	**36**	**37**	35
15	Rosehill	29	30	35
17	Berrilee	20	22	39
18	Flemington	21	23	39
20	Sunrise (BG2)	21	23	40
21	Wanda Bye (BG1)	12	13	41
22	Glenburn	17	18	41
23	Fifield (BG7)	15	16	35
26	Warrawandi (BG4)	16	16	39
27	Slapdown	22	23	39

Impact Assessment

- The evening $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria during prevailing adverse wind conditions except at Currajong Park.
- The predicted $L_{Aeq(15minute)}$ noise emissions at Currajong Park are marginally (1 dBA and 2 dBA respectively) above the recommended autumn and winter assessment criteria under adverse wind conditions.

Conclusion

Noise impacts arising from the Syerston Mine evening Year 5 operations are acceptable at all assessment locations except Currajong Park under prevailing adverse wind conditions (where only marginal exceedances are predicted).

9.4 Mine Operations - Night-time - Year 5

The predicted contributed night-time $L_{Aeq(15minute)}$ noise emissions for the proposed mine operations during Year 5 to the surrounding residential assessment areas are presented in **Table 9.4.1** under both prevailing adverse wind and prevailing adverse temperature inversion conditions.

Table 9.4.1 Predicted Night-time $L_{Aeq(15minute)}$ Mine Operating Noise Emissions - Year 5 - dBA

No	Location	$L_{Aeq(15minute)}$ Noise Emission		$L_{Aeq(15minute)}$ Noise Criteria
		Winter SE Wind	3°C/100 m plus Inversion	Night-time (2200 hrs to 0700 hrs)
		2 m/s	2 m/s SE Wind	
13	Brooklyn	25	29	35
14	Currajong Park (BG3)	**36**	**38**	35
15	Rosehill	32	32	35
17	Berrilee	22	25	35
18	Flemington	24	26	35
20	Sunrise (BG2)	25	30	35
21	Wanda Bye (BG1)	14	18	35
22	Glenburn	19	21	35
23	Fifield (BG7)	17	18	35
26	Warrawandi (BG4)	15	17	35
27	Slapdown	23	25	35

Impact Assessment

The following is derived from the data presented in **Table 9.4.1** for night-time mine operations.

- The night-time $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria during prevailing adverse wind and prevailing inversion conditions except at Currajong Park.
- The predicted $L_{Aeq(15minute)}$ noise emissions at Currajong Park are marginally (1 dBA) and moderately (3 dBA) above the recommended assessment criteria under prevailing adverse wind and prevailing adverse inversion (plus wind) conditions respectively.

Conclusion

Noise impacts arising from the Syerston Mine night-time operations are acceptable at all assessment locations except Currajong Park (under prevailing adverse wind and adverse prevailing temperature inversion plus wind conditions).

9.5 Mine Operations - Daytime - Year 20

The predicted contributed $L_{Aeq(15minute)}$ noise emissions for the proposed mine operations during Year 20 to the surrounding residential assessment areas are presented in **Table 9.5.1** under prevailing calm meteorological conditions.

Table 9.5.1 Predicted Daytime $L_{Aeq(15minute)}$ Mine Operating Noise Emissions - Year 20 - dBA

No	Location	$L_{Aeq\ (15minute)}$ Noise Emission	$L_{Aeq(15minute)}$ Noise Criteria
		Calm	Daytime (0700 hrs to 1800 hrs)
13	Brooklyn	29	40
14	Currajong Park (BG3)	33	40
15	Rosehill	26	40
17	Berilee	16	36
18	Flemington	19	36
20	Sunrise (BG2)	24	40
21	Wanda Bye (BG1)	20	39
22	Glenburn	21	39
23	Fifield (BG7)	18	36
26	Warrawandi (BG4)	16	36
27	Slapdown	28	36

Impact Assessment

The following is derived from the data presented in **Table 9.5.1** for daytime mine operations.

- The daytime $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria during calm meteorological conditions.

Conclusion

Noise impacts arising from the Syerston Mine daytime Year 20 operations are acceptable at all assessment locations.

9.6 Mine Operations - Evening - Year 20

The predicted contributed evening $L_{Aeq(15minute)}$ noise emissions for the proposed mine operations during Year 20 to the surrounding residential assessment areas are presented in **Table 9.6.1** under prevailing adverse wind conditions.

Table 9.6.1 Predicted Evening $L_{Aeq(15minute)}$ Mine Operation Noise Emissions - Year 20 - dBA

No	Location	$L_{Aeq(15minute)}$ Noise Emission		$L_{Aeq(15minute)}$ Noise Criteria
		SSE Wind (2 m/s)		Evening (1800 hrs to 2200 hrs)
		Autumn	Winter	
13	Brooklyn	30	30	35
14	Currajong Park (BG3)	**38**	**39**	35
15	Rosehill	30	31	35
17	Berrilee	21	23	39
18	Flemington	26	27	39
20	Sunrise (BG2)	24	25	40
21	Wanda Bye (BG1)	19	20	41
22	Glenburn	20	21	41
23	Fifield (BG7)	17	18	35
26	Warrawandi (BG4)	16	17	39
27	Slapdown	27	28	39

Impact Assessment

- The evening $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria under prevailing adverse wind conditions except at Currajong Park.
- The predicted $L_{Aeq(15minute)}$ noise emissions at Currajong Park are moderately (3 dBA and 4 dBA respectively) above the recommended autumn and winter assessment criteria under adverse wind conditions.

Conclusion

Noise impacts arising from the Syerston Mine night-time Year 20 operations are acceptable at all assessment locations except Currajong Park (under prevailing adverse wind conditions).

9.7 Mine Operations - Night-time - Year 20

The predicted contributed night-time $L_{Aeq(15minute)}$ noise emissions for the proposed mine operations during Year 20 to the surrounding residential assessment areas are presented in **Table 9.7.1** under both prevailing adverse wind and prevailing adverse temperature inversion conditions.

Table 9.7.1 Predicted Night-time $L_{Aeq(15minute)}$ Mine Operating Noise Emissions - Year 20 - dBA

No	Location	$L_{Aeq(15minute)}$ Noise Emission		$L_{Aeq(15minute)}$ Noise Criteria
		Winter SE Wind	3^oC/100 m plus Inversion	Night-time (2200 hrs to 0700 hrs)
		2 m/s	2 m/s SE Wind	
13	Brooklyn	29	33	35
14	Currajong Park (BG3)	**38**	**40**	35
15	Rosehill	31	33	35
17	Berrilee	24	26	35
18	Flemington	28	30	35
20	Sunrise (BG2)	27	30	35
21	Wanda Bye (BG1)	20	23	35
22	Glenburn	21	24	35
23	Fifield (BG7)	18	20	35
26	Warrawandi (BG4)	16	18	35
27	Slapdown	28	29	35

Impact Assessment

The following is derived from the data presented in **Table 9.7.1** for night-time mine operations.

- The night-time $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria during prevailing adverse wind and prevailing inversion conditions except at Currajong Park.
- The predicted $L_{Aeq(15minute)}$ noise emissions at Currajong Park are moderately (3 dBA and 5 dBA respectively) above the recommended assessment criteria under prevailing adverse wind and prevailing adverse inversion (plus wind) conditions.

Conclusion

Noise impacts arising from the Syerston Mine night-time Year 20 operations are acceptable at all assessment locations except Currajong Park (under prevailing adverse wind and prevailing adverse temperature inversion plus wind conditions).

9.8 Quarry Operations - Daytime

The predicted contributed daytime $L_{Aeq(15minute)}$ noise emissions for the proposed limestone quarry operations during Year 5 to the surrounding residential assessment areas are presented in **Table 9.8.1** under prevailing calm meteorological conditions.

Table 9.8.1 Predicted Daytime $L_{Aeq(15minute)}$ Quarry Operating Noise Emissions - Year 5 - dBA

No	Location	$L_{Aeq(15minute)}$ Noise Emission	$L_{Aeq(15minute)}$ Noise Criteria
		Calm	Daytime (0700 hrs to 1700 hrs)
3	Reas Falls (BG5)	30	37
4	Moorelands	**42**	37
6	Gillenbine	36	37
7	Lesbina	**38**	36
9	Hillsdale	24	37
25	The Troffs	33	36
39	Eastbourne	**38**	36

Impact Assessment

The following is derived from the data presented in **Table 9.8.1** for daytime quarry operations.

- The daytime $L_{Aeq(15minute)}$ noise emissions at all assessment locations are below the recommended assessment criteria under prevailing calm meteorological conditions except at Moorelands, Lesbina and Eastbourne.
- The predicted $L_{Aeq(15minute)}$ noise emissions at Lesbina and Eastbourne are marginally (2 dBA) and at Moorelands moderately (5 dBA) above the recommended assessment criteria under calm meteorological conditions.

Conclusion

Noise impacts arising from the Project limestone quarry daytime Year 5 operations are acceptable at all assessment locations except at Moorelands, Lesbina and Eastbourne (under prevailing calm meteorological conditions).

9.9 Mine and Quarry Noise Impact Summary

In summary, given that compliance with the EPA's nominated noise criteria has to be demonstrated under **prevailing** meteorological conditions (refer to **Section 8**), the only predicted noise level exceedance is:

- **Evening Mine Operations Year 5:**
  Marginal 1 dBA/2 dBA exceedances at Currajong Park only, for an autumn/winter 2 m/s south-southeasterly wind.

- **Night-time Mine Operations Year 5:**
  Marginal/moderate 1 dBA/3 dBA exceedances at Currajong Park only, for a winter 2 m/s southeasterly wind and a temperature inversion together with a 2 m/s southeasterly wind respectively.

- **Evening Mine Operations Year 20:**
  Moderate 3 dBA/4 dBA exceedances at Currajong Park only for an autumn/winter 2 m/s south-southeasterly wind.

- **Night-time Mine Operations Year 20:**
  Moderate 3 dBA/5 dBA exceedances at Currajong Park only, for a winter 2 m/s southeasterly wind and a temperature inversion together with a 2 m/s southeasterly wind respectively.

- **Daytime Quarry Operations Year 5:**
  Marginal 2 dBA exceedances at Lesbina and Eastbourne and a moderate 5 dBA exceedance at Moorelands under calm meteorological conditions.

9.10 Assessment of Noise Impact of Pipeline Construction

Noise emitting sources to be used for the construction of the pipelines include two backhoes and a crane. These items of mobile plant are not considered to be particularly noisy items of plant. It is unlikely that any residential receiver will be affected by pipeline construction noise emissions for more than several hours.

9.11 Assessment of Noise Impact of Road Upgrades and Fifield Bypass Construction

As with the pipeline construction works described above, it is unlikely that any residential receiver will be affected by roadworks necessary for the road upgrades and construction of the Fifield Bypass for more than several weeks. Roadworks associated with the upgrade of several roads and the construction of the Fifield Bypass are proposed to be conducted during daylight hours only.

9.12 Assessment of Noise Impact of Rail Siding Construction

The construction of the rail siding is expected to be undertaken within three months. Construction noise will include those associated with the construction of the rail spur line, installation of appropriate switching and rail signals, construction of loading and unloading facilities, hardstands, access road, rail crossing and administrative facilities.

For an expected construction period of three months, for the purposes of this assessment, a construction noise criterion for the period 4 to 26 weeks (in accordance with the EPA's ENCM) has been applied. Based on the daytime ambient background noise level of 32 dBA measured at "Reas Falls", a daytime construction noise criterion of 42 dBA (background plus 10 dBA) has been applied to all construction activities when measured at the facade of nearest potentially affected residential receivers.

The nearest potentially affected receiver to the rail siding is "Glen Rock", situated approximately 750 metres from the siding. Therefore, $L_{A10(15minute)}$ construction noise emission levels should remain below 83 dBA when measured 7 metres from the noise source. Based on previous measurement data, it is unlikely that the construction equipment likely to be used at the rail siding would exceed these noise levels, hence noise levels associated with construction of the rail siding is expected to be below the nominated assessment criterion.

10 ROAD TRAFFIC NOISE IMPACT ASSESSMENT

10.1 Mine Operations Road Traffic

Further to the road vehicles included in the Syerston Mine noise model as described in **Section 5.3**, the noise impacts of mine related road traffic on the surrounding public road network was conducted via the prediction of existing and future (with the mine operating) peak hourly traffic noise levels on the respective roads.

The US Environment Protection Agency's (EPA's) method was used for the prediction of the $L_{Aeq(1hour)}$ noise levels for a range of offset distances of the closest residences adjacent to the local access roads.

The US EPA's method for prediction of $L_{Aeq\ (1\ hour)}$ is an internationally accepted theoretical traffic noise prediction model which takes into account the L_{Amax} vehicle noise levels (light and heavy), receiver offset distance, passby duration, vehicle speed, ground absorption (based on the ratio of soft ground and average height of propagation), number of hourly vehicle movements, receiver height, truck exhaust height and the height and location of any intervening barriers.

The noise level predictions at the potentially most affected receivers adjacent to the respective roads are presented in **Table 10.1.1** and were based on the existing and future (pm) peak hour traffic flows given in **Table 5.3.5** for the operation of the mine. In each case (existing and future) the number of heavy vehicles was calculated using the total and heavy vehicle numbers for the respective roads presented in **Table 5.3.4** and the road design speeds given in **Section 5.3**.

Table 10.1.1 Predicted Existing and Future $L_{Aeq(1hour)}$ Peak Traffic Noise Levels

Receiver	Road	Location	Offset Distance	Peak Traffic Noise Levels - $L_{Aeq(1hour)}$	
				Existing	Future
Fifield Village	Fifield Bypass	-	1100 m	50 dBA	50 dBA
Platina Farm	MR 57 North	North of SR 90	300 m	34 dBA	36 dBA
Gillenbine	SR 64	East of MR 57 North	1100 m	21 dBA	35 dBA
Reas Falls	SR 64	East of MR 57 North	325 m	28 dBA	42 dBA
Glen Rock	MR 350	North of Trundle	750 m	30 dBA	35 dBA
Trundle Township	MR 350	-	20 m	52 dBA	54 dBA
Trundle School	MR 350	-	30 m	49 dBA	50 dBA

Review of the road traffic level predictions given in **Table 10.1.1** indicates that all future peak hour noise levels are lower than both the recommended daytime and night-time traffic noise assessment criteria (of $L_{Aeq(1hour)}$ 60 dBA and 55 dBA respectively) presented in **Table 7.4.1**.

Assuming a conservative 10 dBA attenuation (allowing for some windows being open), the predicted traffic noise levels at the Trundle School are also below the EPA's recommended criterion (**Section 7.4**).

10.2 Construction Road Traffic

The construction road traffic, as summarised in **Table 5.4.2** will be principally focussed on:

- Fifield Bypass and SR64 between the mine site and the limestone quarry site and rail siding construction site.
- MR350 plus State Road 90 to/from Parkes.

SR60 and MR57 North to/from Condobolin will be used to a lesser extent by any construction workforce living in Condobolin.

At the peak of construction, traffic increases on MR350, State Route 90 and SR64, MR57 to and from Parkes and Condobolin would be comparable to those estimated above for the operational phase of the mine. Traffic volumes on the Fifield Bypass and SR64 between the mine and MR350 would be lower as there would not be sulphur or limestone deliveries between the rail siding/quarry and the mine.

Construction of the water and gas pipelines, the Fifield bypass and SR64 upgrade will be subject of separate construction management plans. The construction management plans for the pipelines will deal with special traffic management measures to be implemented where these cross roads. They are to be prepared prior to construction in consultation with local Councils and the RTA.

Based on a (conservative) 10 hour working day for the construction works and the estimated peak daily construction traffic given in **Table 5.4.2**, the $L_{Aeq(1hour)}$ traffic noise levels at the noise sensitive receiver adjacent to the respective access roads were predicted.

These predictions were based on a peak hourly mine construction related traffic flow of 58 vehicles, with 16 heavy vehicles and 42 light vehicles.

Table 10.2.1 presents the existing and predicted future traffic noise levels (existing plus construction) at the noise sensitive receivers adjacent to the roads between the mine site and the rail siding.

Table 10.2.1 Existing and Future (Construction) $L_{Aeq(1hour)}$ Traffic Noise Levels

Receiver	Road	Offset Distance	$L_{Aeq(1hour)}$ Traffic Noise Levels	
			Existing	Construction (including existing)
Fifield Village	Fifield Bypass	1100 m	50 dBA	50 dBA
Platina Farm	MR 57 North	300 m	34 dBA	41 dBA
Gillenbine	SR 64	1100 m	21 dBA	33 dBA
Reas Falls	SR 64	325 m	28 dBA	40 dBA
Glen Rock	MR 350	880 m	30 dBA	35 dBA

Review of the predicted $L_{Aeq(1hour)}$ mine construction plus existing traffic noise levels presented in **Table 10.2.1** indicates that all the levels are lower than both the recommended daytime and night-time traffic noise assessment criteria (of $L_{Aeq(1hour)}$) 60 dBA and 55 dBA respectively, given in **Table 7.4.1**.

In terms of noise sensitive receivers situated adjacent to MR350 and State Road 90 between the rail siding and Parkes based on a speed of 100 km/hr for all the peak level construction traffic along SR90, compliance with the recommended daytime $L_{Aeq(1hour)}$ 60 dBA assessment criterion would be met at offset distances of 20 m and more.

11 RAIL TRAFFIC NOISE IMPACT ASSESSMENT

A summary of the weekly train movements on the branch line is presented in **Table 5.2.1**. There will be a maximum of four train movements per week transporting sulphur and two train movements per week transporting caustic soda (each return train trip equals two movements).

The closest residences to the branch line are Glen Rock and Ballenrae, offset approximately 750 m and 1350 m from the rail line respectively.

Calculation of the 24 hour equivalent continuous noise level (L_{Aeq}) and the maximum passby level have been conducted using a computer prediction model developed by Richard Heggie Associates. The prediction model uses characteristic noise levels for the various sources (locomotive engine and exhaust noise as a function of throttle notch, wheel/rail noise as a function of train speed, etc) at a fixed reference distance. The model then makes adjustments for the actual distance from the track, the train length and the presence of natural or artificial barriers. Parameters including the $L_{Aeq(24hour)}$ and maximum passby level L_{Amax} can then be determined by summing the effects of individual noise sources and by incorporating in the number of daily train events.

Table 11.1.1 Predicted Noise Levels due to Rail Transportation

Receiver	Maximum Number of Train Movements per Day*	Predicted Noise Level		EPA Recommended Criteria	
		$L_{Aeq(24hour)}$	L_{Amax}	$L_{Aeq(24hour)}$	L_{Amax}
Glen Rock	4	35 dBA	38 dBA	60 dBA	85 dBA
Ballenrae	4	33 dBA	14 dBA	60 dBA	85 dBA

* The maximum number of train movements would likely be less than those presented in this table and as such the predicted noise levels are considered to be higher than likely and therefore conservative.

The results presented in **Table 11.1.1** indicate that the predicted noise levels are below the recommended EPA's train noise assessment criteria at the nearest potentially affected properties.

12 USE OF EXPLOSIVES

Blasting for the Project will only be conducted at the Limestone Quarry. Material at the Syerston Mine will be free dug.

Explosives are used in quarrying in order to dislodge and fracture the natural rock into a size which can be handled by the mining equipment. To achieve this end, holes are drilled into the rock in a designed pattern giving strict attention to their angle, depth and spacing. Drilling will be ongoing throughout the year. These holes are then filled with an explosive charge consisting of an ammonium nitrate fuel oil mix (ANFO) or emulsion type explosive. The explosive is initiated with the aid of primers and detonators. The detonation of each hole is delayed in a pre-designed sequence to ensure that each hole is fired individually in close succession. This delayed firing technique improves the efficiency of the blast and also reduces its environmental impact. Blasting would occur approximately twice per month.

12.1 Blasting Practice

A summary of the proposed blast design details for the quarry are presented in **Table 12.1.1**. The limestone would probably be drilled on 15 m benches with a burden and spacing each of about 2.6 m. Figures described in Table 12.1.1 are conservative and would cover potential blast impacts. It is anticipated that Ammonium Nitrate Fuel Oil (ANFO) explosive would be utilised for the column charge. If wet holes occur, some emulsion explosive may be necessary.

Table 12.1.1 Proposed Blast Design Details - Limestone Quarry

Blast Design Parameter	Typical Dimension
Number of Holes	168
Number of Rows	6
Hole Diameter	102 mm
Hole Inclination	Vertical
Bench Height	15 m
Burden	2.6 m
Spacing	2.6 m
Subdrill	1.0 m
Stemming Depth	2.8 m (aggregate)
Delay Timing	Nonel (single hole per delay)
Column Explosive	ANFO
Powder Factor	0.85 kg/bcm
Maximum Instantaneous Charge (MIC)	87 kg

12.2 Blast Emission Levels

Prediction of Blast Emission Levels

By adopting the suggested blast design, the levels of blast vibration emissions can be predicted using Figure J2 of AS 2187-1993, applicable to free face blasting in hard rock quarries. A similar approach is advocated by ICI Australia in regard to prediction of airblast emissions.

The relevant formulae used are as follows:

PVS = 500(R/(Q)^0.5)^-1.6

dB = $164.2 - 24(\log_{10} R - 0.33 \log_{10} Q)$

where,

PVS = Peak Vector Sum ground vibration levels (mm/s)
dB = Peak airblast noise level (dB Linear)
R = Distance between charge and receiver (m)
Q = Charge mass per delay (kg)

The relationship between the peak vector sum (PVS) ground vibration and peak airblast from the blast site is presented in **Figure 12.2.1** and **Figure 12.2.2** respectively.

Figure 12.2.1 Relationship Between Ground Vibration and Distance for an MIC of 87 kg

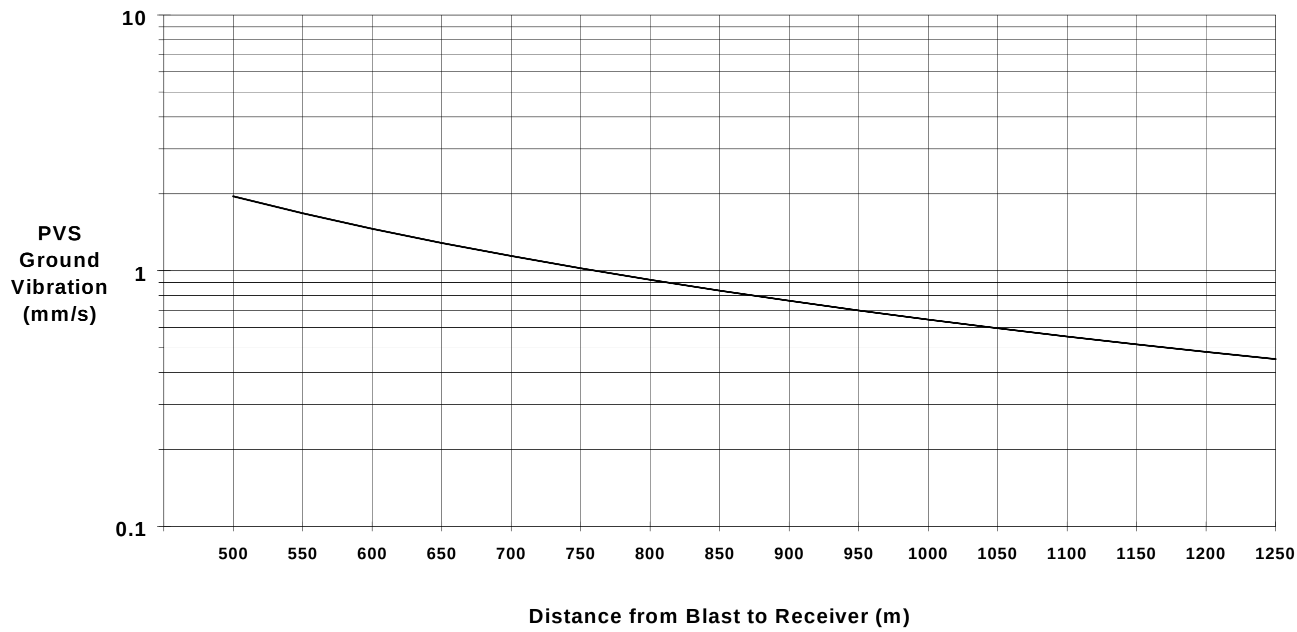
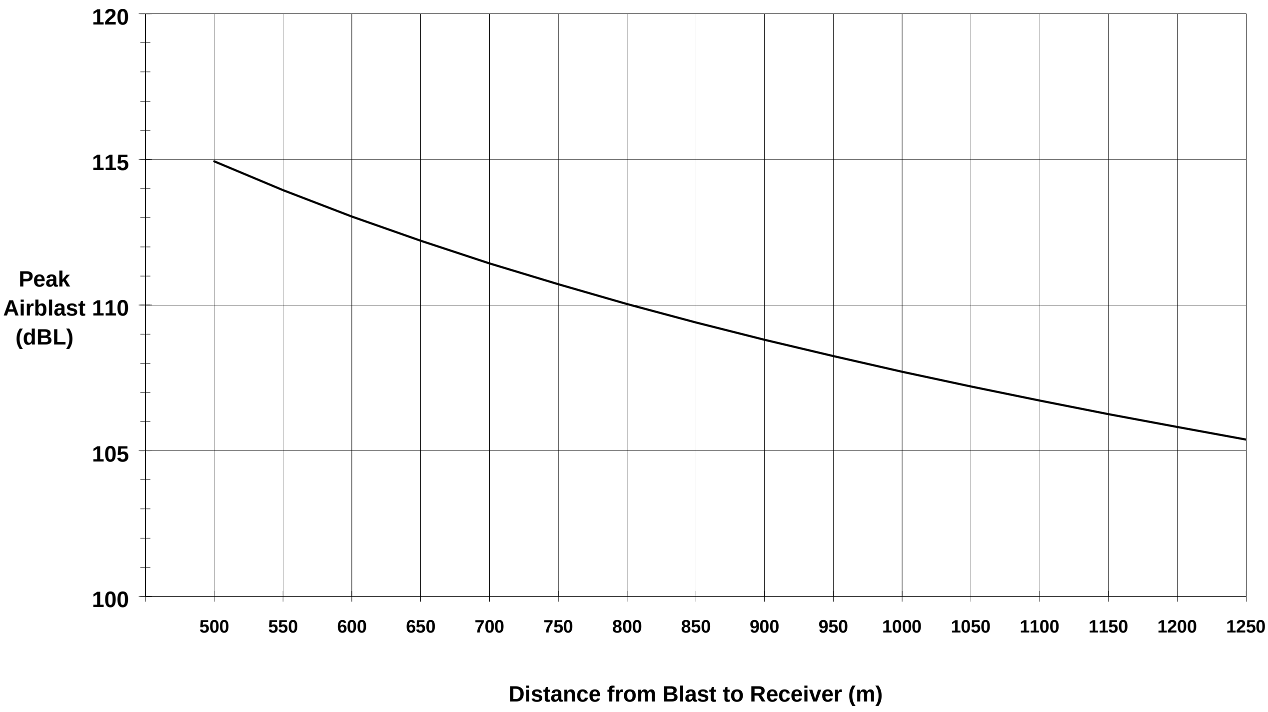


Figure 12.2.2 Relationship Between Airblast and Distance for an MIC of 87 kg



In view of the foregoing, the blast emissions prediction charts were used to determine the levels of ground vibration and airblast at the three nearest potentially affected residential dwellings from blasting at the near and far points of the limestone quarry. The results are presented in **Table 12.2.1**.

Table 12.2.1 Predicted Blast Emissions (MIC of 87 kg)

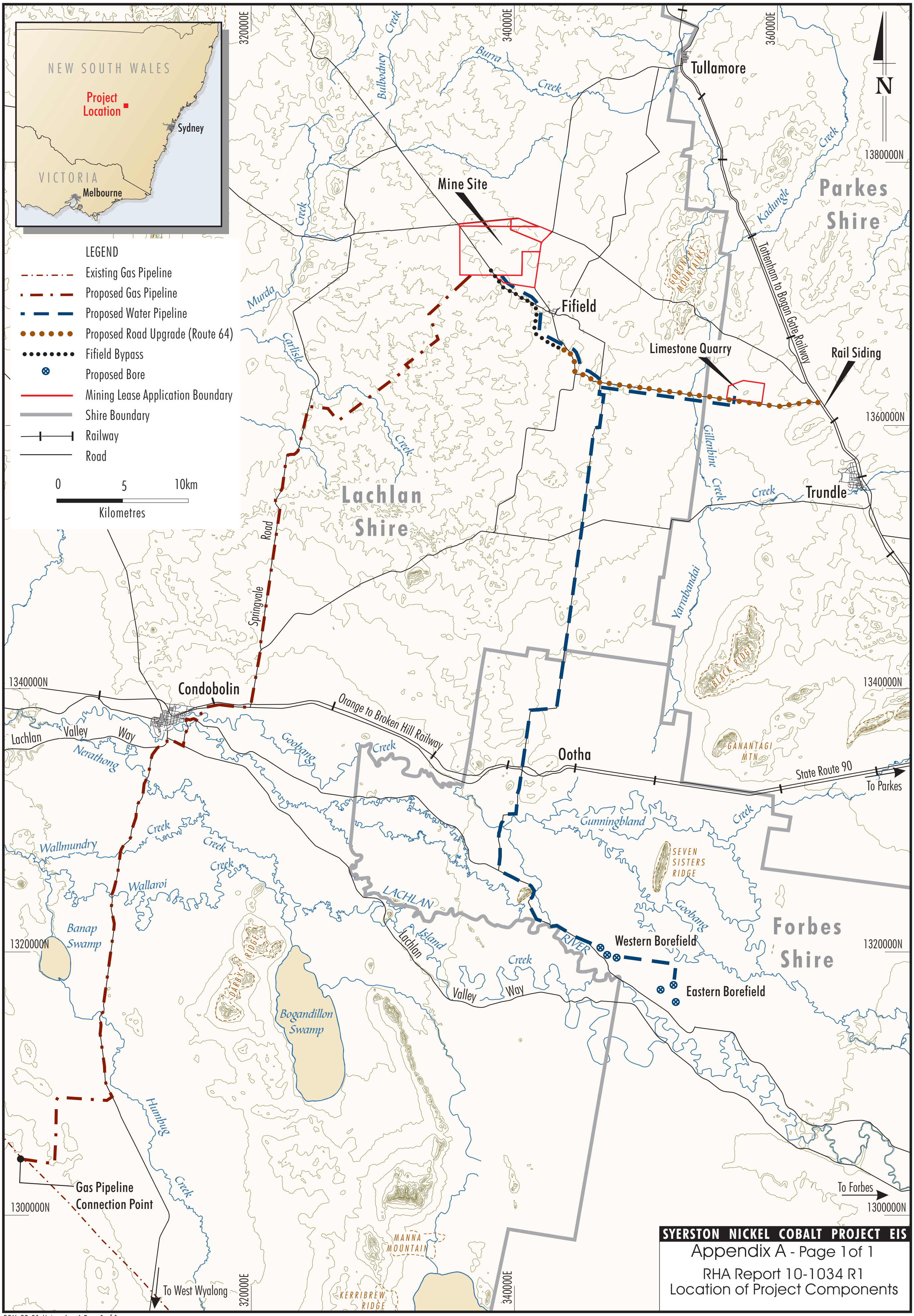
Location Number	Property Description	Distance from Nearpoint of Blasting	Predicted Blast Emission Level	
			PVS Ground Vibration Velocity	Peak Linear Airblast Level
BG5	Reas Falls	1450 m	0.2 mm/s	104 dB Linear
BG6	Danganmore	1650 m	0.1 mm/s	103 dB Linear
-	The Troffs	1150 m	0.2 mm/s	106 dB Linear

The following assessments are derived from the predicted levels of blast emissions given in **Table 12.2.1** and the recommended structural damage and human comfort criteria presented in **Section 7.6**.

- The predicted levels of ground vibration at all residential properties (maximum 0.2 mm/s) are below the structural damage criterion of 15 mm/s recommended for residential buildings in British Standard 7385:Part 2-1993.
- The predicted levels of ground vibration at all residential properties are also therefore below the human comfort criterion of 5 mm/s for daytime blasting (Monday to Saturday 0900 hours to 1700 hours)
- The predicted levels of peak airblast at all residential properties (maximum 106 dBLinear) are well below the US Bureau of Mines' structural damage limit of 132 dB Linear
- The predicted levels of peak airblast at all residential properties are also below the human comfort criterion of 115 dB Linear for daytime blasting (Monday to Saturday 0900 hours to 1700 hours) recommended by the ANZECC.

APPENDIX A

LOCATION OF PROJECT COMPONENTS



SYERSTON NICKEL COBALT PROJECT EIS

Appendix A - Page 1of 1

RHA Report 10-1034 R1

Location of Project Components

BRM-98-01-Noise_App A Page 1 of 1a

APPENDIX B1

DUAP EIS GUIDELINES

INSERT 2 PAGES

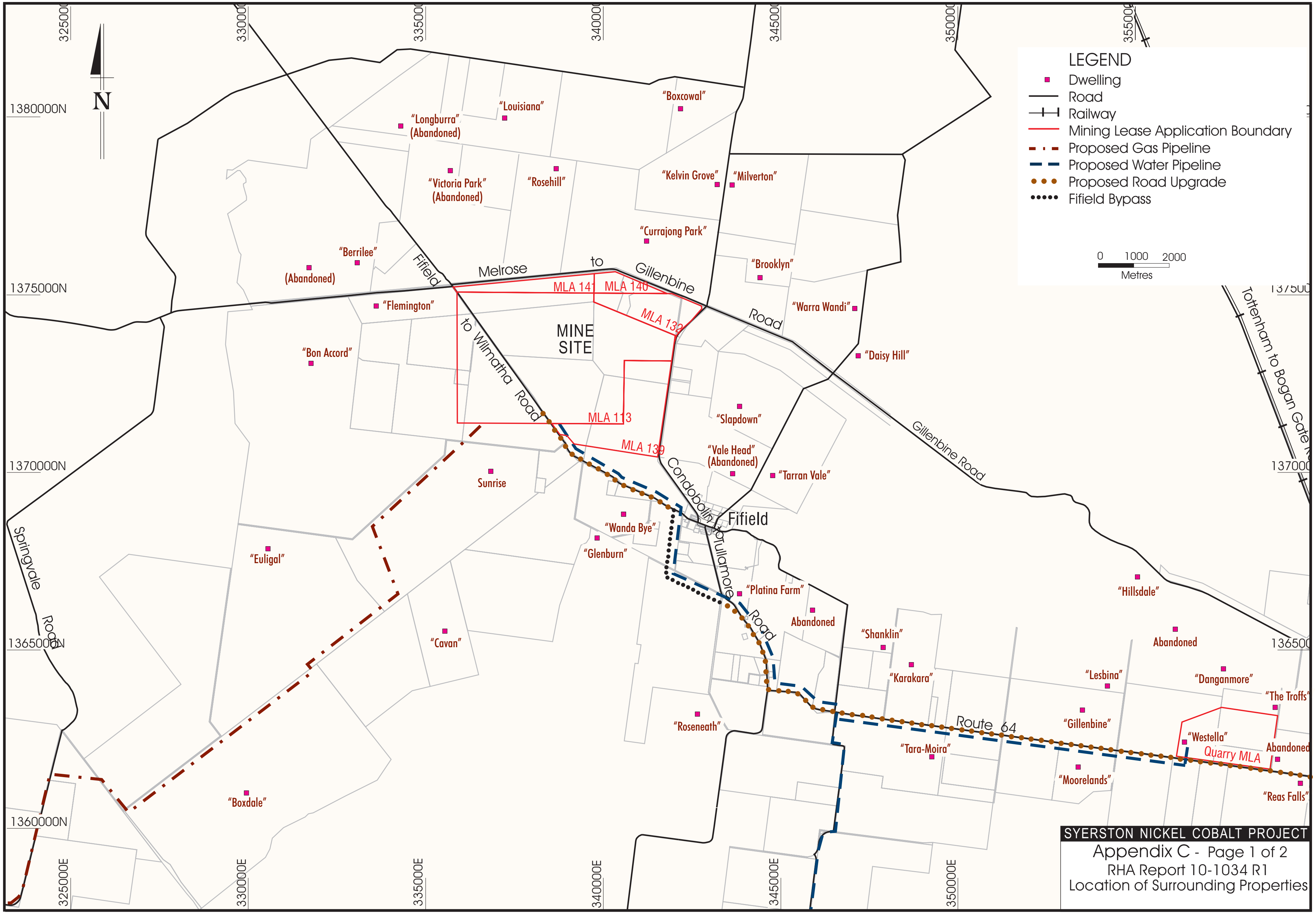
APPENDIX B2

EPA EIS REQUIREMENTS

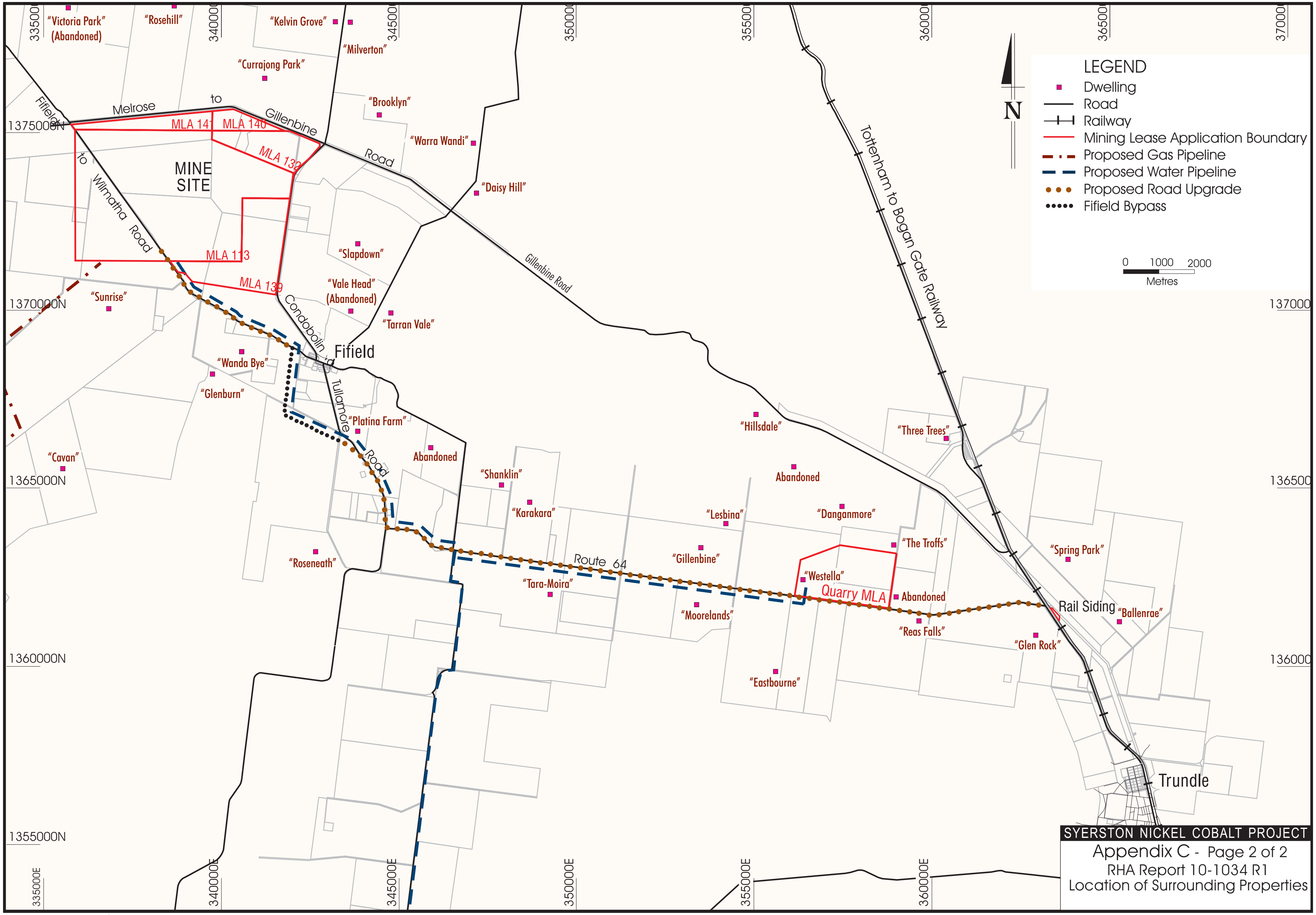
INSERT 5 PAGES

APPENDIX C

LOCATION OF SURROUNDING PROPERTIES



BRM-98-01-Noise_App C Page 1of 2a



SYERSTON NICKEL COBALT PROJECT

Appendix C - Page 2 of 2

RHA Report 10-1034 R1

Location of Surrounding Properties

BRM-98-01-Noise_App C Page 2of 2a

APPENDICES D to J

Background Noise Survey Results (103 Pages)

Not included in this copy
Available on request from Black Range Minerals
Telephone (02) 9233-1400

APPENDIX K

ENM NOISE MODEL INPUT DATA

ENM Sound Power Level Data and Coordinate System - ISG minus 333000mE, minus 1350000mN

SYERSTON NICKEL COBALT PROJECT - BRM

Source No.	Equipment Description	Maximum Octave Band SWL Centre Frequency (Hz) - dBL re 1pW									dBA	ISG (m)		ENM (m)		Ground	Elevation
		32	63	125	250	500	1k	2k	4k	8k	Overall SWL	East	North	East	North	RL(m)	RL(m)
	Mine Site - Year -1 (Construction)																
10	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	340000	1372000	7000	22000	289	1.8
20	140G Grader	111	122	117	116	108	110	106	102	92	114	339000	1372600	6000	22600	289	2.4
30	140G Grader	111	122	117	116	108	110	106	102	92	114	340100	1372100	7100	22100	286	2.4
40	50t water cart	97	103	105	106	102	100	95	90	77	105	337700	1374200	4700	24200	291	2.9
50	50t water cart	97	103	105	106	102	100	95	90	77	105	340000	1372100	7000	22100	286	2.9
60	966 Front End Loader	104	105	116	110	108	104	101	93	87	110	340100	1372000	7100	22000	286	2.6
70	966 Front End Loader	104	105	116	110	108	104	101	93	87	110	341000	1373000	8000	23000	285	2.6
80	966 Front End Loader	104	105	116	110	108	104	101	93	87	110	339100	1372900	6100	22900	293	2.6
90	Scraper	105	116	115	109	107	106	104	97	92	111	338800	1372750	5800	22750	295	3.0
100	Scraper	105	116	115	109	107	106	104	97	92	111	339900	1372000	6900	22000	288	3.0
110	Scraper	105	116	115	109	107	106	104	97	92	111	340500	1371500	7500	21500	287	3.0
120	Roller	99	104	109	112	107	105	102	96	90	107	340200	1372000	7200	22000	285	3.0
130	Roller	99	104	109	112	107	105	102	96	90	107	340000	1371500	7000	21500	290	3.0
140	Small Excavator	103	104	107	103	104	99	94	86	76	104	339100	1372600	6100	22600	289	3.0
150	Small Excavator	103	104	107	103	104	99	94	86	76	104	340200	1372200	7200	22200	286	3.0
160	Product Truck	108	117	108	113	109	105	102	96	91	111	338510	1371610	5510	21610	305	3.0
170	Product Truck	108	117	108	113	109	105	102	96	91	111	338590	1372865	5590	22865	294	3.0
180	Product Truck	108	117	108	113	109	105	102	96	91	111	340000	1371900	7000	21900	288	3.0
190	Product Truck	108	117	108	113	109	105	102	96	91	111	339200	1371500	6200	21500	308	3.0
200	Pressure relief valves (steam blows)	44	84	83	81	86	88	92	97	95	100	338900	1372750	5900	22750	294	1.5
210	20t truck	101	113	111	106	102	106	102	98	89	109	339370	1374120	6370	24120	289	2.5
220	20t truck	101	113	111	106	102	106	102	98	89	109	339180	1373730	6180	23730	290	2.5
230	20t truck	101	113	111	106	102	106	102	98	89	109	340270	1373220	7270	23220	296	2.5
240	20t truck	101	113	111	106	102	106	102	98	89	109	339760	1373060	6760	23060	300	2.5
250	20t truck	101	113	111	106	102	106	102	98	89	109	340240	1372780	7240	22780	291	2.5
260	20t truck	101	113	111	106	102	106	102	98	89	109	340240	1371450	7240	21450	290	2.5
270	20t truck	101	113	111	106	102	106	102	98	89	109	338940	1373370	5940	23370	293	2.5
280	20t truck	101	113	111	106	102	106	102	98	89	109	338390	1373370	5390	23370	289	2.5
290	20t truck	101	113	111	106	102	106	102	98	89	109	337650	1373570	4650	23570	290	2.5
300	20t truck	101	113	111	106	102	106	102	98	89	109	338784	1373960	5784	23960	289	2.5
310	20t truck	101	113	111	106	102	106	102	98	89	109	339450	1372000	6450	22000	291	2.5
320	20t truck	101	113	111	106	102	106	102	98	89	109	340160	1372430	7160	22430	287	2.5
	Mine Site - Year 5 (Typical Worst Case)																
10	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	340400	1374250	7400	24250	300	4.0
20	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	338000	1374750	5000	24750	308	4.0

Appendix K

30	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	338650	1373600	5650	23600	288	4.0
40	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	337600	1375000	4600	25000	320	3.3
50	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	337850	1374700	4850	24700	308	3.3
60	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	339250	1373000	6250	23000	289	3.3
70	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	337900	1373400	4900	23400	290	3.3
80	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	338700	1373800	5700	23800	288	3.3
90	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	338500	1373550	5500	23550	287	3.3
100	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	338900	1374650	5900	24650	288	3.3
110	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	339100	1373200	6100	23200	291	3.3
120	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	341700	1374400	8700	24400	315	3.3
130	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340800	1374750	7800	24750	282	3.3
140	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340600	1374100	7600	24100	300	3.3
150	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	339800	1373400	6800	23400	296	3.3
160	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	340450	1374050	7450	24050	300	1.8
170	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	338750	1373700	5750	23700	288	1.8
180	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	338000	1374850	5000	24850	308	1.8
190	140G Grader	111	122	117	116	108	110	106	102	92	114	339450	1372160	6450	22160	292	2.4
200	140G Grader	111	122	117	116	108	110	106	102	92	114	341700	1374700	8700	24700	315	2.4
210	140G Grader	111	122	117	116	108	110	106	102	92	114	338600	1373700	5600	23700	288	2.4
220	140G Grader	111	122	117	116	108	110	106	102	92	114	337450	1374500	4450	24500	320	2.4
230	50t water cart	97	103	105	106	102	100	95	90	77	105	340040	1372900	7040	22900	293	2.9
240	50t water cart	97	103	105	106	102	100	95	90	77	105	340300	1374750	7300	24750	300	2.9
250	50t water cart	97	103	105	106	102	100	95	90	77	105	341650	1374500	8650	24500	315	2.9
260	50t water cart	97	103	105	106	102	100	95	90	77	105	340350	1371240	7350	21240	290	2.9
270	992D Front End Loader	107	111	126	109	111	113	108	102	94	117	338667	1375100	5667	25100	320	3.0
280	966 Front End Loader	104	105	116	110	108	104	101	93	87	110	340710	1372900	7710	22900	287	2.6
290	Roller	99	104	109	112	107	105	102	96	90	107	339290	1371290	6290	21290	308	3.0
300	Small Excavator	103	104	107	103	104	99	94	86	76	104	340900	1371500	7900	21500	285	3.0
310	Product Truck	108	117	108	113	109	105	102	96	91	111	338510	1371610	5510	21610	305	3.0
320	Product Truck	108	117	108	113	109	105	102	96	91	111	338590	1372865	5590	22865	294	3.0
330	Product Truck	108	117	108	113	109	105	102	96	91	111	338745	1372865	5745	22865	294	3.0
340	Product Truck	108	117	108	113	109	105	102	96	91	111	339529	1373570	6529	23570	290	3.0
350	Pressure relief valves (steam blows)	44	84	83	81	86	88	92	97	95	100	338900	1372750	5900	22750	294	1.5
360	MMD sizer	107	99	94	100	106	110	114	111	107	118	339000	1372800	6000	22800	294	3.0
370	Limestone Ball Mill / Secondary crusher - (rubber line	118	113	114	110	111	109	106	99	91	114	339100	1372750	6100	22750	294	6.0
380	Electric pumps	96	103	106	96	97	100	96	95	88	104	339000	1372600	6000	22600	294	1.5
390	Slurry Ball Mill - (rubber lined)	118	113	114	110	111	109	106	99	91	114	339050	1372650	6050	22650	294	6.0

Mine Site - Year 20 (Typical Worst Case)

10	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	340750	1373900	7750	23900	300	4.0
20	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	340500	1374400	7500	24400	300	4.0
30	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	338300	1373750	5300	23750	308	4.0
40	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	337250	1374800	4250	24800	330	3.3
50	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	337600	1373800	4600	23800	294	3.3

60	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	338200	1373800	5200	23800	308	3.3
70	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	338900	1373650	5900	23650	291	3.3
80	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	339400	1372750	6400	22750	289	3.3
90	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340000	1373200	7000	23200	296	3.3
100	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	341600	1374000	8600	24000	290	3.3
110	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340600	1373500	7600	23500	300	3.3
120	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	342300	1374650	9300	24650	305	3.3
130	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340400	1374400	7400	24400	300	3.3
140	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340600	1373800	7600	23800	300	3.3
150	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	340900	1373650	7900	23650	289	3.3
160	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	338200	1373800	5200	23800	308	1.8
170	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	336900	1374800	3900	24800	330	1.8
180	CAT D10 Dozer with universal blade	114	115	114	101	105	104	102	94	88	109	339250	1373000	6250	23000	289	1.8
190	140G Grader	111	122	117	116	108	110	106	102	92	114	340310	1371180	7310	21180	292	2.4
200	140G Grader	111	122	117	116	108	110	106	102	92	114	342200	1374600	9200	24600	305	2.4
210	140G Grader	111	122	117	116	108	110	106	102	92	114	340500	1374750	7500	24750	300	2.4
220	140G Grader	111	122	117	116	108	110	106	102	92	114	337100	1374800	4100	24800	330	2.4
230	50t water cart	97	103	105	106	102	100	95	90	77	105	341020	1372080	8020	22080	281	2.9
240	50t water cart	97	103	105	106	102	100	95	90	77	105	340450	1373200	7450	23200	291	2.9
250	50t water cart	97	103	105	106	102	100	95	90	77	105	338200	1373250	5200	23250	292	2.9
260	50t water cart	97	103	105	106	102	100	95	90	77	105	340350	1371240	7350	21240	290	2.9
270	992D Front End Loader	107	111	126	109	111	113	108	102	94	117	338667	1375100	5667	25100	330	3.0
280	966 Front End Loader	104	105	116	110	108	104	101	93	87	110	341060	1372670	8060	22670	286	2.6
290	Roller	99	104	109	112	107	105	102	96	90	107	339730	1370900	6730	20900	299	3.0
300	Small Excavator	103	104	107	103	104	99	94	86	76	104	340900	1371500	7900	21500	287	3.0
310	Product Truck	108	117	108	113	109	105	102	96	91	111	338510	1371610	5510	21610	305	3.0
320	Product Truck	108	117	108	113	109	105	102	96	91	111	338590	1372865	5590	22865	294	3.0
330	Product Truck	108	117	108	113	109	105	102	96	91	111	338745	1372865	5745	22865	294	3.0
340	Product Truck	108	117	108	113	109	105	102	96	91	111	339529	1373570	6529	23570	290	3.0
350	Pressure relief valves (steam blows)	44	84	83	81	86	88	92	97	95	100	338900	1372750	5900	22750	294	1.5
360	MMD sizer	107	99	94	100	106	110	114	111	107	118	339000	1372800	6000	22800	294	3.0
370	Limestone Ball Mill / Secondary crusher - (rubber line	118	113	114	110	111	109	106	99	91	114	339100	1372750	6100	22750	294	6.0
380	Electric pumps	96	103	106	96	97	100	96	95	88	104	339000	1372600	6000	22600	294	1.5
390	Slurry Ball Mill - (rubber lined)	118	113	114	110	111	109	106	99	91	114	339050	1372650	6050	22650	294	6.0

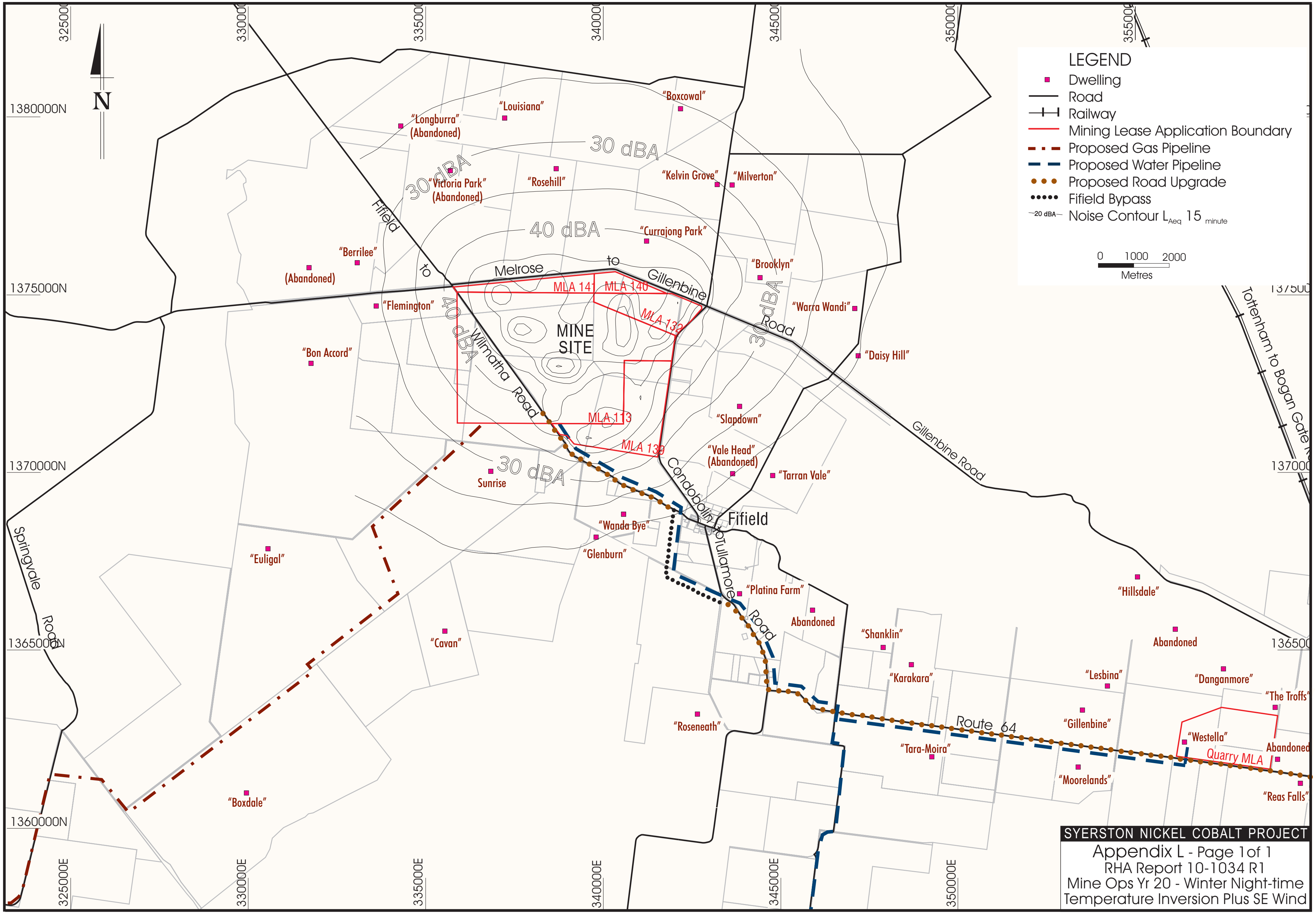
Quarry Site - Year 5 (Typical Worst Case)

10	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	356700	1362500	23700	12500	247	4.0
20	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	356700	1362650	23700	12650	247	4.0
30	PC1000 Excavator	117	122	120	116	113	110	109	101	94	116	356750	1362650	23750	12650	247	4.0
40	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	357800	1362300	24800	12300	253	3.3
50	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356750	1362600	23750	12600	320	3.3
60	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356900	1362700	23900	12700	248	3.3
70	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	357350	1362650	24350	12650	251	3.3
80	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	357850	1362350	24850	12350	253	3.3

90	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	357850	1362300	24850	12300	300	3.3
100	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	357800	1362300	24800	12300	253	3.3
110	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356700	1362400	23700	12400	247	3.3
120	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356300	1362450	23300	12450	247	3.3
130	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356300	1362400	23300	12400	247	3.3
140	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356400	1362550	23400	12550	247	3.3
150	CAT 777b Haul Truck (Travelling)	118	123	121	117	114	111	109	102	95	117	356400	1362500	23400	12500	247	3.3
160	CAT D8 Dozer with universal blade	69	86	95	99	107	103	102	100	92	110	358000	1362300	25000	12300	251	1.8
170	CAT D8 Dozer with universal blade	69	86	95	99	107	103	102	100	92	110	358100	1362300	25100	12300	251	1.8
180	CAT D8 Dozer with universal blade	69	86	95	99	107	103	102	100	92	110	358000	1362250	25000	12250	251	1.8
190	140G Grader	111	122	117	116	108	110	106	102	92	114	358100	1362250	25100	12250	251	2.4
200	140G Grader	111	122	117	116	108	110	106	102	92	114	356400	1362600	23400	12600	247	2.4
210	140G Grader	111	122	117	116	108	110	106	102	92	114	356000	1362750	23000	12750	246	2.4
220	Product Truck	108	117	108	113	109	105	102	96	91	111	356355	1361960	23355	11960	247	3.0
230	Product Truck	108	117	108	113	109	105	102	96	91	111	356380	1362300	23380	12300	247	3.0
240	Product Truck	108	117	108	113	109	105	102	96	91	111	356450	1362665	23450	12665	247	3.0
250	Product Truck	108	117	108	113	109	105	102	96	91	111	356885	1362720	23885	12720	249	3.0
260	Product Truck	108	117	108	113	109	105	102	96	91	111	356855	1362515	23855	12515	248	3.0
270	Powergrid scalping plant (vibrating screen)	78	87	98	102	107	109	107	100	90	113	356750	1362350	23750	12350	248	3.0
280	Secondary crusher (impact crusher)	107	99	94	100	106	110	114	111	107	118	356350	1362650	23350	12650	248	3.0

APPENDIX L

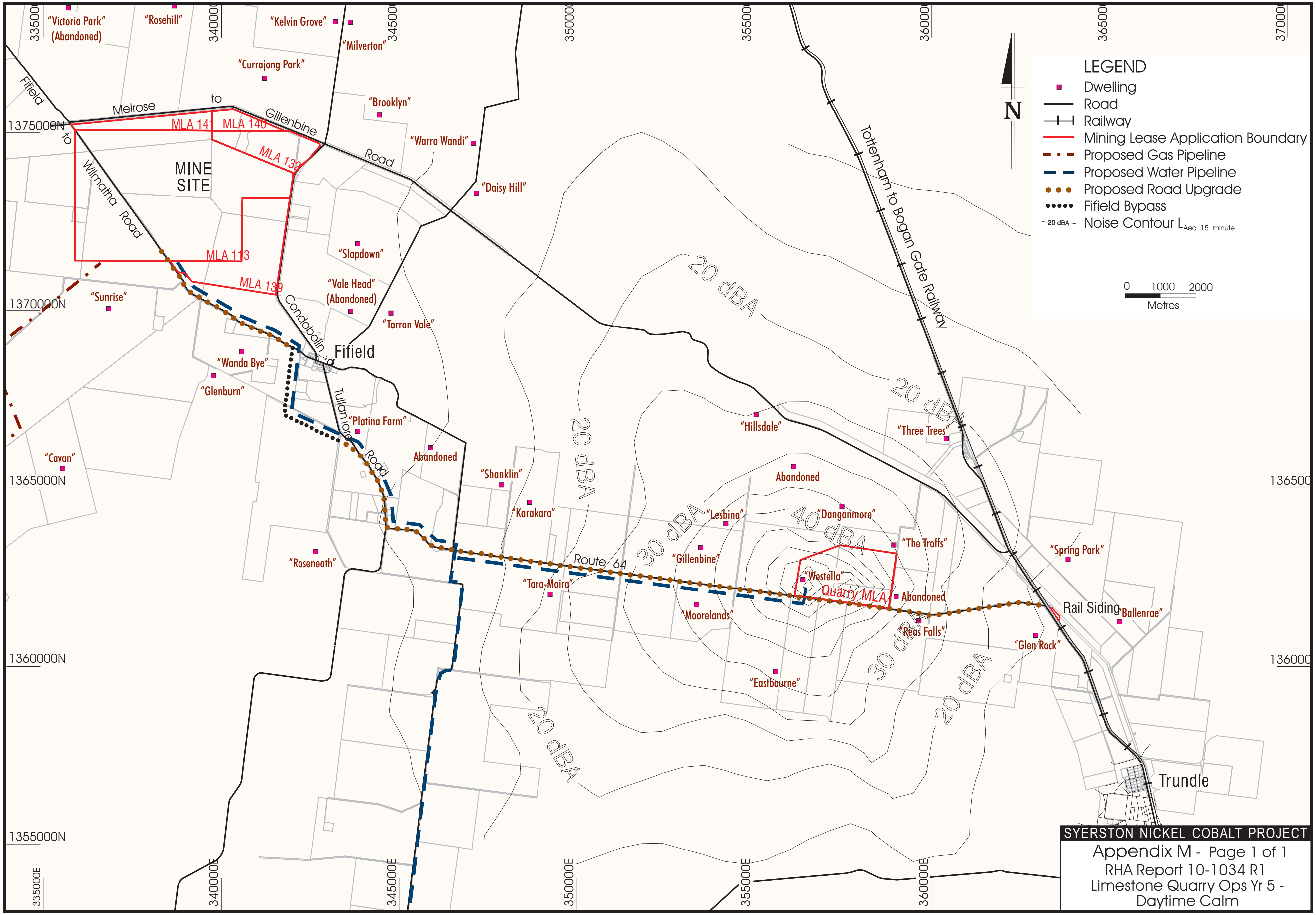
MINE OPERATION – YEAR 20
WINTER NIGHT-TIME TEMPERATURE INVERSION



BRM-98-01-Noise_App L Page 1of 1a

APPENDIX M

QUARRY OPERATION – YEAR 5
DAYTIME CALM



SYERSTON NICKEL COBALT PROJECT
Appendix M - Page 1 of 1
RHA Report 10-1034 R1
Limestone Quarry Ops Yr 5 -
Daytime Calm
LEGEND
Dwelling
Road
Railway
Mining Lease Application Boundary
Proposed Gas Pipeline
Proposed Water Pipeline
Proposed Road Upgrade
Fifield Bypass
Noise Contour $L_{Aeq\ 15\ minute}$
20 dBA
0 1000 2000
Metres
N
MINE SITE
MLA 141
MLA 140
MLA 132
MLA 113
MLA 139
Quarry MLA
Melrose to Gillenbine Road
Fifield to Wilmatha Road
Condobolin Rd
Tullamore Road
Route 64
Tottenham to Bogan Gate Railway
Fifield
Trundle
Rail Siding
20 dBA
30 dBA
40 dBA
"Victoria Park" (Abandoned)
"Rosehill"
"Kelvin Grove"
"Milverton"
"Currajong Park"
"Brooklyn"
"Warra Wandi"
"Daisy Hill"
"Slapdown"
"Vale Head" (Abandoned)
"Tarran Vale"
"Sunrise"
"Wanda Bye"
"Glenburn"
"Platina Farm"
Abandoned
"Cavan"
"Shanklin"
"Karakara"
"Roseneath"
"Tara-Moira"
"Hillsdale"
"Three Trees"
Abandoned
"Lesbina"
"Danganmore"
"Gillenbine"
"The Troffs"
"Westella"
Abandoned
"Moorelands"
"Spring Park"
"Ballenrae"
"Reas Falls"
"Glen Rock"
"Eastbourne"
1375000N
1370000N
1365000N
1360000N
1355000N
335000E
340000E
345000E
350000E
355000E
360000E
365000E
370000E

The report of the archaeological investigation of the Mine Site and sites of Associated Ancillary Infrastructure for the

SYERSTON NICKEL-COBALT PROJECT

Condobolin/Fifield Area, Western NSW

John Appleton
ARCHAEOLOGICAL SURVEYS & REPORTS PTY LTD

MAY 2000

APPENDIX L-B.DOC

for

Resource Strategies Pty Ltd

on behalf of

BLACK RANGE MINERALS LTD

ASR

**This report has been compiled in ‘plain English’,
but presented in a format suitable for developing policies
for the management of the cultural resources,
and as a basis for scientific reference
in future research studies.**

Proponents

Black Range Minerals Ltd
Level 10
17 Castlereagh Street
SYDNEY NSW 2000

Copies of this report to

Mr A. Hutchins – Archaeologist
NPWS Western Zone
PO Box 1007
Dubbo 2030
02 6883 2262

The Chairperson
Condobolin Aboriginal Land Council
Condobolin 2877
02 6895 4194

Mr R. Williams, Sites Curator, Wiradjuri R.A.L.C.
153 Docker Street
PO Box 1013
Wagga Wagga 2650
02 6921 6544

All inquiries in regard to this report should be addressed to

John Appleton
Archaeological Surveys & Reports Pty Ltd
10 Roslyn Avenue
Armidale 2350
Tel./Fax. 02 6772 6512   Mob. 0428 651 789
Email. japples@northnet.com.au

EXECUTIVE SUMMARY

This investigation was performed for Black Range Minerals Ltd, who are preparing an Environmental Impact Statement for the Syerston Nickel Cobalt Project in the Fifield area, in Central West, New South Wales.

My brief was to investigate a number of proposed sites and routes that will be impacted upon by the proposed project, to identify any Aboriginal sites or places of significance that have the potential to impose constraints upon the project. The report of the results of the investigation was to include a full description of any sites identified, and options and recommendations for the management of the sites. Where it was possible the objective was to minimise or mitigate the impact to sites by redirecting routes to avoid them, but where this was not practical, the report was to include a description of the mitigation measures to be implemented to minimise impacts to the site or the procedure to obtain an appropriate permit for the management of the site.

The investigations were to be performed with the assistance of a representative of the appropriate Local Aboriginal Land Council, and the survey and report were to meet the requirements of NSW National Parks and Wildlife Standards and Guidelines. Copies of the report of the results of the investigation were to be distributed to the appropriate authorities, and Site Recording Forms for any sites recorded during the investigation, lodged with NPWS.

Fourteen sites were recorded during the investigation, comprising of six isolated artefacts, six scarred trees, an open scatter, and an extensive camp site. In addition, three carved trees listed on the Aboriginal Sites Register were investigated to identify the potential for the proposed works to impact upon the site locations.

Of the seventeen sites only one isolated artefact (‘Syerston 1’) will be impacted upon by the proposed mine development, and will require a Consent to Destroy from NPWS. An artefact scatter (‘Syerston 2’) might be indirectly impacted upon by the mine development, and if it is not practical to protect the site by fencing, this also will require a Consent to Destroy. A second isolated artefact (‘Iso.F1’) will be impacted upon by the proposed Gas Pipeline if earthworks take place within 10m of the fenceline in the vicinity of the site. If this area cannot be avoided then a Consent to Destroy will be necessary. The proposed Gas Pipeline route crosses through the extensive camp site (‘Humbug CS1’), but mitigation of the impact can be achieved by utilising the disturbed road verges adjacent to the bridge and along the approaches.

The recommendation is that an application for a Consent to Destroy should be lodged with NSW NPWS for the site, ‘Syerston 1’, if it cannot be avoided. In addition, the proponents should consider the practicability of erecting a fence to protect ‘Syerston 2’, and routing the Gas Pipeline to avoid ‘Iso.F1’. In the event that either of the sites cannot be avoided applications for Consents to Destroy must be lodged with NPWS prior to commencement of work at the relevant sites.

In regard to the extensive camp site, 'Humbug CS1', it is recommended that the proposed Gas Pipeline route should cross Humbug Creek within a strip delimited by a line 10m to the west of the bridge and by a line drawn 5m parallel to, and to the east of the side track, but ideally, should cross the creek between the bridge and the side track. The pipeline should be laid within the existing 'graded' profile of the road for at least 75m from the bridge on the south side, to at least 50m to the north side of the bridge. Highly visible temporary flagging should be erected along the edge of the graded strip to prevent vehicular and plant impact to the unaltered surfaces during the earthworks. Plant and vehicles should not be allowed outside the flagging. It is further recommended that a representative of the Condobolin LALC or Wiradjuri RALC should be in attendance to monitor any earthworks for the pipeline within 75m south of the bridge to 50m north of the bridge. Any artefacts disturbed or impacted upon by the earthworks should be salvaged and subject to analysis.

Three scarred trees were recorded in the road easement to the southeast of Condobolin. While the proposed gas pipeline will not impact upon the trees it is recommended that highly visible temporary flagging should be erected around each of the trees, for a minimum radius of 10 metres, during any earthworks in the area.

In addition to the recommendations above, the proponents are advised that under the obligations and provisions imposed by the National Parks and Wildlife Act 1974 they are obliged to comply with the following provision:
All earthmoving contractors and operators should be instructed that in the event of any bone or stone artefacts, or discrete distributions of shell, being unearthed during earthmoving, work should cease immediately in the area of the find, and the Condobolin Local Aboriginal Land Council, and officers of the National Parks and Wildlife Service, informed of the discovery. Work should not recommence in the area of the find, until those officials have inspected the material and permission has been given to proceed. Those failing to report a discovery and those responsible for the damage or destruction occasioned by unauthorised removal or alteration to a site or to archaeological material may be prosecuted under the National Parks and Wildlife Act 1974, as amended.

TABLE OF CONTENTS

FIGURES

1. INTRODUCTION

This investigation was performed for Black Range Minerals Ltd, who are preparing an Environmental Impact Statement for the Syerston Nickel Cobalt Project in the Fifield area, in Central West, New South Wales.

My brief was to investigate a number of proposed sites and routes that will be impacted upon by the proposed project, to identify any Aboriginal sites or places of significance that have the potential to impose constraints upon the project. The report of the results of the investigation was to include a full description of any sites identified, and options and recommendations for the management of the sites. Where it was possible the objective was to minimise or mitigate the impact to sites by redirecting routes to avoid them, but where this was not practical, the report was to include a description of the mitigation measures to be implemented to minimise impacts to the site or the procedure to obtain an appropriate permit for the management of the site.

The investigations were to be performed with the assistance of a representative of the appropriate Local Aboriginal Land Council, and the survey and report were to meet the requirements of NSW National Parks and Wildlife Standards and Guidelines.

A report of the results of the investigation was to be written and distributed to the appropriate authorities, and Site Recording Forms for any sites recorded during the investigation, lodged with NPWS.

This report references and builds upon initial survey work conducted by this consultant at the Project Mine Site in 1997.

As referred to above the present investigation was of a number of areas, each to be impacted upon in different ways. The survey areas extend for considerable distances from the mine area, and for this reason the report has been compiled in sections. Each section consisting of an area or route of a clearly defined proposed function. The sections are as follow:

1. The Mine Site surveyed in 1997
2. The extension area to the mine site
3. The proposed Gas Pipeline
4. The proposed Fifield Bypass
5. The proposed Water Pipeline

6 The proposed Water Borefields and Pipeline Link
7 The proposed Limestone Quarry
8 The proposed Transport Route (Route 64)
9 The proposed Rail Siding and access road.

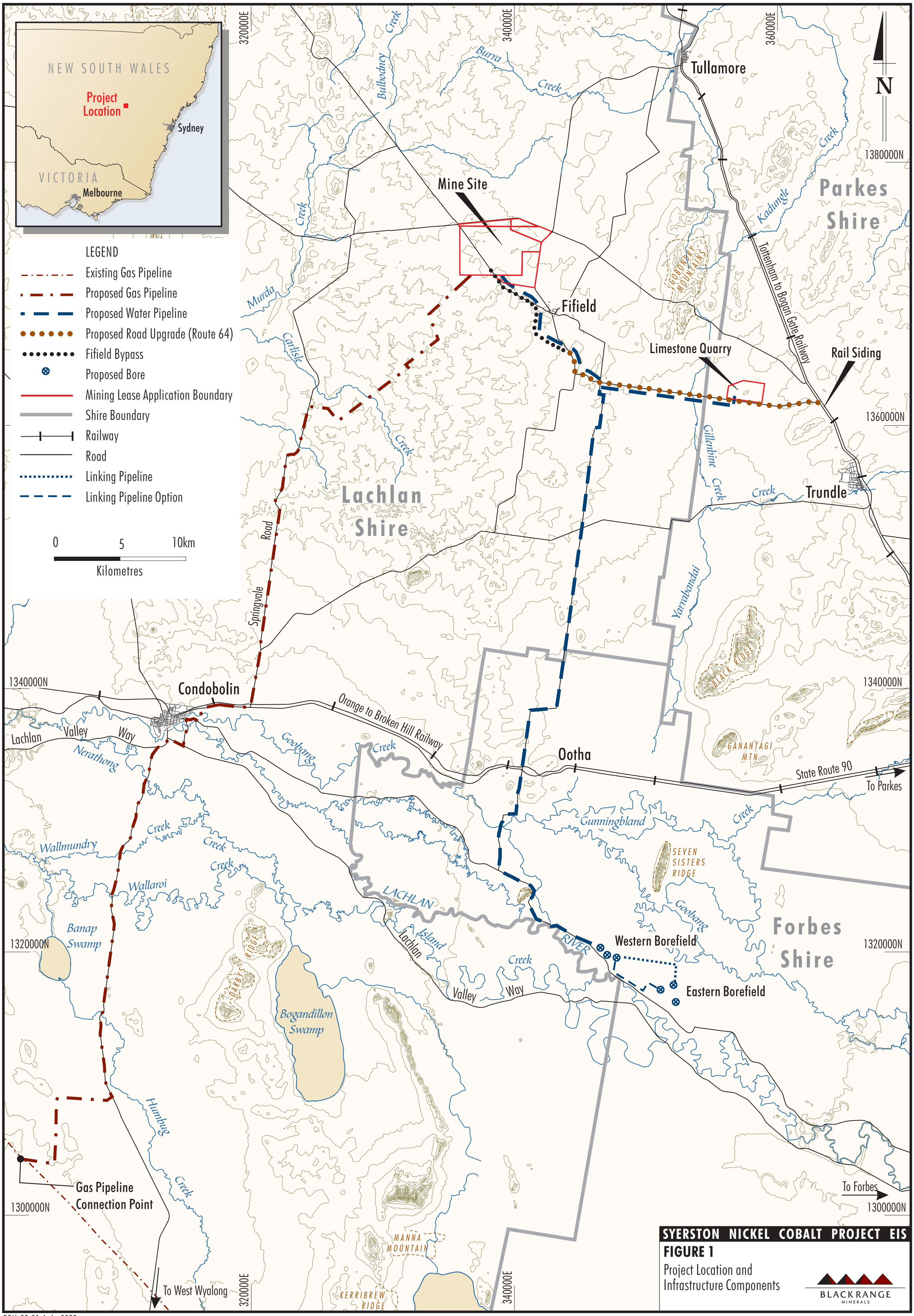
A map of the region, which includes all of the above sections, is shown in Figure 1.

2. ABORIGINAL CONSULTATION

Prior to the investigation I made numerous attempts to contact the Condobolin Local Aboriginal Land Council (LALC), but was unsuccessful. As the Condobolin area is part of the traditional region of the Wiradjuri people I then contacted Mr Roland Williams, Sites Curator, Wiradjuri Regional Aboriginal Land Council, at Wagga Wagga. Mr Williams is frequently required to represent different LALCs in the Wiradjuri region in archaeological investigations, and has performed numerous surveys throughout the region over the last fifteen years.

Mr Williams agreed to assist me in this investigation, which we performed in mid-December and mid April.

Coincidently, when Mr Williams and I met in Condobolin on the first morning of the survey, we inadvertently met the previous Chairperson of the Condobolin LALC, who informed us that the LALC was not presently operational. She also informed me that she was very pleased that Mr Williams was performing the survey on behalf of the Condobolin LALC.



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 1

Project Location and Infrastructure Components

BRM-98-01-Arch_002B

3. PAST AND FUTURE IMPACTS

Much of the total area to be surveyed has been subject to alteration and disturbance through land use practices. For this reason many of the potential impacts will occur within disturbed contexts, however the intention is to mitigate and minimise fresh impacts upon the existing environment.

Previous impacts to the proposed mine, limestone quarry, and rail siding areas are varied. The northeastern corner of the proposed mine area has been significantly altered by historic open cut magnesite mines, mullock heaps, and service roads. In the remaining northern half and central section of the mine area vast areas were cleared in the early 1970's, and have been under cereal crops since then. Impacts to the southern and southeastern sections are less apparent, but clearly show that vast areas have been cleared in pasture improvement. In the southwestern corner there are pits and mullock heaps that probably date from the brief early phase of small-scale gold mining activity in the 1890's and later (Cook & Garvey, 1999; 97-9).

The limestone deposit area in the proposed limestone quarry area is perhaps the least altered of all the survey areas as little grows on the limestone hill that is the focus of the proposed quarry. It is possible that some tree-clearing has taken place in pasture improvement, and surface boulders have been collected into heaps at the edges of the paddocks, but generally the rocky nature of the ground would have prevented any significant disturbance for pasture improvement.

The site of the proposed rail siding is presently concealed beneath a dense, tall grass cover, with a few mature trees along the eastern boundary. However, while there is no clear evidence that the area has been cleared of trees, the presence of so many mature trees in adjacent areas suggests that this too was once open woodland.

The existing road easements generally are in the order of three times wider than the road and shoulder area, but at least 50% of the flanking strips are generally disturbed by drains, or banks, or by tree removal, or by in-ground services, mostly Telecom lines.

Disturbance from the proposed development in the areas set aside for the mine, the limestone quarry, and the rail siding, will be significant. The mine and quarry areas will be significantly altered either by the extraction of rock and the stockpiles of overburden, or by peripheral plant, service areas, dams, and roads. In the rail siding area the earthworks and infrastructure will impact on a large percentage of the rail siding project area.

The proposed gas and water pipelines will be laid within the road reserves for the majority of their length (with the exception of the northern section of the gas pipeline), avoiding mature trees where possible, but occasionally requiring the clearing of scrub and ground cover. At its northern end the proposed gas pipeline crosses through pastoral land, but to minimise the impact the line will follow a well-worn vehicle track, fence lines and vegetation clearings, thus minimising the need to remove trees or to disturb land management practices and drainage lines.

The route of the proposed Fifield Bypass will necessitate clearing, however, as the route is over cleared paddocks only minimal clearing will be necessary at the midway bend in the route, and at the eastern end of the route where the bypass links up with the Fifield to Condobolin road.

The access road to the rail siding will require the upgrading of the existing dirt road.

Disturbance to the environment in the areas of the western and eastern borefields will be minimal as both are cleared areas. Each of the two borefields will contain 3 or 4 bores, each of which will have a disturbance area of approximately 10 m x 10 m. A pipeline will link the two borefields via one of two route options. The pipeline will be below ground and run along fence lines. A dirt road will follow the pipeline, and access to each borefield will be via existing tracks or on tracks to be formed along existing fence lines.

From an archaeological perspective any sites within either the mine, limestone quarry, borefield, or rail siding area, or along pipeline routes, or borefield pipeline link, will be destroyed by the proposed activities, unless they are identified, and if necessary, protected, or alternatively, appropriate management strategies to destroy sites, relocate artefactual material, or to mitigate impacts are identified.

In a project such as this which extends over such a large area, and in a variety of environments, and in which impacts range from minimal disturbance to shallow surface deposits from the grading of access tracks, to deeper excavations for trenching for the laying of pipelines, through to water bores and open-cut mining, there is a potential for artefactual material to be disturbed at any depth. Likewise, there is a potential for aboveground sites such as scarred, or carved trees, or stone arrangements to be disturbed or damaged during land clearing.

4. THE CULTURAL CONTEXT

There are few references to the first contact between the non-indigenous settlers and the Indigenous occupants of the region, other than to a reference to the poisoning of waterholes. In fact, the two publications presently available relating the history of Condobolin area imply that the first settlers arrived in an unoccupied land in the early 1890's.

The Condobolin/Fifield area was part of Wiradjuri (sometimes 'Warradgerry') country when the first settlers took up land along the Lachlan in the 1830's, but unfortunately none of the settlers bothered to record either the number of Aborigines, or where their main camp sites were. Craze and Marriott (1988; 4) suggest that the Wiradjuri numbered between 1,000 and 1,500, but there is no way of knowing how close the estimate is, or what the population was before 1788 before the first European diseases began their dreadful depletion of Aborigines. Within two to three years of non-indigenous settlement of the Lachlan area Aboriginal numbers were further depleted by smallpox, and as many as one in three to one in six died.

The Wiradjuri occupied a significantly large area extending from the Murray River in the south to between the Lachlan and Macquarie Rivers in the northwest, and east as far as the highlands near Mudgee and Bathurst.

By 1853 the Wiradjuri population had contracted from a widely scattered population of numerous small tribes constantly on the move, to a few concentrated groups camping near major watercourses. The Land Commissioner for the Lachlan wrote that there were three distinct tribes. The largest group of 130 occupied the north bank of the Murrumbidgee, the second group of about 100 occupied the south bank of the Lachlan, and the third group of about 60 occupied the Burrowa River area (Craze & Marriott, 1988; 4).

5. MODELS FOR SITE LOCATION

In order to design an investigative strategy it is firstly necessary to develop a predictive model for site location. This is not to determine where the investigation should be conducted, but to establish a theoretical model for the distribution of archaeological material against which the effectiveness and subsequent analysis of the survey results can be tested, compared and reasoned. The basis upon which the predictive model is derived must however be one of consideration of which archaeological material might realistically be expected to not only be present, but also detectable.

The first objective of any archaeological investigation must be to observe and record sufficient of the archaeological record that is present to be able to propose that it is representative of the record as a whole. The investigative strategy is therefore directed and designed to detect that which is representative of the record in the particular study area, and naturally, as different study areas will comprise variations in environment, vegetation, topography, etc., so the investigative strategy must be designed to best suit the circumstances. The objective must be to detect material evidence, and so it is necessary to consider the extent to which artefactual material may be present, and the degree to which it is visible or might be discovered.

There are several factors, which are likely to affect, firstly, where Aboriginal people are most likely to have been, secondly, where they have left evidence of their activities, and thirdly, the degree to which that evidence is observable in the present record.

Places are visited by people mainly to obtain resources and in general places that are richest in resources are more likely to have been visited by people than those places with fewer resources. Important resources are permanent water, ephemeral water, food resources, stone raw material sources, shelter (from sun, wind, and rain), and perhaps suitable surfaces for rock art, and proximity to mythological natural features. These resources may affect the suitability of a location for particular ceremonial activities but cultural boundaries also influence the choice of ceremonial grounds. Alternatively, sites frequently occur along preferred access routes and particularly where that route coincides with a watercourse, although the attraction of such an environment is also a cause for a discontinuous or significantly disturbed archaeological record scattered and pounded by stock and vehicles in the post-European contact phase.

Frequency of visits and use of particular locations is also determined by the 'accessibility' or freedom from environmental constraints in the area. For example, whether there are alternative, preferred or easier ways to travel around or over natural barriers, be they geological, geographical, cultural, or imposed by fauna or flora, or whether they are only seasonally accessible, such as mounds on flood terraces, or the availability of water during periods of drought, or whether or not floods, fire or snow hinder access.

Few past Aboriginal activities are represented by surviving material evidence. This in part is because many activities did not leave material evidence (eg. Tools were reused), but it is also because very little cultural material survives. An exception to this is shellfish, which are very durable.

The survival of material that is durable is also affected by recent European land use. Cultivation has destroyed many archaeological sites. However, cultivation can also help expose sites that might otherwise be covered. This brings us to the other important point about site distribution, which is that to a great extent site distribution recorded by archaeologists reflects the distribution of places where the ground surface is sufficiently eroded to expose artefactual material.

By far the majority of recorded sites are stone artefact scatters or isolated stone artefacts, and in the vast majority of sites they are found in one or more of the following contexts:

i) On or adjacent to deposits containing quartz, quartzite, jasper, silcrete, chert, chalcedony, metamorphosed greywacke, and other indurated or siliceous sedimentary rocks, or redeposited fine-grained volcanics, or

ii) On river banks or adjacent to river banks where the watercourse contains river pebbles of quartz, quartzite, jasper, silcrete, chert, fine-grained volcanics, basalts, etc., and particularly at the junctions of watercourses, or

iii) On ridges and spurs overlooking watercourses or on high vantage points affording uninterrupted views of swamps, water holes, saddles, passes, and any other likely access path into the observer's area, or

iv) In the vicinity of outcrops of suitable raw material such as basalt, silcrete, chert, or other highly silicified sedimentary rock.

Other site types do occur and perhaps because of their lower and less predictable profile, are present in far greater numbers than we are aware of. People die but there are few recorded burials. One reason may be that in many instances the soils are too acid for the preservation of bone, but a far more likely reason is simply that burial frequently entailed subsurface internment, and a surface survey will only discover a burial where there has been erosion of significant disturbance to the surface deposits. As a consequence many burials are only discovered when exposed by erosion of a sand body or river terrace.

Other site types such as carved trees, scarred trees, stone arrangements, Bora rings, etc., may once have been present, but are unlikely to have survived in easily accessible country from the attention of non-indigenous people. Thus, much of what might have existed is now lost or destroyed, and the archaeological record biased by the post-contact utilisation of resources, and by the selective exploitation and preservation of particular environments.

Other factors which affect the distribution of sites recorded during an investigation include the time of year at which the fieldwork is performed (how dense the ground cover is) and the conditions under which the survey is performed – wet, dry, cold, windy, poor light, etc.).

A brief description of site types such as isolated artefacts, open scatters, camp sites, knapping floors, quarries, middens, mounds, hearths, carved trees, scarred trees, stone arrangements, Bora rings, burials, engravings, paintings, grinding grooves, occupation deposits (and Potential archaeological deposits: PADs), and ceremonial and mythological sites is given in Appendix i.

6. THE SURVEY STRATEGY

The survey strategy was based on two considerations. Four of the survey units (the proposed gas and water pipelines, the transport route (Route 64), and the rail siding access road) each occur within existing road easements, most of which have been highly disturbed by road construction and maintenance. The survey strategy along each of the routes was to investigate all mature trees, all erosion features, and all drainage and creek lines. While there were many instances of each, they totalled less than 5% of the total route survey units. The remaining 95% being shrouded in a dense grass ground cover. As a consequence all routes along existing roads were surveyed from a moving vehicle, frequent stops and inspections on foot being made of any features of potential archaeological significance. However, at least 60% of the northern section of the gas pipeline across the paddocks was surveyed on foot.

The other major survey units (the mine, limestone quarry, borefield, bypass route, borefield pipeline link, and rail siding areas) required a far broader survey strategy. In the mine area the strategy was to survey all drainage lines, all stands of mature trees, and any erosion features. In addition, and as a means of testing the effectiveness of the predictive model, random transects were made of areas in which it was predicted sites would not be found. All surveys in the mine area were made on foot.

In the limestone quarry area the focus of the survey was on the hill that is to be quarried. There were few mature trees in the area, and so the search was concentrated on the few erosion features on the cobbled surface, and on the heaps of limestone rubble at the edges of the paddocks. A ploughed paddock in the northeastern corner provided good surface visibility, but no artefacts, and there were a number of erosion features and worn tracks at the base of the hill in the area of the central gateway to the Fifield to Trundle road, and these provided an ideal sample of exposed and only superficially disturbed contexts.

The rail siding area was shrouded in a dense, tall grass cover, and there were only minor erosion features towards the central section inside the southern boundary. Fortunately, a railway maintenance track had recently been cut by a grader parallel to the track, and passing through the survey area. The track had been graded to a depth of up to 10 cm deep, thereby providing an ideal transect along the length of the site. Recent rain had washed the track and spoil heap clean of superficial deposits providing an ideal situation for observing any artefacts that might be present. This track was inspected on foot.

The western and eastern borefields are both areas cleared of trees. A large portion of the western borefield, and almost the entire area of the eastern borefield have recently been ploughed, although the latter was partly obscured by new grass shoots. Random transects were walked in both areas and the edges of the paddocks surveyed from a vehicle.

Both route options for the linking pipeline were surveyed from a vehicle where there was vehicular access, and walked where there was not. In both instances both sides of the fence lines were surveyed, as it was unclear at the time of the survey as to which side of the fence line would be used.

7. THE SURVEY

SECTION 1. The Mine Site surveyed in 1997

1.1 The survey area

The irregularly shaped area of approximately 25 square kilometres is approximately 4.5 km to the northwest of the small settlement of Fifield (Figure 1) and includes approximately 2 square kilometres of Fifield State Forest.

The survey area is bounded by the Condobolin to Tullamore road to the east, by the Melrose to Gillenbine road along its northern boundary, by a north/south line approximating 147°23′00″ along the western boundary. The southern boundary follows a boundary fenceline. Figure 7.1.1 is taken from a draft report of the 1997 survey, and shows the survey area, and the locations of the sites recorded during that survey.

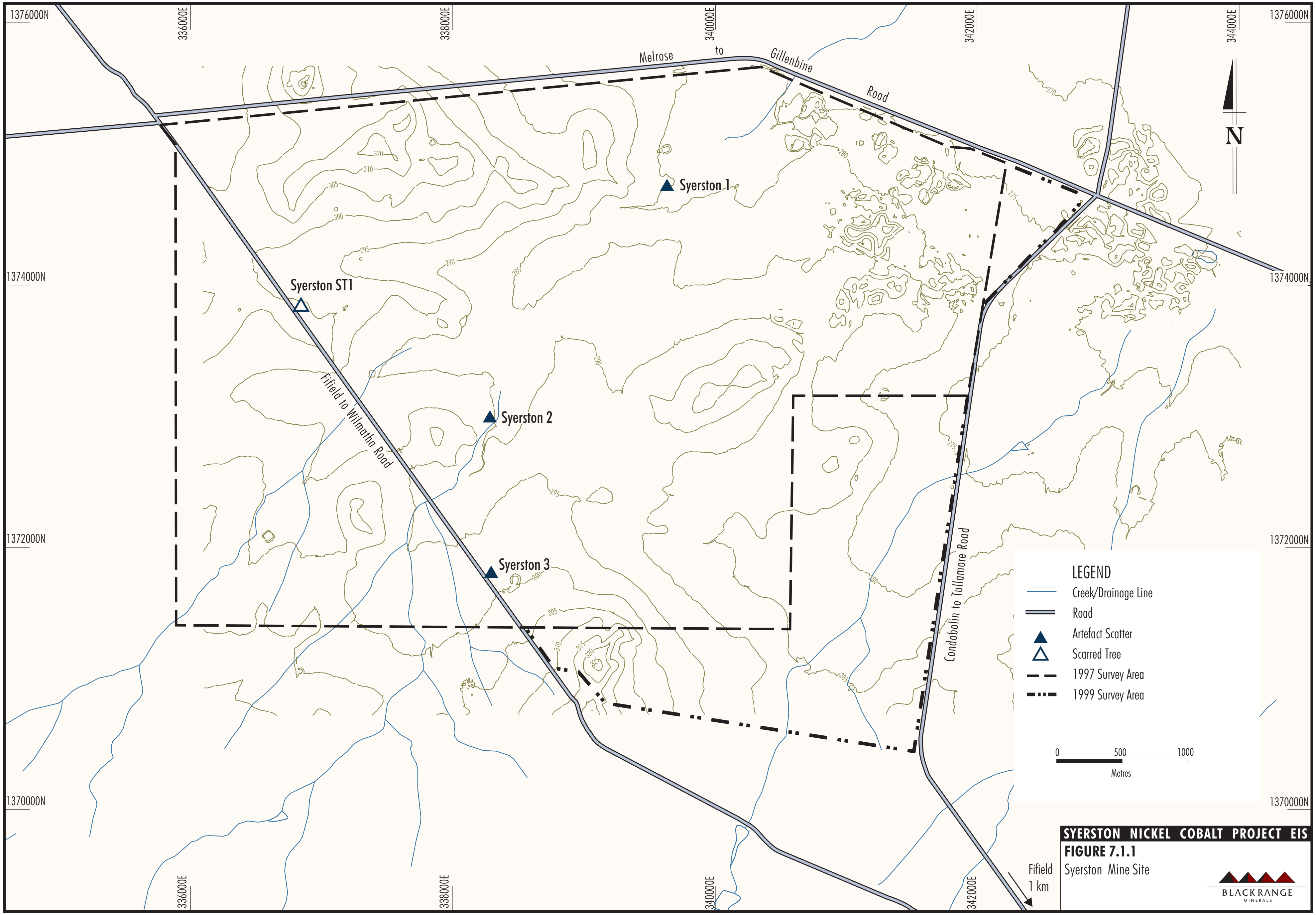
1.2 The environment

The survey area occurs on the Girilambone Beds in the Girilambone Anticlinorial Zone, which extends from Bourke in the north to the Victorian border in the south. In general the Girilambone Beds do not occur south of the Lachlan River, (Suppel, 1974; 119).

The Girilambone Beds form a highly metamorphosed sequence occurring beneath less metamorphosed and deformed rocks, but there have been few geological investigations and descriptions are therefore general. The bulk of the metamorphosed rock in the Fifield area being described as quartz-albite-mica, and quartz-mica schists (Suppel, 1974, 122).

The Fifield area was, until 1974, the largest producer of platinum in Australia, and both the Fifield Mine and Gillenbine Tank leads have produced platinum and gold (Suppel, 1974; 125).

As well as the large pits of Fifield Mine there are numerous small hand-excavated gold mines and mullock heaps scattered in the Fifield district, and there are several in the southwestern corner of the survey area in the vicinity of ‘Syerston 3’ (see below).



BRM-98-01-Arch_003B

The only rock seen in the survey area comprised of a sub-angular indurated sedimentary rubble which lines the beds and banks of the main drainage gully, and angular poorly-silicified metasedimentary rubble at the western end of the gully to the east of the Fifield to Wilmatha road.

Some small angular pieces of highly fractured quartz (< 6cm), and a fine rubble of sub-angular metasedimentary stone was observed along the banks of the northeastern section of the main gully – but none were suitable for the manufacture of stone artefacts.

Elevations in the survey area vary from just over 300m AHD in the western section, down to below 280m AHD in the northeastern section, but generally the area could be described as gently rolling slopes and plains country.

1.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites have previously been recorded in the area. Detail of the printout is included in Appendix ii.

1.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, in which there are no shelters or overhangs, only ephemeral creeks, and no naturally occurring stone resources for knapping material (see glossary).

- Isolated artefacts may be present and visible in erosion features,
- Low density artefact scatters may be present and visible in erosion features, but it is unlikely that any debitage will be visible,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There is a potential for any trees of more than 150 years old to be scarred,
- There is a potential for any trees of more than 150 years old to be carved,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no shell middens,
- There will be no intact occupation deposits,
- There are no known Mythological sites,

- There will be no stone quarries.

1.5 Effective survey coverage

See Table T.7.1.

1.6 Results

Artefacts were found in three locations, two of these being adjacent to the main drainage line and the third in an area, which while not indicated on the Topographic map as being a drainage line, corresponds with a drainage depression that feeds into a large dam in the south western corner of the mine area.

As well as the artefacts a scarred tree was observed beside the Fifield to Wilmatha road. There are no clear marks to indicate whether the bark was removed by a steel or stone axe, or whether the scar was accidentally made by contact from a grader or bulldozer during road construction. However, as the shape of the scar appears to be that typically identified with ‘shield scars’, it has been recorded as an Aboriginal site.

Details of the sites are given below, the locations are shown on Figure 7.1.1, and photographs of three of the sites are presented as Figures 7.1.2, 7.1.3, and 7.1.4.

‘Syerston 1’ : AMG Ref. 539570 6375950 (ISG Ref. 339583.459 1374717.330).
Fifield Topographical Map 8332-II & III
An isolated flake of milky white quartz, on an eroded surface in an area of mixed regrowth of cypress pine and eucalypt, immediately to the south of, and within 10m of the central drainage line.

‘Syerston 2’ : AMG Ref. 538280 6374200 (ISG Ref. 338293.020 1372966.735).
Fifield Topographical Map 8332-II & III
An open scatter and possible knapping floor of 7 artefacts, within an area of approximately 7m diameter, on an actively eroding track and stock-entry point, on the northern bank of the central drainage line. All artefacts were flakes, one of orange volcanic? material, one of dark indurated sandstone, two of dark brown chert, one of brown chert, one of grey-brown chert, and one of brown chert with a quartz band.

Table T.7.1 – Table of Effective Survey Coverage

Unit	Topography/ Environment	Approx. Area in sqm.	Vegetation	Land Use	Soil	Average Surface Visibility	Exposure	Av. Arch. Visibility in Exposures	Survey Coverage	Archaeology
1	Fifield State Forest and disused mines	2,300,000	Box, Kurrajong, Ironbark	Logging	F.g. red earths, rubble in depressions	<5%	Drainage line, logging erosion	60%	20%	None
2	Main drainage line (25 m each side of gully)	250,000	Box, Mallee-box, Kurrajong, Cypress	Logging and dams to west	Indurated rubble and f.g. red earths	<50%	Slopewash in logged areas	90%	80%	"Syerston 1" "Syerston 2"
3	Paddocks to north of yards to forest track	2,800,000	Isolated Box and Kurrajong	Cereal and grazing	Clayey/loamy red earths	<5%	Unsown strip along edges of paddocks	80%	25%	None
4	Woodland to north of yards to forest track	2,900,000	Box and Kurrajong, some Cypress regrowth	Minor logging and grazing	Red earths	<20%	Minor slopewash	80%	25%	"Syerston ST1" in road reserve
5	Paddocks to south of yards to forest track	7,500,000	Isolated Box and Kurrajong	Cereal and grazing	Clayey/loamy red earths	<5%	Unsown strip along edges of paddocks	80%	25%	None
6	Woodland to south of yards to forest track	3,750,000	Box and Kurrajong, some Cypress regrowth	Minor logging and grazing	Red earths	<20%	Minor slopewash	80%	20%	None
7	Paddocks west of Albert/Fifield Road	5,460,000	Isolated Box and Kurrajong	Cereal and grazing	Clayey/loamy red earths, rubble on rises	<5%	Unsown strip along edges of paddocks	80%	40%	None
8	Minor drainage line to south (40 m wide)	40,000	Unidentified "wet ground" shrub and Box	Grazing and dam	Clayey/loamy red earths	<20%	Unsown strip along edges of paddocks	75%	75%	"Syerston 3"

Figure 7.1.2 - Looking north-eastwards along the drainage line. 'Syerston 1' is to the left of camera.

Figure 7.1.3 - 'Syerston 2'. The artefacts were on the central slope in and adjacent to the wheel tracks

Figure 7.1.4 – 'Syerston ST1'

Tree type :	Box	Shape of scar :	lozenge
Circumference mid-scar :	301cm	Height of scar above ground :	43cm
Length of scar :	162cm	Maximum width of scar :	38cm
Depth of scar (at top) :	Approx 8cm	Depth of scar (at base) :	Approx 8cm

‘Syerston 3’: AMG Ref. 538290 6373070 (ISG Ref. 338303.024 1371836.350).
Fifield Topographical Map 8332-II & III
An isolated flake of brown/red vitreous volcanic material, in an actively eroding area, in a partially cleared area, adjacent to a drainage depression. This site is within a short distance of gold mine workings (to the southeast).

‘Syerston ST1’: AMG Ref. 536800 6375050 (ISG Ref. 336812.517 1373817.024).
Fifield Topographical Map 8332-II & III Scarred tree beside the Fifield to Wilmatha road.

1.7 Discussion

Of the four sites the scatter at ‘Syerston 2’ and the scarred tree at ‘Syerston ST1’ are the only two that provide useful information that Aboriginal people were occupying the area. Although the scarred tree is of uncertain origin, there can be no question that the scatter, and the variety of material it contains, indicates that this was at least a knapping site, if not a camp site. In the absence of any other sites in the area this is important as evidence that Aboriginal were using the drainage line, either as a core base or simply as a route.

The two isolated artefacts clearly indicate that Aboriginal people used the area, but the two artefacts were probably discarded or dropped in transit, and do not represent identifiable activities or functions of the findspots associated with the artefacts.

The provisional plan of Conceptual Pit Outlines and Infrastructure for the mine indicates that sites ‘Syerston 1’ and ‘Syerston 2’ will probably be impacted upon, but that neither ‘Syerston 3’ nor ‘Syerston ST1’ will be impacted upon by development of the mine – see Section 8.

‘Syerston 2’ is in the vicinity of the proposed Floodwater Culvert, and if not directly impacted upon by the earthworks for the culvert might be disturbed by peripheral impacts if not protected. The site occurs on the outside of a bend in the gully and the culvert will probably pass to the south of the site, but as this is a natural crossing-point and the most likely point for earth-moving machinery to cross the gully the site is vulnerable to disturbance from heavy machinery. The preferred option would be to fence this site off, but if this is not practical then a Consent to Destroy must be obtained from NSW NPWS.

The scarred tree, 'Syerston ST1', is in a public road reserve. In a location such as this which is both remote and generally hidden from anyone other than those travelling the road, and therefore beyond practical management by either NSW NPWS or the Aboriginal Community, it is recommended that public attention should not be drawn to the existence of the tree by the erection of a protective fence.

1.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

1.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

At the time of the 1997 survey I was assisted by Mr Cecil Coe representing the Condobolin LALC. Mr Coe was of the opinion that the two sites, 'Syerston 2', and 'Syerston ST1' were of cultural significance, but that the two isolated artefacts were of low cultural significance.

1.8.2 Research potential

None of the four sites were assessed to be of any further research potential. The artefact scatter was in highly disturbed contexts, and the artefacts are of unremarkable features, exhibiting neither retouch, use-wear, nor being diagnostically identifiable as tools. All three artefact sites are lacking in both content and integrity of context, and have no comparative analysis potential. Perhaps the scarred tree has some potential for further research into scarred trees generally.

1.9 Recommendations

Site Recording Forms will be completed for each of the four sites, and lodged with NPWS for listing on the Aboriginal Sites Register. The consequences of this will be that it will be necessary for the proponents to obtain a written consent to the destruction of any of the sites from Condobolin LALC, or the Wiradjuri Regional Aboriginal Land Council, to obtain a Consent to Destroy from the NPWS, should they wish to develop a site. If it should become necessary to destroy ‘Syerston 2’ then a limited salvage operation to recover the artefacts both on and beneath the surface should be performed under the conditions of the Permit to Destroy. If the site can be avoided and preserved then it should be fenced off and marked with highly visible flagging prior to any earthworks proceeding in the area.

Following discussion with Mr Coe my opinion is that it is probable that Consents to Destroy could be obtained for each of the three artefact sites, but that there should be no impact to the scarred tree.

SECTION 2. The Extension to the Mine Area – Surveyed in 1999

2.1 The survey area

The Extension to the Mine Area is an extension to the mine site surveyed in 1997, described in Section 1. For the purposes of separating the two survey events the area covered in 1997 is described as The Mine Site, and the portion surveyed in 1999 is described as the Extension to the Mine Area.

The Extension to the Mine Area comprises of two sections. The larger section is bounded by the Condobolin to Tullamore road to the east, and by boundary fence lines along its northern, western, and southern boundaries. The second section comprises of a triangle of land bounded by the Condobolin to Tullamore road along the eastern boundary, by the Melrose to Gillenbine road along the northern boundary, and by the eastern boundary of The Mine Site – see Figure 7.1.1.

The larger section is approximately 4.5 km to the northwest of the small settlement of Fifield. The length of the property is approximately 3,000m from north to south along its eastern boundary, and the greatest width (along the southern boundary) is approximately 2,000m. The smaller triangular section is approximately 1100 m x 1000 m x 700 m. Note that the map has been slightly reduced and is not a true 1: 50,000 scale map.

At the time of the survey no layout plans had been developed for the study area, and so my brief was to assess the archaeological significance of the entire study area.

2.2 The environment

The southern section comprises of the lower slopes and plain that dip towards the northeast. Relief is minimal and the fall from the southwestern corner to the northeastern corner, a distance of approximately 3.5 km, is less than 25m. Figure 7.1.1 shows a drainage pattern through the survey area, but in reality, the only clear evidence of a drainage line is the 100m long depression shown in the photographic record. As a consequence of mechanical alteration to the drainage depression, surface run-off it is retained within the altered area.

There is very little vegetation within the southern section other than grass, the trees having been cleared for pasture improvement, however, a few Kurrajongs have been retained – or planted, to supplement stock feed. Sheep presently graze the property, and there are numerous worn sheep-trails through the red soils of the more elevated areas.

The northern section occurs on a broad slope that dips gently towards the northeast. For all but a very small area, which consists of the edge of a disused mine that extends eastwards across the Condobolin to Tullamore road, the section comprises of open dry sclerophyll woodland. Figures 7.2.1 and 7.2.2 on the following pages show two aspects of the only significant feature within the study area, the drainage gully that has been mechanically altered to improve the retention of water.

2.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites have been recorded in the study area, however refer to Section 1 for a description of the sites recorded in the survey of The Mine Site in 1997.

Figure 7.2.1 - Looking southeastwards across the drainage line from the centre of the survey area.

Figure 7.2.2 - Looking northeastwards along the central drainage line.

2.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, which has been cleared, and in which there are no shelters or overhangs, no significant drainage lines, and in which there are no apparent naturally occurring stone resources for knapping material.

- Isolated artefacts may be present and visible in erosion features, but it is unlikely,
- Low-density artefact scatters may be present in erosion features, but it is unlikely,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There will be no scarred trees,
- There will be no carved trees,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no middens,
- There will be no intact occupation deposits,
- There are no known Mythological sites,
- There will be no stone quarries.

2.5 Effective survey coverage

See Table T.7.2.

2.6 Results

No sites were recorded in the study area.

2.7 Discussion

The survey area occurs in dry, open country, with no water resources, no shelter other than what would have been open dry sclerophyll woodland and grassland, and in which there are no naturally occurring stone material resources.

Table T.7.2 – Effective Survey Coverage
Extensions to the Mine Area

Unit	Topography/ Environment	Approx. Area (map)	Rock/soil	Vegetation	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed	Arch. Visibility of Exposures	Archaeology
1	Triangular area of State Forest, northern section	440,000 sqm	Weathered sedimentary red earths	Box, Kurrajong, Ironbark	Past logging and mining, now abandoned	< 5 %	Vehicle tracks	60% (surveyed in 1997)	60%	Nil
2	Wooded slopes in southwest corner of southern section	480,000 sqm	Weathered sedimentary red earths	Box, Kurrajong, Cypress	Minor logging, and grazing	< 10 %	Minor tracks	30% (surveyed in 1997)	25%	Nil
3	Central depression	33,000 sqm	Weathered sedimentary red earths	Cleared pasture	Sheep grazing	25%	Sheep tracks and over-grazing wear	95%	95%	Nil
4	Low rise on which homestead is built	350,000 sqm	Weathered sedimentary	Cleared pasture	Sheep grazing	45%	Sheep tracks and over-grazing wear	40%	95%	Nil
5	Gentle slopes and plain to either side of central drainage depression	3,237,000 sqm	Weathered sedimentary red earths	Cleared pasture	Sheep grazing	15%	Sheep tracks and over-grazing wear	10%	95%	Nil

The only reasons why people would have used this country was in pursuit of game for food, or in transit between the surrounding country. In the absence of water and decent shelter, visitation would have been brief, and in the absence of any stone resources, any artefactual material discarded or lost during transit, would have consisted of small retouch or tool maintenance artefacts, or of small isolated flakes or flaked pieces.

The absence of artefactual material in the survey area was as predicted.

2.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

2.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area.

2.8.2 Research potential

In the absence of any artefactual material in the Extension area the assessment is that the area is of no research potential.

2.9 Recommendations

As a consequence of this survey, and in the absence of any known constraints on the basis of Indigenous cultural grounds, it is recommended that development of the study area should be permitted to proceed as proposed.

SECTION 3. The proposed Gas Pipeline

3.1 The survey area

The proposed gas pipeline is approximately 90 km long, and will connect the mine site with the existing Natural Gas Pipeline in the vicinity of the Milne Scraper Station, in the shadow of the Microwave Tower, west of the Condobolin to West Wyalong road.

With the exception of the northern section of the gas pipeline, the pipeline will run alongside roads and tracks within existing road easements (Figure 1). For the other 15 km the pipeline will be situated within private property cleared for agriculture.

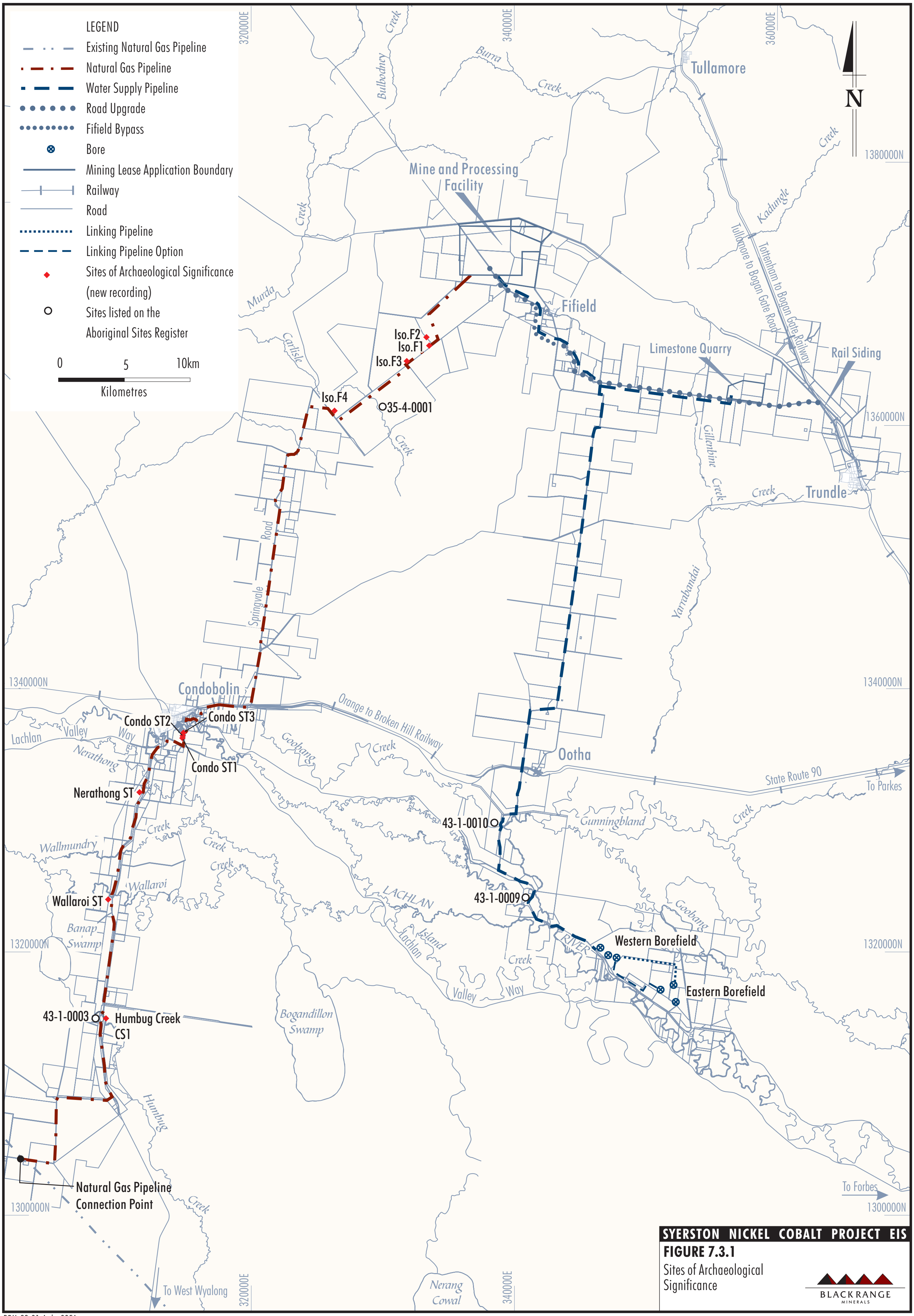
From the northern point of entry onto Springvale Road the pipeline heads south to join the Condobolin to Parkes Road east of Condobolin. From there it follows the latter to the eastern outskirts of Condobolin, then takes a sharp turn southwards to cross the Lachlan to join Lachlan Valley Way to the southeast of the town. The pipeline then follows the latter to its junction with the Condobolin to West Wyalong road. From there the pipeline heads south along the latter for some 26 kilometres, and turns right onto a graded track approximately 10 km to the south of Humbug Creek. The pipeline then follows the track firstly westwards and then southwards, and finally westwards again, to a proposed connection point with the Sydney to Moomba gas pipeline.

A series of maps presented as Figures 7.3.1, 7.3.2, 7.3.3, 7.4.4, and 7.3.5, show the known archaeological sites, and the sites recorded during this investigation, on the proposed gas pipeline. Note that the topographic maps have been slightly reduced and that they are not true 1: 50,000 scale maps.

3.2 The environment

North of the Lachlan River the proposed pipeline descends over gentle downs-like country of broad low rises that decrease in height towards the south. The pipeline exits the mine site at 300 m AHD, before gently rising to just over 320 mAHD, then progressively descending to below 200 m AHD east of Condobolin. For the remaining 37 km of the route elevations vary little, hovering between 180 m and 200 m AHD, except for the last two kilometres where the route gently rises above 200 m AHD.

The downs-like country to the north of the Lachlan is well drained, and has been cleared for wheat and cattle, but to the south of the Lachlan the flood-prone plains generally remain unaltered except for minor tree clearing, and is primarily cattle country.



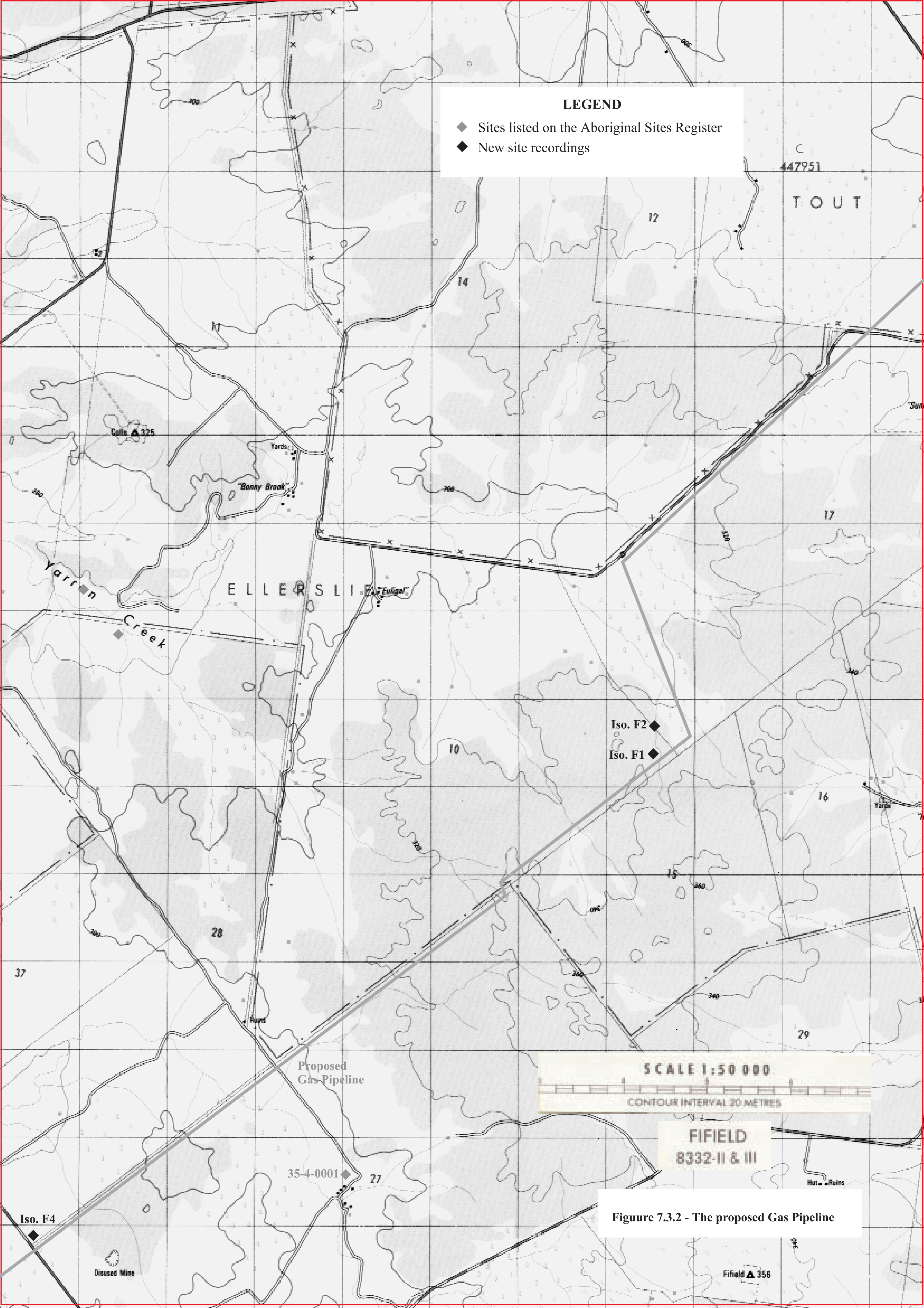
SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 7.3.1

Sites of Archaeological Significance

BLACK RANGE MINERALS

BRM-98-01-Arch_005A



Figuure 7.3.2 - The proposed Gas Pipeline

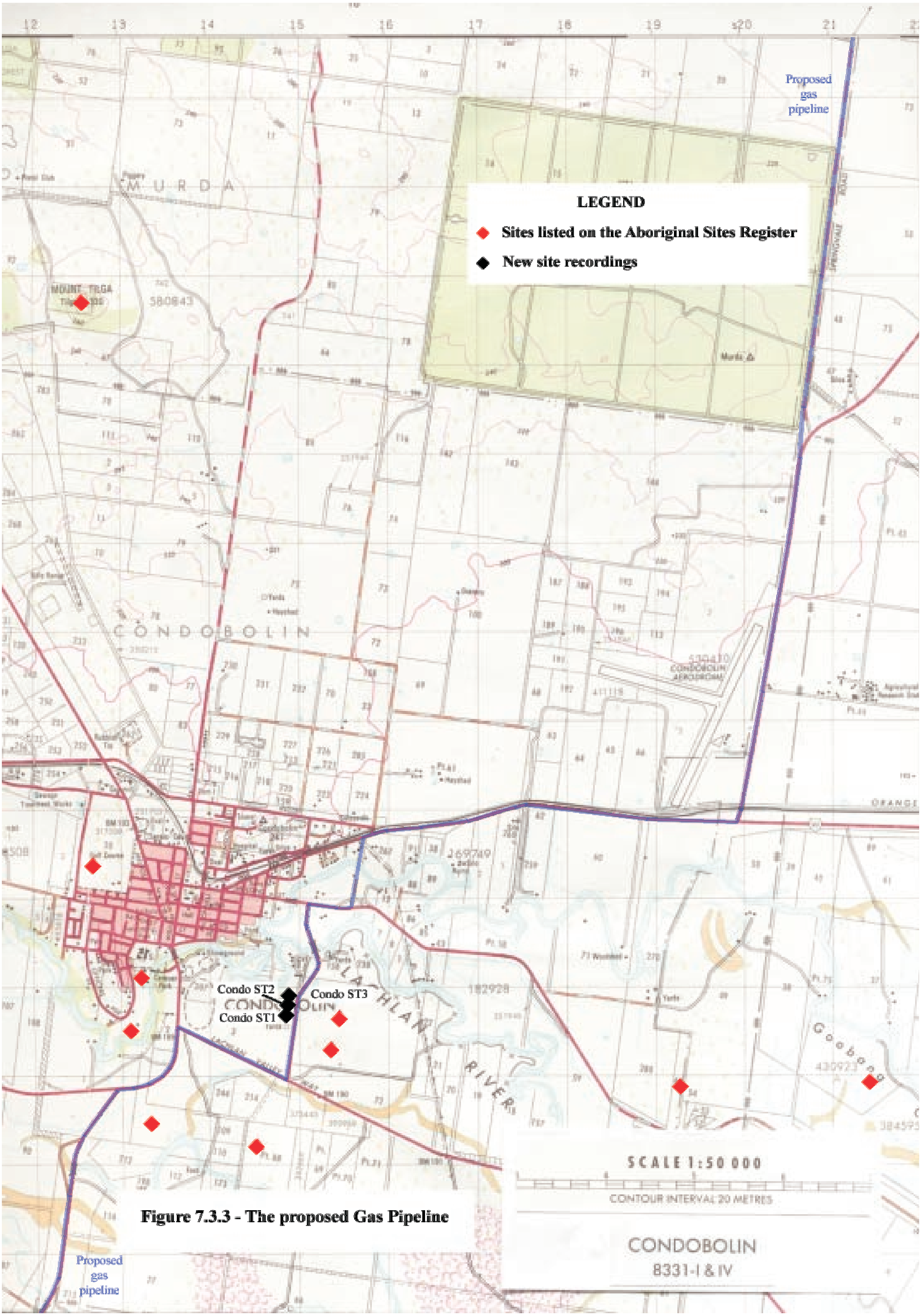


Figure 7.3.3 - The proposed Gas Pipeline

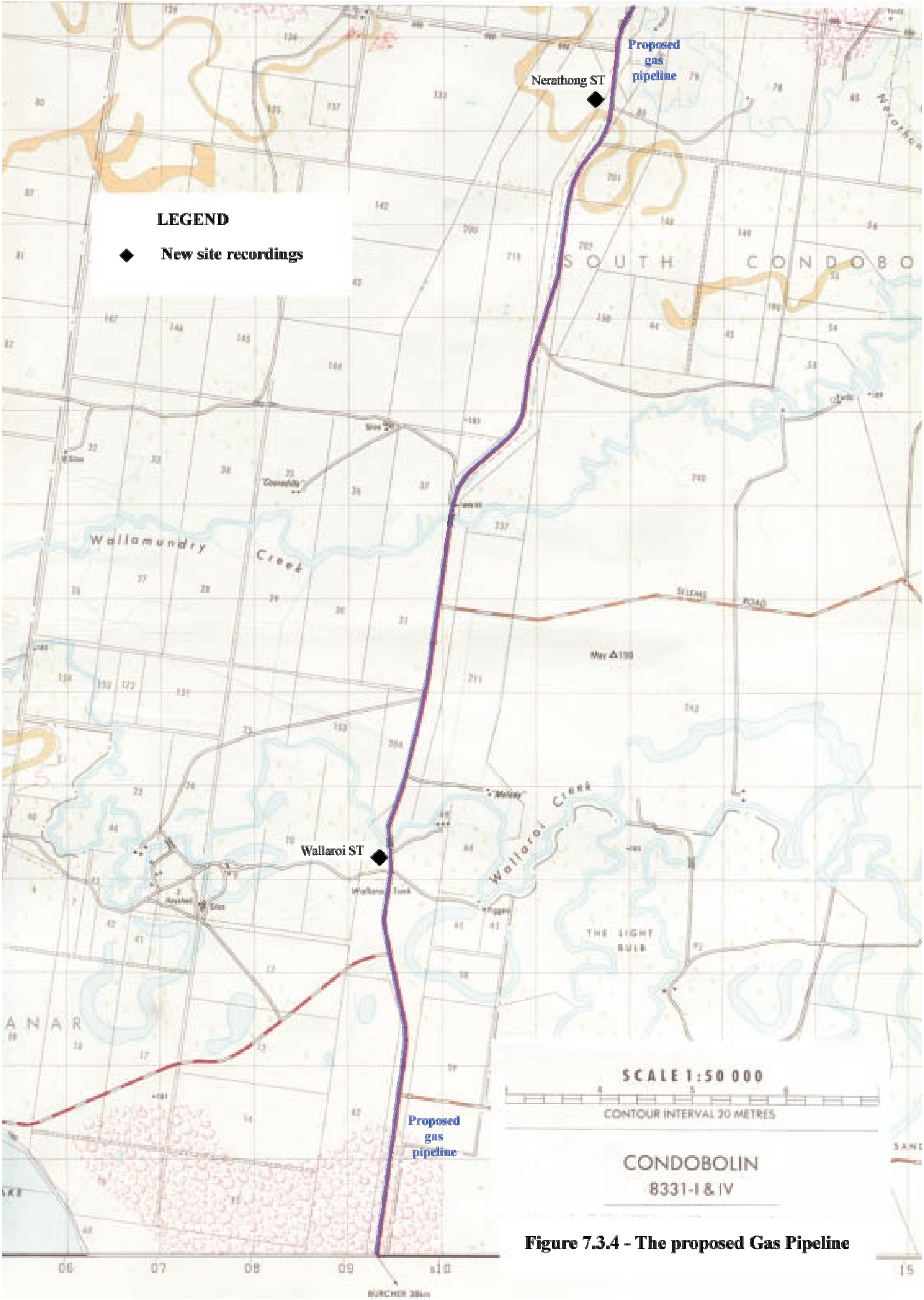


Figure 7.3.4 - The proposed Gas Pipeline

Figure 7.3.5 - The proposed Gas Pipeline

3.3 The archaeological record

A search of the Aboriginal Sites Register found that 14 sites had previously been recorded in the area of the map coverage of maps, Figures 7.3.2, 7.3.3 and 7.3.5 – see Appendix ii. Of these the most significant to this investigation was a Carved Tree (#35-4-0001 shown on Figures 7.3.1 and 7.3.2), and an Open Camp Site at Humbug Creek (#43-1-0003 shown on Figures 7.3.1 and 7.3.5). Several sites have been recorded in the vicinity of Condobolin, but none will be impacted upon by the proposed pipeline, however, they are of some significance in providing a cultural context for the area.

Despite a thorough search the carved tree listed on the Aboriginal Sites Register as #35-4-0001 was not observed during the investigation. As carved trees are commonly associated with burials, and because the map reference for the tree placed it in the vicinity of the gas pipeline route it was essential that either the tree or its original location be identified.

The archaeologist at the Western Zone office of NSW NPWS was contacted, and asked to provide a copy of the Site Recording Form for the site. The Site Recording Form, included as Appendix iii, shows that the site was recorded in 1979, and that the map reference was plotted from a 1: 250,000 scale map. A note to the record states that the carved tree was moved to the Condobolin Community Centre in June 1981.

While the tree is of cultural significance the probability that it marked a burial site is of greater significance. Fortunately, the recorder had included a ‘mud map’ of the site, and so it was possible to plot the site onto a 1: 50,000 Topographic Map. On the Aboriginal Site Register the map reference is given as 528911 6363773 AMG (ISG Ref. 328920.834 1362536.188), however, the new location plotted from distances and bearings provided on the ‘mud map’ is 529925 6362600 AMG (ISG Ref. 329935.179 1361362.789). This is a position over 1,000 metres to the east, and over 1,100 metres to the south of the listed location. As the distances and bearings shown on the ‘mud map’ are to the nearest metre and degree it is reasonable to assume that the error is in the map reference, and as 1 mm on a 1:250,000 scale map represents 250 metres the error is not surprising. The new location places the original site of the carved tree and any associated burial at least 1,000 metres from the gas pipeline route.

The listed map reference for the open camp site recorded at Humbug Creek as #43-1-0003, places the site 150 to 200 metres to the west of the road and gas pipeline route. The site was recorded in 1987, six years after the 1: 50,000 scale Topographic Map had become available, and so the reference should be reasonably accurate. It is possible that the reference is to the arbitrary centre point of what was observed to be an extended camp site, as an extensive camp site was recorded either side of the road during this investigation – see below.

3.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, in which there are no shelters or overhangs, and in which there are no apparent naturally occurring stone resources for knapping material, but in which there are ephemeral creeks, and significant creeks with waterholes, and a major river.

- Isolated artefacts may be present and visible in erosion features,
- Low density artefact scatters may be present and visible in erosion features north of the Lachlan, but more extensive scatters may occur along the banks of creeks to the south of the Lachlan,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There is a potential for any trees of more than 150 years old to be scarred,
- There is a potential for any trees of more than 150 years old to be carved,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no shell middens north of the Lachlan, but there is a potential for middens of shell and/or bone to occur along creek banks south of the Lachlan,
- There will be no intact occupation deposits north of the Lachlan, but intact or partially disturbed occupation deposits may occur along creek banks south of the Lachlan,
- There are no known Mythological sites,
- There will be no stone quarries.

3.5 Effective survey coverage

See Table T.7.3.

Table T.7.3 – Effective Survey Coverage – Gas Pipeline

Unit	Topography/ Environment	Approx. Area (map)	Rock/soil	Vegetation	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed (includes road)	Arch. Visibility of Exposures	Archaeology
1	Cross-country leg from the Mine Site to Springvale Road - 15m wide corridor	262,500 sqm (17.5k m)	Weathered sedimentary red earths	Box, Kurrajong, ironbark, cypress, Casuarina	Cleared grazing paddocks with remnant woodland along fence lines	15%	Vehicle tracks along fence lines	75%	95%	4 isolated artefacts - Iso.F1, Iso.F2, Iso.F3, and Iso.F4
2	Springvale Road to Condobolin - 20m to either side of centre line	540,000 sqm (27 km)	Weathered sedimentary red earths	Box, Kurrajong, ironbark, cypress, Casuarina	Roadway - Shoulders and verges cleared	25%	Verges regularly graded	80%	50%	Nil
3	Condobolin to south bank of Nerathong Creek - 20m to either side of centre line	160,000 sqm (8 km)	Predominantly floodplain soils with depressions/ drainage lines of swamp sediments	Box and river gum	Roadway - Shoulders and verges cleared	25%	Verges regularly graded	80%	50%	3 scarred trees - Condo ST1, Condo ST2, and Condo ST3
4	Nerathong Creek to south side of Humbug Creek - 20m to either side of centre line	370,000 sqm (18.5 km)	Weathered sedimentary red earths and depressions/ drainage lines of flood sediments	Box and river gum	Roadway - Shoulders and verges cleared	25%	Verges regularly graded	80%	50%	2 scarred trees - Nerathong ST, and Wallaroi ST
5	Humbug Creek to Sydney/Moomba Gas Pipeline - 20m to either side of centre line	380,000 sqm (19 km)	Weathered sedimentary	Box, Casuarina and scrub	Roadway - Shoulders and verges cleared	25%	Verges regularly graded	80%	50%	Camp site - Humbug CS1

3.6 Results

Ten sites were recorded along or in the vicinity of the gas pipeline route (Figure 7.3.1). For convenience the following descriptions are segregated according to the topographic map on which they are shown.

Figure 7.3.2

Site 'Iso.F1' (Figure 7.3.6): AMG Ref. 533680 6367300 (ISG Ref. 333691.456 1366064.388).

Fifield Topographical Map 8332-II & III

An isolated flake of silcrete with possible use-wear. Found beside a vehicle track approximately 5 m north of the fenceline, on the rise east of a drainage depression between two NW/SE-trending longitudinal dunes of red sandy soils. Predominantly mallee scrub country with isolated eucalypts along drainage depressions.

Site 'Iso.F2' (Figure 7.3.7): AMG Ref. 533400 6367720 (ISG Ref. 333411.361 1366484.531).

Fifield Topographical Map 8332-II & III

An isolated flake of black chert. Found in a vehicle track adjacent to a fenceline, on the rise west of a drainage depression of red sandy soils. Predominantly open dry sclerophyll woodland.

Site 'Iso.F3' (Figure 7.3.8) : AMG Ref. 531920 6366100 (ISG Ref. 331930.857 1364863.980).

Fifield Topographical Map 8332-II & III

An isolated large flake of quartzite. Found in open dry sclerophyll woodland on the crest of a hill/ridge, less than 5 metres from a track at the edge of a plough-zone, and approximately 50 m north of the fenceline.

Site 'Iso.F4' (Figure 7.3.9) : AMG Ref. 532450 6361920 (ISG Ref. 332461.037 1360682.558).

Fifield Topographical Map 8332-II & III

An isolated flake (split cone) of quartzite, in a scalded area in the corner of a paddock, opposite a gateway, approximately 10 m from fencelines to the west and south.

Figure 7.3.3

Site 'Condo ST1' (Figure 7.3.10) : AMG Ref. 514890 6337700 (ISG Ref. 314895.065 1336454.320).

Condobolin Topographical Map 8332-I & IV

A scarred tree in the road easement to the west of the road, the trunk some 5m from the edge of the sealed road.

Tree type :	Box	Shape of scar :	lozenge, broader at top

Circumference mid-scar :	330cm	Height of scar above ground :	115cm
Length of scar :	206cm	Maximum width of scar :	65cm
Depth of scar :	10cm	Aspect :	SW (facing road)

Site 'Condo ST2' (Figure 7.3.11) : AMG Ref. 514890 6337800 (ISG Ref. 314895.065 1336554.354).
Condobolin Topographical Map 8332-I & IV

A scarred tree in the road easement to the west of the road, the trunk some 8m from the edge of the sealed road. The face of the scar has been 'mutilated' by many random steel axe cuts.

Tree type :	Box	Shape of scar :	lozenge
Circumference mid-scar :	368cm	Height of scar above ground :	65cm
Length of scar :	216cm	Maximum width of scar :	42cm
Depth of scar :	12cm	Aspect :	SW (facing road)

Site 'Condo ST3' : AMG Ref. 514890 6337860 (ISG Ref. 314895.065 1336614.374).
Condobolin Topographical Map 8332-I & IV

A scarred tree in the road easement to the west of the road, the trunk some 5m from the edge of the sealed road. The tree has three scars, two of which appear to have been made by deliberate bark removal, and the third, which may or may not be natural.

Scar 1 (Figure 7.3.12)

Tree type :	Box	Shape of scar :	lozenge
Circumference mid-scar :	402cm	Height of scar above ground :	102cm
Length of scar :	54cm	Maximum width of scar :	22cm
Depth of scar :	10cm	Aspect :	ESE (facing road)

Scar 2 (Figure 7.3.13)

Tree type :	Box	Shape of scar :	lozenge
Circumference mid-scar :	not rec.	Height of scar above ground :	150cm
Length of scar :	65cm	Maximum width of scar :	21cm
Depth of scar :	10cm	Aspect :	S (facing trunk)

This scar is on the inside of a major limb 100cm above the fork.

Scar 3 (possibly natural)

Tree type :	Box	Shape of scar :	elliptical
Circumference mid-scar :	not rec.	Height of scar above ground :	77cm
Length of scar :	33cm	Maximum width of scar :	9cm
Depth of scar :	10cm	Aspect :	W

Figure 7.3.6 - Looking westwards across 'Iso.F1'. The artefact was found to the left of the road.

Figure 7.3.7 - Looking northwards across 'Iso.F2'. The artefact was found on the track in the foreground.

Figure 7.3.8 - Looking eastwards across 'Iso.F3'. The notepad marks the findspot.

Figure 7.3.9 - Looking southwards across 'Iso.F4'. The artefact was found to the right of centre.

Figure 7.3.10 - 'Condo ST1' (scale 25cm). Note the scarred tree in the background to the right of centre.

Figure 7.3.11 - 'Condo ST2'.

Figure 7.3.12 - 'Condo ST3', Scar 1.

Figure 7.3.13 - 'Condo ST3', Scar 2.

As can be seen in Figure 7.3.10 another scarred tree is visible from the road (to the right of centre), but as this was well beyond the proposed impact area it was not examined.

Figure 7.3.4

Site 'Nerathong ST' (Figures 7.3.14 and 7.3.15) : AMG Ref. 511650 6333350 (ISG Ref. 311653.963 1332102.840). Condobolin Topographical Map 8332-I & IV

A scarred tree in the paddock (TSR ?) to the west of the road, in remnant open dry sclerophyll woodland. Although this scar extends to ground level, the roundedness of the top of the scar, and the fact that the scar was partially on the inside of a fork, were sufficient reasons to consider the scar to have been deliberately made in bark removal. The tree is well beyond the proposed pipeline.

Tree type :	Box	Shape of scar :	rounded at the top
Circumference mid-scar :	367cm	Height of scar above ground :	N/A
Length of scar :	275cm	Maximum width of scar :	115cm
Depth of scar :	13cm	Aspect :	SW (facing road)

Site 'Wallaroi ST' (Figures 7.3.16 and 7.3.17): AMG Ref. 509390 6225270 (ISG Ref. 309393.194 1223986.078). Condobolin Topographical Map 8332-I & IV

A scarred tree in the road reserve (TSR) to the west of the road. The tree occurs in semi-closed dry sclerophyll woodland, some 85m south of the bridge, 50m west of the road, and 6m from a dirt sidetrack. There is some evidence of minor logging or clearing, but there is no evidence to indicate that the scar could have been made during the logging that produced the stumps.

Tree type :	Box	Shape of scar :	lozenge/canoe shape
Circumference mid-scar :	189cm	Height of scar above ground :	26cm
Length of scar :	240cm	Maximum width of scar :	70cm
Depth of scar :	5-8cm	Aspect :	S

Figure 7.3.5

Site 'Humbug CS1 (Figures 7.3.18 to 7.3.21) : AMG Ref. 508650 6316550 (ISG Ref. 308652.942 1315297.126)(centred on the bridge). Fairholme Topographical Map 8331-II & III

An extensive Camp Site and scarred tree on the banks of Humbug Creek.

The camp site is probably an extension of the site (#43-1-0003) previously recorded to the north of "Burragong".

Figure 7.3.14 -'Nerathong ST' viewed from the road. The scarred tree is the forked tree at centre.

Figure 7.3.15 -'Nerathong ST'.

Figure 7.3.16 - 'Wallaroi ST' at centre, viewed from south, with the bridge visible to the right.

Figure 7.3.17 - 'Wallaroi ST'.

Figure 7.3.18 - 'Humbug CS1' viewed from the southeast. All erosion features contain artefacts.

Figure 7.3.19 - 'Humbug CS1'. A knapping floor the southeastern area (scale 25cm).

Figure 7.3.20 - 'Humbug CSI' viewed from the north, with the bridge to the right. The scarred tree is on the left.

Figure 7.3.21 - 'Humbug CSI'. The scarred tree.

To the northwest of the bridge there are erosion features with low density (1 per 10sqm) scatters of flakes and flaked pieces. To the northeast of the bridge there are erosion features with low density (1 per 10sqm) scatters of flakes and flaked pieces, and a knapping floor (max. density 3 per sqm). A scarred tree also occurs to the northeast of the side road. To the southwest of the bridge there are few erosion features but several of the few that there are contained isolated artefacts.

To the southeast of the bridge the flood terrace contains numerous scalds and wash-outs, and every erosion feature contains artefacts. There are several knapping floors (max. density 15 per sqm), and various cores and scrapers (or adzes). There are two discrete low mounds of what appear to be burnt clay, which may be fireplaces. Isolated scrapers (or adzes) were observed along the creek bank. Artefactual material was visible over an area from the creek bank to over 50m away to the south, and from the shoulder of the road for at least 80m eastwards. It is probable that the site extends further eastwards for perhaps as much as 800m.

Scarred tree ('Humbug CS1')

Tree type :	Box	Shape of scar :	elliptical
Circumference mid-scar :	176cm	Height of scar above ground :	80cm
Length of scar :	100cm	Maximum width of scar :	24cm
Depth of scar :	5-8cm	Aspect :	SW (facing road)

3.7 Discussion

The sites recorded during this investigation, both in character and content, were very much as predicted, although it had been expected more open scatters would have been found on the Lachlan overflow channel south of Condobolin, on Wallamundry Creek, and on Wallaroi Creek. The fact that none were may be because that the artefact distribution did not correspond with the erosion features, or simply that there are no sites in the road easements where the road crosses these creeks. There were in fact several large erosion features on the banks of the first two creeks, but no artefacts were observed.

The location of the Humbug creek open site was not surprising, however the distribution and density of artefacts was. It is probable that although no stone source material was visible at the time of the survey, the volume of material on site indicates that material was available in the creek bed before soils released by land clearing upstream had concealed the creek bed.

It is unlikely that the resources of the study area would have been sufficient to have supported a permanent camp, or that the area was habitable during droughts or floods, but the area and volume of the site indicates that this was either a semi-permanent camp site, or that it was frequently used. The site would have been a well-known and significant place to Aboriginal people in the past. For the same reasons, and because there have been so few open scatters recorded in this region the site is also significant to the Aboriginal people today.

The existence of the three scarred trees on the outskirts of Condobolin, and the fact that they were not on the Aboriginal Sites Register, was surprising, but as scarred trees are so difficult to identify it may be that they have been seen but were not identified as having been scarred by deliberate bark removal. It is interesting to note that during a recent investigation north of Pooncarie in the southwest of New South Wales, I was told by Mr Rex Smith, Aboriginal Sites Officer, Dareton LALC, that burials in that region were sometimes marked by four scarred trees around the burial, one of which had multiple scars. It is possible that the three scarred trees in the road reserve south of Condobolin, and the fourth scarred tree in the paddock, mark a burial site within the paddock.

3.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

3.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams assessed all of the scarred trees to be of moderate to high cultural significance, and the open camp site at Humbug Creek to be of high cultural significance. He assessed the isolated artefacts to be of low cultural significance. A draft of this report was sent to Mr Williams for comment and recommendations. A copy of his response is included as Appendix vi.

3.8.2 Research potential

For practical purposes a separate assessment is made for each of the ten sites. The assessments are based on two basic criteria. Firstly whether the observed material or relic can provide additional useful or significant information to that recorded in this report, and secondly, whether the context or site matrix has the potential to contain additional material or relics that might be of potential research value.

Iso.F1	Assessed to be of low research potential
Iso.F2	Assessed to be of low research potential
Iso.F3	Assessed to be of low research potential
Iso.F4	Assessed to be of low research potential
Condo ST1	Assessed to be of low research potential
Condo ST2	Assessed to be of low research potential
Condo ST3	Assessed to be of low research potential
Nerathong ST	Assessed to be of low research potential
Wallaroi ST	Assessed to be of low research potential
Humbug CS1	Assessed to be of high research potential.

3.9 Recommendations

Site Recording Forms will be completed for each of the sites, and lodged with NPWS for listing on the Aboriginal Sites Register. The consequences of this will be that it will be necessary for the proponent to obtain a written consent for the destruction of any of the sites from Condobolin LALC, or the Wiradjuri Regional Aboriginal Land Council. Such consent is necessary to support an application for a Consent to Destroy to the NPWS, should it become the preferred option.

The recommended management option for each of the sites is as follows:

Iso.F1 This site is likely to be impacted upon either directly or by peripheral activities to the laying of the pipeline. A written agreement should be obtained from the Condobolin LALC or the Wiradjuri Regional Aboriginal Land Council to the destruction of the site, and an application for Consent to Destroy lodged with NPWS.

Iso.F2 This site will not be impacted upon by the proposed pipeline.

Iso.F3 It is presently uncertain whether the proposed pipeline will impact upon this site. If however it does then a written agreement should be obtained from the Condobolin LALC or the Wiradjuri Regional Aboriginal Land Council to the destruction of the site, and an application for a Consent to Destroy lodged with NPWS.

Iso.F4 This site is likely to be impacted upon either directly or by peripheral activities to the laying of the pipeline. A written agreement should be obtained from the Condobolin LALC or the Wiradjuri Regional Aboriginal Land Council to the destruction of the site, and an application for a Consent to Destroy lodged with NPWS.

Condo ST1 This site will not be impacted upon by the proposed pipeline. However, the proponents should ensure that those personnel or contractors laying the pipeline are informed of the presence of the tree, and instructed to avoid inflicting either direct damage to the tree, or disturbance to the root system. Highly visible temporary flagging should be erected around the tree, for a minimum radius of 10 metres, during any earthworks in the area.

Condo ST2 This site will not be impacted upon by the proposed pipeline. However, the proponents should ensure that those personnel or contractors laying the pipeline are informed of the presence of the tree, and instructed to avoid inflicting either direct damage to the tree, or disturbance to the root system. Highly visible temporary flagging should be erected around the tree, for a minimum radius of 10 metres, during any earthworks in the area.

Condo ST3 This site will not be impacted upon by the proposed pipeline. However, the proponents should ensure that those personnel or contractors laying the pipeline are informed of the presence of the tree, and instructed to avoid inflicting either direct damage to the tree, or disturbance to the root system. Highly visible temporary flagging should be erected around the tree, for a minimum radius of 10 metres, during any earthworks in the area.

Nerathong ST This site will not be impacted upon by the proposed pipeline.

Wallaroi ST This site will not be impacted upon by the proposed pipeline.

Humbug CS1 This site is of both high cultural significance and research potential, and there should be no impact to the site outside of the existing roadway and shoulders, and it is also recommended that subsurface investigation should be avoided in the areas outside the graded verges to minimise damage to the site. The timber beam bridge over Humbug Creek has recently been replaced by a concrete span bridge, but a sealed side track to the east of the bridge once provided an alternative route for wide or heavy traffic over the former bridge. As a consequence of the construction of the sidetrack, and more recently, as a consequence of the construction of the replacement bridge, there has been significant alteration to the creek bank adjacent to the bridge and the sidetrack. There are very few artefacts visible in these contexts.

It is recommended that the proposed pipeline should cross the creek within a strip delimited by a line 10m to the west of the bridge and by a line drawn 5m parallel to, and to the east of the side track, but ideally, should cross the creek between the bridge and the side track. The pipeline should be laid within the existing 'graded' profile of the road for at least 75m from the bridge on the south side, to at least 50m to the north side of the bridge. Highly visible temporary flagging should be erected along the edge of the graded strip to prevent vehicular and plant impact to the unaltered surfaces during the earthworks. Plant and vehicles should not be allowed outside the flagging.

It is further recommended that a representative of the Condobolin LALC or Wiradjuri RALC should be in attendance to monitor any earthworks for the pipeline within 75m south of the bridge to 50m north of the bridge.

Any artefacts disturbed or impacted upon by the earthworks should be salvaged and subject to analysis.

Site $^{\#}$35-4-0001

This site will not be impacted upon by the proposed pipeline.

SECTION 4. The proposed Fifield Bypass

4.1 The survey area

The proposed Fifield Bypass is approximately 3 km long, and will bypass the village to the southwest, connecting the Fifield to Wilmatha road and the Fifield to Condobolin road (Figure 7.3.1).

The bypass will comprise of two sections or legs. The first is a 1.6 km long north/south leg from the Fifield to Wilmatha road, which runs parallel to but outside the Fifield Golf Course boundary fence to a ‘Closed Road’. The bypass then takes a sharp turn to the southeast, and continues for a further 1.4 km within private property to connect with the Fifield to Condobolin road.

A 30 m wide corridor to the west and south of the respective fence lines was surveyed. The bypass route is shown in Figure 7.3.1.

4.2 The environment

The proposed route crosses gently undulating downs-like grazing and fodder-crop pastoral country. There is very little relief other than for a shallow water-filled depression towards the eastern end of the southern leg of the route, and a low rise midway along the same leg.

The paddocks through which the bypass crosses have been cleared, and are periodically ploughed for pasture improvement.

Elevations along the route dip from approximately 310m AHD at the northern end down to approximately 280m AHD at the eastern end.

Figures 7.4.1 to 7.4.4 on the following pages show various aspects of the route. No sites were recorded along the route during this investigation.

4.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites had previously been recorded in the area.

4.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, in which there are no shelters or overhangs, no distinct drainage lines, and in which there are no apparent naturally occurring stone resources for knapping material.

- Isolated artefacts may be present and visible in erosion features,
- Low-density artefact scatters may be present,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,

Figure 7.4.1 - Looking southwards down the northern leg of the bypass route, from the northern end

Figure 7.4.2 - Looking southwards from midway along the northern leg, towards the junction with the closed road.

Figure 7.4.3 - Looking eastwards from midway along the southern leg of the bypass route.

Figure 7.4.4 - Looking eastwards to the junction of the southern leg with the Fifield to Condobolin road.

- There is a potential for any trees of more than 150 years old to be scarred,
- There is a potential for any trees of more than 150 years old to be carved,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no middens,
- There are unlikely to be any intact occupation deposits,
- There are no known Mythological sites,
- There will be no stone quarries.

4.5 Effective survey coverage

See Table T.7.4.

4.6 Results

No sites were recorded along the proposed bypass route.

A tree with a surveyor's scar and galvanised roofing nail was observed near the fenceline towards the eastern end of the bypass route, but there were no marks in the scar area.

4.7 Discussion

The survey conditions were good and the ploughed paddock on the northern leg, and wheel tracks, scalding, and slopewash provided excellent archaeological visibility. Any archaeological material present on the ground surface would therefore have been visible.

Generally, the environment is devoid of useful resources other than perhaps those offered by box trees, which are frequently the homes of possums, birds, snakes, bats, and insects. There is no reliable water source, no shelter, and no visible stone material suitable for the manufacture of tools. It is therefore an environment, which while not hostile to travellers, is unlikely to have seen anything but brief Aboriginal visitation.

Table T.7.4 – Effective Survey Coverage
Proposed Fifield Bypass

Unit	Topography/ Environment	Approx. Area (map)	Rock/Soil	Vegetation	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed	Arch. Visibility of Exposures	Archaeology
1	Northern half of the northern leg from the Fifield to Wilmatha road (30m wide strip to the west of the fence line)	27,000 sqm (0.9km)	Brown earth	Cleared pasture under grass	Pasture	< 5%	Minor stock wear along fence line	85%	40%	Nil
2	Southern half of the northern leg to the 'closed road' (30m wide strip to the west of the fence line)	24,000 sqm (0.8km)	Brown earth tending to redder earths downslope	Cleared pasture	Pasture	85%	Ploughed surface	85%	85%	Nil
3	Western half of the southern leg to the central rise (30m wide strip to the south of the tree line)	18,000 sqm (0.6km)	Red earth prone to scalding	Cleared pasture	Pasture	75%	Vehicle tracks have become scalds	85%	95%	Nil
4	Eastern half of the southern leg from the central rise to the Fifield to Condobolin road (30m wide strip to the south of the tree line)	21,000 sqm (0.7km)	Weathered sedimentary red earths	Cleared pasture	Pasture	< 10%	Minor bare patches beneath trees	60%	60%	Nil
5	Bypass link to the Fifield to Condobolin road across the Road reserve (30m wide strip)	3,000 sqm (0.1km)	Weathered sedimentary red earths	Box with minor Casuarina	Road reserve	25%	Verges regularly graded	80%	30%	Nil

In such an environment the only artefactual material likely to be present would comprise of isolated artefacts and perhaps scarred trees. No artefactual material was observed, and the only scarred trees other than the tree with the surveyor's scar were those that had been scarred by galahs protecting their nests from tree climbers such as goannas and snakes.

It is extremely unlikely that any artefactual material of any significance is present, and if there are any sites, they are likely to be isolated artefacts.

4.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

4.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area.

4.8.2 Research potential

In the absence of any artefactual material along the proposed bypass route the assessment is that the route is of no research potential.

4.9 Recommendations

The recommendation is that there are no archaeological grounds to constrain the construction of the Fifield Bypass as proposed.

SECTION 5. The proposed Water Pipeline

5.1 The survey area

The proposed water pipeline is approximately 65 km long, and will connect the mine site with two Borefields on two properties, to the southeast of Mulguthrie Mountain (Figure 7.3.1).

For all but the last kilometre or so where the pipeline enters the borefields, the pipeline will run alongside roads and tracks within existing road easements.

From the northern point of entry onto the Fifield to Wilmatha road the pipeline will follow the proposed Fifield Bypass onto the Fifield to Condobolin road, and approximately 3 km to the south, turn eastwards onto the Fifield to Trundle road. It will then follow the latter for approximately 2 km, before turning southwards down the unsealed road to Ootha. The pipeline will pass Ootha to the west, and approximately 3 km to the south turn westwards at the ‘T’ junction. It will continue for a further kilometre before turning southwards towards Mulguthrie Mountain, passing the mountain to the east, and continue to the western borefield. The western borefield will be linked to the eastern borefield via an underground pipeline.

Figure 7.5.1 shows the known archaeological sites along the water pipeline route. No new sites were recorded during this investigation. Note that the map has been slightly reduced and is not a true 1:50,000 scale map.

5.2 The environment

North of the Lachlan River the proposed pipeline descends over gentle downs-like country of broad low rises that decrease in height towards the south. The proposed pipeline route exits the mine site at 300m AHD, then progressively descends over gentle rises to below 220m AHD west of Ootha. South of Ootha the route descends onto the Lachlan flood plain, on which elevations stay between 220m and 200m AHD.

The downs country to the north of the Lachlan is well drained, and has been cleared for wheat and cattle, but to the south of the Lachlan the flood-prone plains generally remain unaltered except for minor tree clearing, and is primarily cattle country.

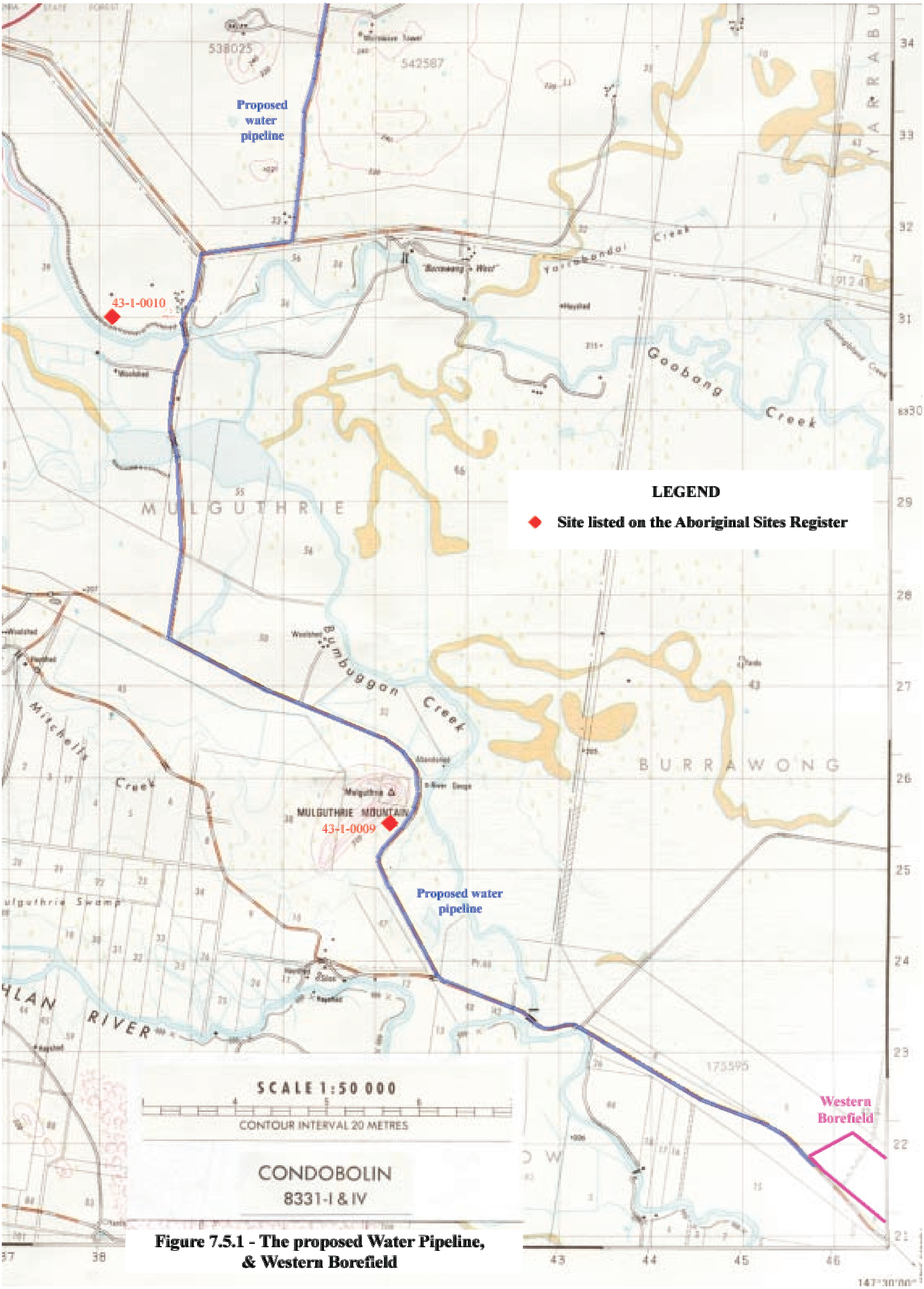


Figure 7.5.1 - The proposed Water Pipeline, & Western Borefield

Figures 7.5.2 to 7.5.5 on the following pages show various aspects of the route. No sites were recorded along the route during this investigation.

5.3 The archaeological record

A search of the Aboriginal Sites Register found that only two sites had previously been recorded in the area. Both sites are Carved Trees (sites #43-1-0010 and #43-1-0009 on the Aboriginal Sites Register), and appear on Figures 7.3.1 and 7.5.1.

Despite a thorough search neither of the carved trees were observed in the vicinity if their listed map reference points. As carved trees are commonly associated with burials, and because the map references for the trees placed them near the water pipeline route it was essential that either the trees or their original locations were identified.

The archaeologist at the Western Zone office of NSW NPWS was contacted, and asked to provide a copy of the Site Recording Form for the sites. Unfortunately he was only able to provide me with the Site Recording Form for one of the trees, site #43-1-0010, and the Zone office did not have a copy of the original report describing the sites.

NSW NPWS Head Office at Hurstville was contacted and a request made for relevant extracts from the original report, listed as C-65, and dated 13/05/85, of the information on the two trees (and the carved tree on the gas pipeline route). Subsequently, I received the tabled information included as Appendix v.

Site #43-1-0009 – 'Edol's Station'. Listed map reference 541156 6325505 AMG
(ISG Ref. 341169.999 1324255.172)
The tabled reference for this site was Etheridge 1918. In 1979 Bell and Urquhart performed an investigation of carved trees for NSW NPWS, but were unable to locate either the tree or the site. It is therefore probable that the map reference was based on Etheridge's map of 1918. In 1979 the only maps available for the region were 1: 250,000 scale Topographic Maps on which 1 mm represented 250 metres. As the listed map references are to the nearest metre, the references can only be approximations, and were probably transposed from Etheridge's map. The transposition of the location from a pre-1918 map to a 1: 250,000 scale map could have resulted in errors in the order of ±1,000 metres. It is extremely unlikely that the true original location of the tree will ever be known, and even if a burial was to be discovered in the area there can be no certainty that it is the same site.
For the purposes of this investigation the recording only serves to flag the potential for burials to be present in the general area.

Figure 7.5.2 - Looking southwards in the northern section of the Fifield to Ootha Road.

Figure 7.5.3 - Looking southwards in the southern section of the Fifield to Ootha Road.

Figure 7.5.4 - Looking southwards towards the bridge across Goobang Creek.

Figure 7.5.5 - Looking northwards along the bank of Bumbuggan Creek opposite Mulguthrie Mountain

Site #43-1-0010 – 'Mulguthrie, Coobong'. Listed map reference 538727 6331057 AMG
(ISG Ref. 338740.172 1329809.060)

The tabled information states that Bell and Urquhart reported that by 1979 the tree had been removed to the "Coobong" homestead. The Site Recording Form for this site includes a 'mud map' of how to reach the site, together with distances to the nearest 10 metres, and bearings to the nearest degree. It is therefore possible to accurately plot the location on to a 1: 50,000 scale map.

The replotted location places the site at 538100 6331000 AMG (ISG Ref. 338112.959 1329752.041). This is over 600 metres to the west and over 50 metres to the south of the listed location. Significantly this places the site 800 metres west of the road and therefore a considerable distance from the water pipeline.

5.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, in which there are no shelters or overhangs, and in which there are no apparent naturally occurring stone resources for knapping material, but in which there are ephemeral creeks, and significant creeks with waterholes, and a major river.

- Isolated artefacts may be present and visible in erosion features,
- Low-density artefact scatters may be present along the banks of creeks,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There is a potential for any trees of more than 150 years old to be scarred,
- There is a potential for any trees of more than 150 years old to be carved,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There is a potential for middens to occur along creek banks,
- There are unlikely to be any intact occupation deposits, but partially disturbed occupation deposits may occur along creek banks,
- There are no known Mythological sites,
- There will be no stone quarries.

5.5 Effective survey coverage

See Table T.7.5.

Table T.7.5 – Effective Survey Coverage
Proposed Water Pipeline

Unit	Topography/ Environment (road reserve)	Approx. Area (map) - (15m to either side of centre line)	Rock/Soil	Vegetation (in road reserve)	Land Use	Average surface visibility	Exposures	Approx Area Surveyed (includes road)	Arch. Visibility of Exposures	Archaeology
1	Section between The Mine Site and the proposed Fifield Bypass	150,000 sqm (5km)	Weathered sedimentary red earths	Box, Kurrajong, ironbark, cypress, Casuarina	Roadway - Shoulders and verges cleared	15%	Verges	75%	30%	Nil
2	Fifield Bypass to junction of Route 64 with Fifield to Ootha road	150,000 sqm (5km)	Weathered sedimentary red earths	Box, Kurrajong, ironbark, cypress, Casuarina	Roadway - Shoulders and verges cleared	25%	Verges	75%	50%	Nil
3	Junction of Route 64 and Ootha road to Kars Trig	570,000 sqm (19km)	Weathered sedimentary red earths	Box, Kurrajong, ironbark, cypress, Casuarina	Roadway - Shoulders and verges cleared	15%	Verges	75%	30%	Nil
4	Kars Trig to Ootha	360,000 sqm (12km)	Weathered sedimentary earths	Box, Kurrajong, ironbark, cypress, Casuarina decreasing southwards	Roadway - Shoulders and verges cleared	15%	Verges, and minor stock wear	75%	30%	Nil
5	Ootha to T junction north of Goobang Creek	150,000 sqm (5km)	Weathered sedimentary earths with alluvial soils in depressions and drainage lines	Box, Casuarina and scrub	Roadway - Shoulders and verges cleared	25%	Verges, and minor stock wear	75%	30%	Nil
6	North of Goobang Creek to road junction north of Lachlan River	300,000 sqm (10km)	Predominantly alluvial flood plain soils	Tall grasses and forbs	Roadway	< 5%	Negligible	75%	< 5%	Nil
7	Above to western borefield	150,000 sqm (5km)	Flood plain alluvium	Tall grasses and forbs	Roadway	< 5%	Minor stock wear	75%	20%	Nil

5.6 Results

No sites were recorded along the proposed water pipeline route.

5.7 Discussion

The absence of sites north of Ootha was very much as predicted. However, it was surprising that there were no sites south of Ootha, particularly on Goobang Creek, where there was good ground surface visibility, or at either the bridge over Bumbuggan Creek, or on the bank of Bumbuggan Creek opposite Mulguthrie Mountain. Each of these locations, which occur on flood plain soils, has been subjected to constant stock trampling and this may in part account for the absence of material. Nevertheless, stock trampling has also exposed large areas of ground surface, and at least a low-density artefact scatter was anticipated.

The fact that carved trees have been recorded in the vicinity of two of the locations would also indicate that these were places that Aboriginal people frequented.

Mr Williams was not aware of any cultural significance attached to Mulguthrie Mountain. However, the dominance of the mountain over the floodplain, and the possible carved tree location at the base of the eastern slopes, would indicate that the mountain might have been of cultural significance in the past, and that there is a potential for sites to be present on the mountain. It is also probable that artefactual material is present on the flood plain to the north and east of the mountain, between the mountain and Bumbuggan Creek.

5.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

5.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area, other than the two carved trees. These tree locations are of high cultural significance and should be avoided.

5.8.2 Research potential

In the absence of any artefactual material along the proposed water pipeline route the assessment is that the route is of no research potential.

5.9 Recommendations

It is recommended that the water pipeline route along the section between Ootha and the southern end of the pipeline should be within a 10m strip to the east of the road. This would reduce the likelihood of impacting on any buried skeletal material. Road and table-drain maintenance has disturbed the surface deposits within this strip in many places, and while buried material might be present below the disturbed horizon, the fact that there is no evidence of graves or skeletal material in the disturbed layer must reduce the possibility that there is an archaeological context below the surface.

With the exception of these provisions there are no archaeological grounds to constrain the laying of the pipeline as proposed.

SECTION 6. The proposed Water Borefields and Pipeline Link

6.1 The survey area

The water Borefields comprises of two areas, the western borefield, and the eastern borefield. An underground pipeline will link the two borefields. At the time of this survey the final pipeline link route had not been selected and the brief was to survey two route options (Figure 1).

The borefield area is on the northern floodplain of the Lachlan River, to the southeast of Mulguthrie Mountain, and south of Ootha. The survey area and pipeline link routes occur in two properties, "Astron Park" and the Ridley property, within the triangle formed by the junction of North Condobolin Road and Yarrabandai Warroo Road.

The western borefield is an irregularly shaped, but generally trapezoid area, bounded by the North Condobolin Road along its southern and longest boundary, and the other three boundaries are delimited by fence lines. The survey area is approximately 2,000 metres long, by 1,100 metres wide at the eastern end, decreasing to 500 metres at the western end.

The eastern borefield is an irregularly shaped area, with arbitrarily determined boundaries, with a longest dimension of approximately 1,500 metres (north to south), and a width of approximately 900 metres.

Pipeline Link Route Option 1 follows the fenceline, from midway along the northern boundary of the eastern borefield, northwards towards the "Astron Park" homestead, for approximately 1,500 metres. At that point the route turns at right-angles towards the west and follows the fenceline for approximately 3,800 metres. It then veers to the southwest following the fenceline for approximately 300 metres where it meets the eastern boundary of the western borefield.

Pipeline Link Route Option 2 follows the fenceline from the southwestern corner of the eastern borefield for approximately 3,000 metres. For the last 900 metres the pipeline route follows the edge of a levee bank. When it reaches the corner of the levee bank the route turns at right angles towards the south, following the levee bank for approximately 400 metres. The route then turns at right-angles back towards the northwest, and follows the fence line for 1,300 metres, where it meets the southeastern corner of the western borefield.

At the time of the survey no layout plans had been developed for the study area, and so the brief was to assess the archaeological significance of the areas described above.

The two borefields and pipeline link route options are shown on the map presented as Figure 7.6.1. The western end of the western borefield is shown in Figure 7.5.1. Note that the maps have been slightly reduced and are not true 1: 50,000 scale maps.

6.2 The environment

The survey area is on the generally flat floodplain of the Lachlan River, immediately downstream of the junction of Bumbuggan Creek with the Lachlan, and opposite the junction of Ulgutherie Creek with the Lachlan. As a consequence significant flooding occurs in the area of the western borefield whenever the river backs-up in major floods. Flooding also occurs in the area of the eastern borefield, but to a lesser extent. Despite the absence of contouring in Figure 7.6.1 the eastern borefield is more elevated than the western borefield, and has more clearly defined drainage lines and depressions. Minor flooding had occurred in an ephemeral wetland area at the western end of the major drainage line from the eastern borefield, at the time of this investigation – see Figure 7.6.9.

Vegetation in the survey area varied according to land use. As referred to above the western borefield is flood prone, and at the time of the survey the western half was under a dense, tall grass cover on cracking soils. The heavy, dark floodplain sediments of the eastern half had recently been ploughed. The eastern borefield was bare of vegetation and had recently been ploughed.

There is no vegetation of note along the pipeline link Route Option 1, and only a few isolated trees along Route Option 2.

The photographic record presented as Figures 7.6.2 to 7.6.9 on the following pages show various aspects of the borefields and link routes.

6.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites have been recorded in the study area.

6.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, which has been cleared, and in which there are no shelters or overhangs, and in which there are no apparent naturally occurring stone resources for knapping material, but which contains ephemeral drainage lines and swamps or wetlands.

- Isolated artefacts may be present and visible in erosion features, but it is unlikely,
- Low-density artefact scatters may be present in erosion features, but it is unlikely,
- There will be no art sites,

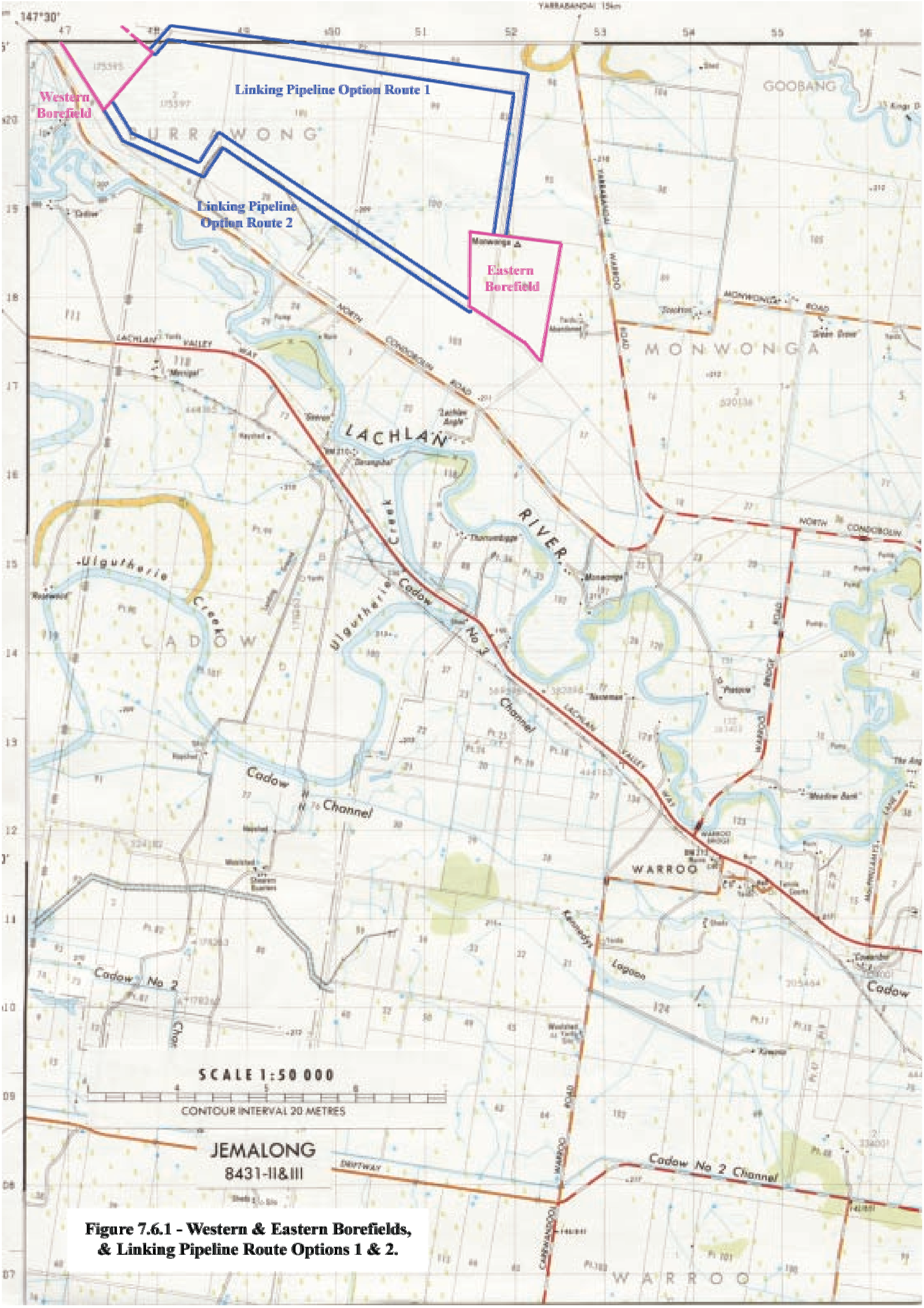


Figure 7.6.1 - Western & Eastern Borefields, & Linking Pipeline Route Options 1 & 2.

Figure 7.6.2 - Looking southeastwards into the western borefield from the North Condobolin Road

Figure 7.6.3 - Looking northeastwards across the western borefield from the eastern boundary.

Figure 7.6.4 - Looking northeastwards across the eastern borefield from the southwestern corner

Figure 7.6.5 - Looking northwards up Route Option 1, from the northern end of the eastern borefield.

Figure 7.6.6 - Looking northwards along Route Option 1, from the eastern borefield.

Figure 7.6.7 - Looking westwards along Route Option 1, from midway along the route.

Figure 7.6.8 - Looking southeastwards towards the eastern borefield, in the eastern section of Route Option 2.

Figure 7.6.9 - Looking northwestwards towards the ephemeral wetland, midway along Route Option 2.

- There will be no surfaces exhibiting engravings, or grinding grooves,
- There will be no scarred trees,
- There will be no carved trees,
- There will be no evidence of burials, although there is some potential for them to be present,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no discrete middens, although there may be scattered shell etc.,
- There will be no intact occupation deposits,
- There are no known Mythological sites,
- There will be no stone quarries.

6.5 Effective survey coverage

See Table T.7.6.

6.6 Results

No sites were recorded in the study area.

6.7 Discussion

The survey area occurs in flood-prone country, which would have been navigable by canoe when in flood, and rich in food resources after the floodwaters had subsided. The Lachlan River was a permanent water source, and the large river gums along its banks would have provided, shelter, food, and bark and wood for tools and implements. The Lachlan would have been a focus of Aboriginal activity and occupation, and the floodplain would have provided readily available alternatives to the riverine diet and subsistence strategies.

In a situation such as this where the survey area is within a few hundred metres of the banks of the Lachlan, it is probable that camp sites would have been along the river banks. The nearest camp sites to those on the river bank were probably ‘hinterland’ camp sites in the higher country to the north, to which people moved during flooding. The survey area would have been well within a day’s walk of the camp sites and so its primary function was probably as a hunting and collecting area, or merely as a route between camp sites.

Table T.7.6 – Effective Survey Coverage
Western and Eastern Borefields and Linking Pipeline Route Options 1 and 2

Unit	Topography/ Environment	Approx. Area (map)	Rock/Soil	Vegetation	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed	Arch. Visibility of Exposures	Archaeology
1	Western section of the western borefield	500,000 sqm	Floodplain alluvium	Tall grasses with minor tree growth along an apparent drainage line	Pasture	0%	None	< 5%	0%	Nil
2	Eastern section of the western borefield	350,000 sqm	Floodplain alluvium	Cleared	Ploughed pasture	85%	Stock wear and plough zone	75%	85%	Nil
3	Eastern borefield	1,000,000 sqm	Friable flood plain earths	Cleared	Ploughed pasture	55%	Plough zone with new grass to 10 cm	60%	30%	Nil
4	North/south section at eastern end of Route Option 1 (15m to either side of fence line)	51,000 sqm (1.7km)	Friable flood plain earths tending to sedimentary earths towards the north	Cleared	Pasture	35%	Plough zone with new grass to 10 cm	85%	30%	Nil
5	East/west section of Route Option 1 (15m to either side of fence line)	129,000 sqm (4.3km)	Sedimentary earths becoming heavier and more blocky and darker towards the west	Cleared	Pasture	40%	Stock wear, and recent surface scrape of a fenceline track by a grader	70%	20%	Nil
6	Eastern section of Route Option 2 (15m to either side of fence line)	30,000 sqm (1km)	Friable flood plain earths	Cleared	Pasture	75%	Plough zone & pasture to north of fence line, stock wear to south	75%	30% to north, < 10% to south	Nil
7	Mid-section of Route Option 2 (15m to either side of fence line)	18,000 sqm (0.6km)	Flood plain earths becoming heavy in the central drainage line	Wetland and box woodland to south of the fence line, cleared to the north of the fence line	Ploughed pasture to north of fenceline, pasture to south of fenceline	75% to north of fenceline, < 20% to south	Plough zone to north of fenceline, swampy claypan to south	50%	80% to north, 30% to south	Nil
8	Western section of Route Option 2 (15m to either side of the fence line)	93,000 sqm (3.1km)	Heavy blocky dark earths	Cleared	Pasture	60%	Plough zone	20%	60%	Nil

Few obvious resources were observed in the study area during the survey, but numerous birds' nests in the vicinity of the wetland area would have provided a very easily obtained food source. A nearby dense clump of remnant woodland of very old box trees in which many trees exhibited hollows and broken limbs would have been a source of possums, goannas, snakes, birds, birds' eggs, insects, and 'sugarbag' (the honeycomb of native bees).

The absence of artefactual material in the survey area would suggest that Aboriginal people did not utilise the area or its resources, but I think that on the contrary, the area in the vicinity of the wetland would have been frequented by the Aboriginal occupants of the river banks, and that the absence of artefactual material is primarily because the activities that were performed in this environment required few tools tools. Some tools such as stone axes, with which to cut into the hollow box trees, may have been used but the frequent inundation of the floodplain and deposit of silts released in land clearing over the last hundred and fifty years would have buried the tools.

The soft floodplain soils might also conceal burials, but these will only be discovered in river-bank erosion, or during earthworks.

If burials are present they are more likely to occur nearer major waterways and the more permanent occupation areas, than at a distance from them. For this reason and the fact that the wetland on Route Option 2 was probably a potentially resource-rich environment and the potentially most archaeologically sensitive area within the study area, I recommend that Route Option 1 should be the preferred route. If however, this is not practical and Route Option 2 is selected then earthworks in the vicinity of the wetland should be monitored by an Aboriginal representative of the Condobolin Aboriginal Community.

6.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

6.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area.

6.8.2 Research potential

In the absence of any artefactual material in the survey area the assessment is that it is of no research potential.

6.9 Recommendations

The recommendation is that there are no archaeological grounds to constrain development of the two borefields as proposed. However, for the reasons stated above I recommend that Route Option 1 should be the preferred pipeline link route. If however, this is not practical and Route Option 2 is selected then earthworks in the vicinity of the wetland should be monitored by an Aboriginal representative of the Condobolin Aboriginal Community.

SECTION 7. The proposed Limestone Quarry

7.1 The survey area

The proposed Limestone Quarry is to the north of, and adjacent to the Fifield to Trundle road, approximately 15 km to the southeast of Fifield (Figure 1).

At the time of the survey no site plans had been developed for the quarry, and so the brief was to assess the archaeological significance of the study area.

7.2 The environment

The site occurs in a cleared strip of what was open dry sclerophyll woodland and grassland. The low hill is composed of limestone and there is only very shallow and generally infertile topsoil on the crest and slopes. There are a few isolated eucalypts on the crest of the hill but the slopes have been cleared in pasture improvement. Colluvial soils at the base of the slopes to the west and northeast have been ploughed, but the vast majority of the survey area is too poor to support all but weed and coarse grasses and forbs.

The hill occurs as a low rise in the middle of the Gillenbine Creek plain, and elevations vary from approximately 250m AHD on the surrounding plain, up to 261m AHD at the summit of the rise.

Figures 7.7.1 to 7.7.4 on the following pages shows various aspects of the survey area.

7.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites have been recorded in the survey area.

7.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, which has been cleared, and in which there are no shelters or overhangs, no drainage lines, and in which there are no apparent naturally occurring stone resources for knapping material.

- Isolated artefacts may be present and visible in erosion features, but it is unlikely,
- Low-density artefact scatters may be present in erosion features, but it is unlikely,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There is a potential for any trees of more than 150 years old to be scarred,
- There is a potential for any trees of more than 150 years old to be carved,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no middens,
- There will be no intact occupation deposits,
- There are no known Mythological sites,
- There will be no stone quarries.

Figure 7.7.1 - Looking westwards towards the rise from the eastern boundary.

Figure 7.7.2 - Looking south-westwards towards the rise from "The Troffs"

Figure 7.7.3 - Looking northwards across the summit of the rise.

Figure 7.7.4 - One of numerous piles of limestone boulders at the edges of the paddocks on the slopes.

7.5 Effective survey coverage

See Table T.7.7.

7.6 Results

No sites were recorded in the study area.

7.7 Discussion

The low limestone rise would have had few resources to attract the attention of the Aboriginal occupants of the region. The ground surface was rocky, there are no water resources, there would have been little shelter other than that provided by isolated trees, and it is probable that the only food resources were kangaroos, and goannas. Perhaps the one attribute the rise did possess was that it was a good vantage point, providing a 360-degree view of the plain.

There are no apparent stone resources in the area, and so anyone using the rise as a vantage point would have had to obtain the stone for any tools or weapons they carried from elsewhere. It is therefore unlikely that if any stone artefacts are present on the rise, that they are more than small isolated flakes, discarded during tool maintenance, or lost in transit. Such artefacts would be extremely difficult to observe on the grass and weed covered ground surface.

It is probable that people did occasionally use the summit of the hill purely as a strategic viewing platform, but it is unlikely that any artefactual remains will be recovered.

The absence of artefactual material in the survey area was as predicted.

7.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

Table T.7.7 – Effective Survey Coverage
Proposed Limestone Quarry

Unit	Topography/ Environment	Approx. Area (map)	Rock/Soil	Vegetation	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed	Arch. Visibility of Exposures	Archaeology
1	The central rise formed by the limestone deposit	500,000 sqm	Limestone bedrock with surface rubble of weathered limestone	Tall grasses with isolated box gums on the summit	Pasture	<10%	Bare rock and minor stock wear	<5%	30%	Nil
2	The eastern lower slopes	1,200,000 sqm	Stony weathered limestone tending towards brown earths downslope	Cleared	Pasture	15%	Stock wear and minor slope wash	75%	20%	Nil
3	The southern and western slopes	870,000 sqm	Stony weathered limestone tending towards brown earths downslope, and redder earths towards the south-west	Cleared with isolated box in the south-western corner	Pasture	25%	Stock wear and a vehicle track	60%	95%	Nil
4	The north-western slopes	640,000 sqm	Stony weathered limestone tending towards brown earths downslope	Cleared and ploughed	Pasture	65%	Plough zone	20%	60%	Nil

7.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area.

7.8.2 Research potential

In the absence of any artefactual material on the site of the Proposed Limestone Quarry the assessment is that the site is of no research potential.

7.9 Recommendations

As a consequence of this survey, and in the absence of any known constraints on the basis of Indigenous cultural grounds, it is recommended that development of the Limestone Quarry should be permitted to proceed as proposed.

SECTION 8. The Proposed Transport Route (Route 64)

8.1 The survey area

The proposed Transport Route (Route 64) will connect the mine via the proposed Fifield Bypass, to the proposed Limestone Quarry, and continue eastwards to the proposed rail siding, adjacent to the Tottenham Bogan Gate Railway, and the Tullamore to Bogan Gate Road (Figure 1). For the purposes of this report, and because the proposed Fifield Bypass is discussed elsewhere, the section of road described in this section is from the northern end of the Fifield to Ootha road to the proposed rail siding, a distance of approximately 25 km.

For the entire length of this section the route will follow an existing sealed two-lane road. However, to facilitate the increase in traffic the road will be upgraded. For the purposes of the investigation the survey and assessment was of the road verges within a strip defined as being the area delimited by lines 15m to either side of the road centre line.

8.2 The environment

From the western end of the section the route gently descends across the western slopes of a broad plain, bisected approximately midway by Gillenbine Creek, then ascends the gentle rise of the eastern slopes, between the proposed Limestone Quarry and the proposed Rail Siding.

Elevations vary little throughout the length of this section, from just below 280m AHD at the western end, dipping to about 250m AHD at Gillenbine Creek, and ascending to about 270m AHD at the Rail Siding site.

This is generally well drained country, and has been cleared for wheat and cattle, but a patchy remnant strip of woodland survives within the road reserve. Vegetation along the route comprises of a remnant strip of dry sclerophyll open woodland dominated by box gum, and isolated trees and minor regrowth. Much of the narrow road reserve has been subjected to massive disturbance from road widening and maintenance to the table drains.

The photograph presented as Figure 7.8.1 (in the following section) shows a typical aspect of Route 64.

8.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites have been recorded along Route 64.

8.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, which has been significantly altered in road construction and maintenance, and in which there are no shelters or overhangs, only one ephemeral creek crossing, and in which there are no apparent naturally occurring stone resources suitable for knapping material.

- Isolated artefacts may be present and visible in erosion features, but it is unlikely,
- Low-density artefact scatters may be present in erosion features, but it is unlikely,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There is a potential for any trees of more than 150 years old to be scarred,
- There is a potential for any trees of more than 150 years old to be carved,
- There will be no evidence of burials,

- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no middens,
- There will be no intact occupation deposits,
- There are no known Mythological sites,
- There will be no stone quarries.

8.5 Effective survey coverage

See Table T7.8.

8.6 Results

No sites were recorded along the proposed Transport Route.

8.7 Discussion

The absence of sites along the proposed route was as predicted. The road reserve has been significantly disturbed and if any artefactual material had been present before construction of the road, it would now be buried beneath the banks of soil that have been excavated for the table drains.

The degree of disturbance, however, is probably of little consequence as it is unlikely that there ever were any sites of significance within the road reserve. This is very dry, generally featureless country, with few resources that were not available near more reliable watercourses to the south. If people were using this country they were probably in transit between preferable environments, and even then, it is probable that they used the water courses as routes.

8.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

Table T.7.8 – Effective Survey Coverage
Proposed Transport Route (Route 64)

Unit	Topography/ Environment (of the road reserve)	Approx. Area (map)	Rock/Soil	Vegetation (in the road reserve)	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed (includes road)	Arch. Visibility of Exposures	Archaeology
1	The western section from the Fifield to Condobolin road to the "Steeton" homestead turn-off (15m to either side of the centre line)	180,000 sqm (6km)	Weathered sedimentary red earths	Remnant ribbon of box woodland with Casuarina and ironbark	Road reserve	25%	Recent road widening and verge maintenance	80%	80%	Nil
2	From the "Steeton" turn-off to the "Westella" homestead turn-off (15m to either side of the centre line)	180,000 sqm (6km)	Weathered sedimentary red earths with darker earths in the lower areas of the flood plain	Remnant ribbon of box woodland with Casuarina and ironbark	Road reserve	< 10%	Verges	75%	30%	Nil
3	From the "Westella" turn-off to the proposed Rail Siding	225,000 sqm (7.5km)	Weathered sedimentary red earths	Remnant ribbon of box woodland with Casuarina and ironbark	Road reserve	10%	Verges	75%	30%	Nil

8.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area.

8.8.2 Research potential

In the absence of any artefactual material along the proposed Transport Route the assessment is that the route is of no research potential.

8.9 Recommendations

As a consequence of this survey, and in the absence of any known constraints on the basis of Indigenous cultural grounds, it is recommended that the upgrade of Route 64 should be permitted to proceed as proposed.

SECTION 9. The proposed Rail Siding and Access Road

9.1 The survey area

The proposed Rail Siding will provide a railhead for the proposed mine, adjacent to the Tottenham Bogan Gate Railway, and the Tullamore to Bogan Gate Road (Figure 1).

The site of the proposed Rail Siding is to the east of the railway line, in a wedge-shaped area enclosed by the Railway line, an unnamed graded track down the eastern flank, and by a property boundary fenceline along the southern boundary. The length of the property is approximately 600m, and the greatest width (at the southern end) is approximately 50m.

The access road to the rail siding will be the unnamed graded track referred to above. This will require upgrading for the length of the rail siding and the potential impact area has been assessed as 15 m to either side of the centre line of the existing track.

9.2 The environment

The rail siding site occurs in a cleared strip of what was dry sclerophyll woodland. Some minor regrowth has occurred but the block is generally blanketed under a dense grass cover to a height of more than 50cm.

The block occurs on the broad level summit of a low rise that dips to flood-prone country to the east and the west.

Elevations throughout the block are generally about 270m AHD, and falls across the site are probably less than 5m.

The graded unnamed track runs through sparse open dry sclerophyll woodland dominated by box gum.

The photographs presented as Figures 7.9.1, 7.9.2 and 7.9.3 show various aspects of the proposed rail siding site.

9.3 The archaeological record

A search of the Aboriginal Sites Register found that no sites have been recorded in the survey area.

Figure 7.8.1 - Looking eastwards along the Proposed Transport Route

Figure 7.9.1 - Looking southwards down the western boundary of the Rail Siding site - note the graded track.

Figure 7.9.2 - Looking northwards along the western boundary of the Rail Siding site.

Figure 7.9.3 - Looking north-eastwards across the Rail siding site.

9.4 The predictive model

Based on all of the above the following model for site distribution was proposed for the study area, which has been cleared, and in which there are no shelters or overhangs, no drainage lines, and in which there are no apparent naturally occurring stone resources suitable for knapping material.

- Isolated artefacts may be present and visible in erosion features, but it is unlikely,
- Low-density artefact scatters may be present in erosion features, but it is unlikely,
- There will be no art sites,
- There will be no surfaces exhibiting engravings, or grinding grooves,
- There will be no scarred trees,
- There will be no carved trees,
- There will be no evidence of burials,
- There will be no surviving Bora rings,
- There will be no surviving stone arrangements,
- There will be no middens,
- There will be no intact occupation deposits,
- There are no known Mythological sites,
- There will be no stone quarries.

9.5 Effective survey coverage

See Table T.7.9.

9.6 Results

No sites were recorded on the site of the proposed Rail Siding or along the Access Road.

Table T7.9 – Effective Survey Coverage
Proposed Rail Siding and Access Road

Unit	Topography/ Environment	Approx. Area (map)	Rock/Soil	Vegetation	Land Use	Average Surface Visibility	Exposures	Approx Area Surveyed	Arch. Visibility of Exposures	Archaeology
1	The flat and featureless area of the proposed Rail Siding	60,000 sqm	Weathered sedimentary earths	Cleared with minor eucalypt regrowth, but generally blanketed in tall grass	Presently fallow, was probably pasture	< 5%	Minor exposures in paddock, recent track graded along western boundary (for track maintenance?)	40% of paddock, 100% of graded track	10% in paddock, 95% in graded track	Nil
2	The existing graded road which it is proposed will be upgraded for the Access Road (15m to either side of the centre line)	18,000 sqm (0.6km)	Weathered sedimentary earths	Remnant open box woodland	Road reserve	< 10%	Table drain	25%	30%	Nil

9.7 Discussion

Despite the dense ground cover throughout the site an excellent opportunity to examine the surface deposits was provided by a recently graded track. The track runs parallel to the railway line and presumably has been made to provide access to the track for railway maintenance crews. The track has been graded to a depth varying from ground level down to 15cm below ground level, and the exposed surface and flanking spoil heap provided near perfect archaeological visibility. As the track follows the longest boundary of the Proposed Rail Siding it provided an ideal sample transect survey for the length of the site.

The absence of artefactual material on the sites was as predicted.

The comments relevant to this section are the same as those for the previous section. This is very dry, generally featureless country, with few resources that were not available near more reliable watercourses to the south. If people were using this country they were probably in transit between preferable environments, and even then, it is probable that they used the water courses as routes.

9.8 Significance assessment

The NPWS policy to safeguard all sites, Aboriginal places, and archaeological material of significance wherever possible requires that some means of assessing the significance of sites is necessary. This is not only for the purpose of determining whether the proposed development can proceed as proposed, but also to provide Cultural Resource Managers with the information for future management of the area.

9.8.1 Cultural significance

The Aboriginal or cultural significance of Aboriginal relics and sites can only be assessed by the Aboriginal community, and in particular, the Elders. It is the responsibility of the archaeologist to ensure that the Elders, or elected representatives of the Aboriginal community are advised of the survey results, and are consulted as to their knowledge and opinion of the significance of the area, and to transcribe and present those expressions in report form.

Mr Williams was not aware of any places of Aboriginal significance in the area.

9.8.2 Research potential

In the absence of any artefactual material on the site of the Proposed Rail Siding or along the access road the assessment is that neither is of research potential.

9.9 Recommendations

As a consequence of this survey, and in the absence of any known constraints on the basis of Indigenous cultural grounds, it is recommended that construction of the Rail Siding and upgrading of the access road should be permitted to proceed as proposed.

8. SUMMARY

As a result of this investigation a number of sites were recorded on or in the vicinity of the proposed works. Each of the new sites will be recorded on Site Recording Forms which will be lodged with NSW NPWS for inclusion on the Aboriginal Sites Register. In Table T.8.1 these sites are identified with the proposed works, together with the recommended management of the sites.

The proponents are advised that as well as the management recommendations set out in Table T.8.1 that under the obligations and provisions imposed by the National Parks and Wildlife Act 1974 they are obliged to comply with the following provision:

> All earthmoving contractors and operators should be instructed that in the event of any bone or stone artefacts, or discrete distributions of shell, being unearthed during earthmoving, work should cease immediately in the area of the find, and the Condobolin Local Aboriginal Land Council, and officers of the National Parks and Wildlife Service, informed of the discovery. Work should not recommence in the area of the find, until those officials have inspected the material and permission has been given to proceed. Those failing to report a discovery and those responsible for the damage or destruction occasioned by unauthorised removal or alteration to a site or to archaeological material may be prosecuted under the National Parks and Wildlife Act 1974, as amended.

Table T.8.1 – Table of Sites Recorded During this Investigation, and the Recommended Management Strategy

Site Name	AMG	ISG	Map Name	Site Type	Proposed Development	Potential Impact	Management
Syerston 1	539570 6375950	339583.459 1374717.330	Fifield 8332-II & III	Isolated artefact	Mine	Probable impact from pit development	Consent to Destroy may be necessary, or it may be possible to fence the site
Syerston 2	538280 6374200	338293.020 1372966.735	Fifield 8332-II & III	Open scatter	Mine	Unlikely to be impacted	Fence if practical. Consent to Destroy will be necessary if impact cannot be avoided
Syerston 3	538290 6373070	338303.024 1371836.350	Fifield 8332-II & III	Isolated artefact	Mine	No impact likely	No action necessary
Syerston ST1	536800 6375050	336812.517 1373817.024	Fifield 8332-II & III	Scarred tree	Mine	No impact likely	No action necessary
Iso.F1	533680 6367300	333691.456 1366064.388	Fifield 8332-II & III	Isolated artefact	Gas Pipeline	Will be destroyed if pipeline is within 10m of the fenceline	Fence if practical, otherwise a Consent to Destroy will be necessary if impact cannot be avoided
Iso.F2	533400 6367720	333411.361 1366484.531	Fifield 8332-II & III	Isolated artefact	Gas Pipeline	No impact likely	No action necessary
Iso.F3	531920 6366100	331930.857 1364863.980	Fifield 8332-II & III	Isolated artefact	Gas Pipeline	No impact likely	No action necessary
Iso.F4	532450 6361920	332461.037 1360682.558	Fifield 8332-II & III	Isolated artefact	Gas Pipeline	No impact likely	No action necessary
Condo ST1	514890 6337700	314895.065 1336454.320	Condobolin 8331-I & IV	Scarred tree	Gas Pipeline	No impact likely	Exercise caution
Condo ST2	514890 6337800	314895.065 1336554.354	Condobolin 8331-I & IV	Scarred tree	Gas Pipeline	No impact likely	Exercise caution
Condo ST3	514890 6337860	314895.065 1336614.374	Condobolin 8331-I & IV	Scarred tree	Gas Pipeline	No impact likely	Exercise caution
Nerathong ST	511650 6333350	311653.963 1332102.840	Condobolin 8331-I & IV	Scarred tree	Gas Pipeline	No impact likely	No action necessary
Wallaroi ST	509390 6225270	309393.194 1223986.078	Condobolin 8331-I & IV	Scarred tree	Gas Pipeline	No impact likely	No action necessary
Humbug CS1	508650 6316550	308652.942 1315297.126	Fairholme 8331-II & III	Camp Site	Gas Pipeline	Will be impacted upon, but impact may be mitigated by using disturbed area adjacent to the road & bridge	Pipeline to be laid within specified corridor. Earthworks to be monitored by a representative of/for Condobolin LALC

Table T.8.1 (Continued) – Table of Sites Recorded During this Investigation, and the Recommended Management Strategy

Site Name	AMG	ISG	Map Name	Site Type	Proposed Development	Potential Impact	Management
SITES PREVIOUSLY RECORDED							
Lara, Boxdale	528911 6363773 s/b 529925 6362600	328920.834 1362536.188 329935.179 1361362.789	Fifield 8332-II & III	Carved tree	Gas Pipeline	Will not be impacted upon	Revised location places tree over 1,000 metres from listed location
Edol's Station	541156 6325505	341169.999 1324255.172	Condobolin 8331-I & IV	Carved tree	Water Pipeline	Not known. Listed location unreliable	Location uncertain. Exercise caution in area of listed location
Coobong, Mulguthrie	538727 6331057 s/b 538100 6331000	338740.172 1329809.060 338112.959 1329752.041	Condobolin 8331-I & IV	Carved tree	Water Pipeline	Will not be impacted upon	Revised location places tree over 600 metres from listed location

GENERAL GLOSSARY: The definitions that follow are for terms used in this and other reports written by the author, and do not necessarily apply to their use in different contexts.

ADZE : A modified flake with at least one steeply-retouched working edge. While all adzes are generally considered to be wood-working tools it is probable that some also served as cores and others as scrapers. Adzes with a uniform butt were frequently hafted to make a chisel-like tool, but the intended use of the adze determined the size of the adze and whether it was hafted (Flenniken and White, 1985).

ARCHAEOLOGICAL DEPOSIT : Sediments which contain evidence of past Aboriginal use of the place, such as artefacts, hearths, burials etc.

ARTEFACT : Any object that has attributes as a consequence of human activity (Dunnell, 1971). In this report artefacts has been used generally to describe pieces of stone that have been modified to produce flakes, flaked pieces, cores, hammerstones, or axes.

BACKED BLADE : A stone tool manufactured from a flake on which one margin has been modified by the removal of small flakes to blunt the edge or margin opposite the cutting edge.

BORA GROUND : A ceremonial site comprising of one or two connected circles composed of compacted or mounded earth, or defined by an arrangement of stones, of 2 to 30m diameter, generally used in male initiation rites.

CAMPSITE : A place at which the density of artefacts and the variety of material indicates that people ‘frequently’ used the place as a stopping or resting place. Such places are also likely to contain or be close to water resources, food resources, or stone material resources. In this report a campsite is used to describe artefact scatters that are associated with hearths or fireplaces; as distinct from scatters that are not associated with hearths or fireplaces, which are described as Open Scatters.

CHALCEDONY : A form of silica (partially translucent), which occurs as linings in cavities in rocks. When banded it is known as AGATE (Department of Mines, 1973). Chalcedony is uniformly coloured and agate has curved bands or zones of varying colour (Cook & Kirk, 1991).

CHERT : Another name for sedimentary chalcedony. It occurs most frequently in limestones, or in marine sedimentary rock, or as pebbles in sedimentary rock. In its depositional context it is often concentrated in bedding planes. Chert found in deep-water limestones is formed from radiolaria and diatoms (siliceous planktonic micro-organisms) (Cook & Kirk, 1991).
Chert is a form of amorphous or extremely fine-grained silica, partially hydrous, found in concertions and beds. It is classified as a chemical sedimentary rock although it may be precipitated both organically and inorganically (Department of Mineral Resources, n.d.).

CONGLOMERATE : Naturally cemented gravel. Conglomerate is a coarse-grained clastic sedimentary rock composed of generally rounded fragments of other rock types larger than 2 mm in diameter, set in a fine-grained matrix of sand, silt, or any of the common natural cementing materials (Department of Mineral Resources, n.d.).

CORE : A piece of stone from which flakes have been removed, that cannot otherwise be described as a retouched or modified artefact.

CORTEX : The naturally altered surface of stone – eg. the water-worn surface of river pebbles.

DEBITAGE : The small waste material observed in knapping floors. Generally, waste material is described as all those fragments having a maximum dimension of less than 10mm

FLAKE : A fragment of stone exhibiting features indicating that it has been deliberately removed from a core piece. These features are evident as:

i) Platform: Plane or point at which a blow was delivered to remove the flake.

ii) Bulb of Percussion: Convex surface that occurs on the face or ventral surface of a flake, radiating from the point of impact, produced as a consequence of the force pattern.

iii) Eraillure: see below.

Other terms:

i) Dorsal: The back or outer face of a flake as it would have been prior to removal from a core. Frequently either ridged or exhibiting negative flake scars when removed in secondary flaking, with a natural weathered cortex when removed in primary flaking.

ii) Ventral: The 'chest' or inner face of a flake as it would have been prior to removal from the core. The surface upon which the Bulb of Percussion occurs.

iii) Platform Preparation: The removal of flakes from a surface to produce a level platform. May be evidenced by retouch scars to the platform.

iv) Retouch: The removal of small flakes from an edge or margin of an artefact to modify its shape or resharpen its edge.

v) Proximal: The end of a flake closest to the striking platform.

vi) Distal: The end of a flake furthest from the striking platform.

vii) Margin: The edge of an artefact.

viii) Eraillure: A small circular to elliptical negative flake scar occurring on the surface of the bulb of percussion on flakes of very fine-grained or highly silicified material. It occurs 'naturally' as a consequence of internal forces generated at the time of flake removal.

ix) Split Cone: Occurs when the flake splits down its axis frequently removing part of the striking platform. Generally believed to be produced by faulty knapping technique, but is also probably a consequence of flawed material.

x) Transverse Snap: Occurs when a flake snaps across its axis. Generally believed to be caused by post-depositional impacts such as human or stock treadage, or vehicular traffic.

FLAKED PIECE :
A fragment of stone exhibiting flake scars indicating that it is an artefact, but not displaying diagnostic features, such as a Bulb of Percussion, Striking Platform, or an Eraillure.

GREYWACKE :
A type of sandstone, grey or greenish-grey in colour, tough and well indurated and typically poorly sorted (Clark & Cook, 1986).
A generally poorly sorted, dark sandstone containing feldspar and sand-sized rock fragments of metamorphic or volcanic rocks (Department of Mineral Resources, n.d.).
Usually a dark and coarse-grained rock compared to mudstones and siltstones which are much finer-grained and better sorted.

HOLOCENE PERIOD :
The period from 10,000 years ago to the present.

IGNEOUS ROCK :
Rock formed by the cooling and solidification of magma on or below the earth's surface (Geography Dictionary, 1985).

In situ : In its original place – as deposited.

ISOLATED ARTEFACT :
A solitary stone artefact, at least 50m from its nearest neighbour. This is based on NPWS policy that two artefacts within 50m of each other constitute a site.

KNAPPING FLOOR:
A discrete scatter of artefacts in which at least two artefacts are recognisably of the same material, and derive from the same piece of stone. Also described as a stone tool manufacturing site or floor.

LOCATION : The place at which an artefact is found, or a place identified as having either archaeological or Aboriginal significance.

MEASUREMENT :
- I) Flake:
  - i) Length: Measured along the percussion axis at right-angles to the platform.
  - ii) Width: The greatest width measured at right-angles to the percussion axis.
  - iii) Thickness: The greatest thickness measured at right-angles to the percussion axis.
- II) Flaked piece:
  - i) Length: The longest dimension
  - ii) Width: The greatest width measured perpendicular to the length.
  - iii) Thickness: The greatest thickness measured perpendicular to the length.
- III) Core:
  - i) Length: The longest dimension.
  - ii) Width: The greatest width measured perpendicular to the length.
  - iii) Thickness: The greatest thickness measured perpendicular to the length.

MIDDEN : A refuse heap or stratum of food remains, such as mollusc shells, and other occupational debris (Dortch, 1984 – see also Meehan, 1982).

MUDSTONE : A fine-grained detrital rock, usually quite massive and well-consolidated. May be black through grey to off-white, browns, reds and dark blues/greens. Frequently found in association with sandstones (Cook & Kirk, 1991).
Identification is often aided by colour variations in layering. A source for stone material tool manufacturing material found as river pebbles in creek beds, and artefacts often display a water-worn cortex.

NEGATIVE FLAKE SCAR :
A concave surface resulting from the removal of a flake, occurring on the surface of the rock from which a flake has been removed.

PLEISTOCENE PERIOD :
The period from about 10,000 years ago to 2 million years ago.

POTENTIAL ARCHAEOLOGICAL DEPOSIT (PAD) :
Synonymous with Potentially Archaeologically Sensitive : Having the potential to contain archaeological material although none is visible.

QUARTZITE :
Quartzites are formed by the regional or contact metamorphism of quartz arenites, siltstones, and flints (cherts). They are composed essentially of quartz, and usually have a fine-grained granoblastic (grains are roughly the same size) texture. Generally massive, but may sometimes show sedimentary structures (Cook & Kirk, 1991).

ROTATION :
The removal of flakes from a core by blows directed at different angles, to different platforms. May be evident on the dorsal surface of a flake as negative flake scars, which do not follow the same direction as the percussion axis of the flake. This may be confused with scars produced during core preparation.

SCAT : The solid waste material produced by an animal – dung, droppings, manure (Triggs, 1985).

SCATTER : Two or more artefacts occurring within 50 metres. Scatter may also be used in the context of ‘background scatter’, meaning the general distribution of artefacts across the landscape that cannot be recognised as discrete concentrations.

SILCRETE : A near surface or surface siliceous induration (Desen & Peterson, 1992).
A conglomerate consisting of surficial sand and gravel cemented into a hard mass by silica.
A siliceous duricrust (Bates & Jackson, 1980).
Crusts may form as a result of low, infrequent rainfall, on reasonably flat surfaces. These are known as duricrusts – those cemented by silica are known as silcretes (Clark & Cook, 1986), sometimes referred to locally as ‘billy’ (Gentilli, 1968), or ‘grey billy’.
Silcrete on the northern tablelands of NSW forms at the surface contact between sediments of the Sandon Beds and the Armidale Beds with overlying basalt, where groundwater (more rich in silica than surficial water) interacts with surficial water and precipitates new quartz as the matrix to the sediments (N.D.J. Cook, Dept. of Geophysics, UNE., pers. Comm..).
In softer formations of quartz sands, groundwater has apparently been responsible for the formation of concretionary layers of silcrete. Under altered climatic conditions, the less competent beds erode away leaving concretions. Since they are often the size of old-fashioned woolsacks and are greyish and white, they are popularly known as gray billy (slang for billy goat) (Fairbridge, 1968).

SITE : A discrete area or concentration of artefactual material, place of past Aboriginal activity, or place of significance to Aboriginal people.

SOIL SCIENCE TERMS (taken from Banks, 1995, and others as referenced).

BEDROCK : Outcrop of in situ rock material below the soil profile.

BENCH : A strip of relatively level earth or rock breaking the continuity of a slope.

BLOWOUT : A closed depression formed in the land surface by wind eroding sands and depositing them on adjacent land.

CLAYPAN : A depression caused by the aeolian deflation of sediments, or by the presence of a prior lake.

DUNE : A ridge built up by wind action composed of sands, silts, or sand-sized aggregates of clay.

FLOODPLAIN :
A large flat area, adjacent to a watercourse, characterised by frequent active erosion and aggradation by channelled and overbank stream flow.

GIBBER : A level surface covered by a thick deposit of gravel or broken siliceous pebbles, occurring in the more arid parts of the continent, thought to have been formed from the break-up of a siliceous (silcrete) surface crust, and termed gibber plains (Whittow, 1984) – see also silcrete.

GILGAI : Surface microrelief associated with soils containing shrink-swell clays. Gilgai consists of mounds and depressions, or irregularly distributed small mounds and subcircular depressions varying in size and spacing. Vertical interval usually <0.3m; horizontal interval usually 3-10m, and surface almost level.
Sometimes called ‘crab-hole’ soils.

GULLY : An open incised channel in the landscape generally greater than 30cm deep and characterised by moderately to very gently inclined floors and steep walls.

HUMMOCK : A small raised feature above the general ground surface.

LANDFORM ELEMENTS :
Crest : Landform element standing above all points in the adjacent terrain.
Flat : Neither a crest or a depression <3% slope.
Upper slope : Adjacent to and below a crest or flat but not a depression.
Midslope : Not adjacent to a crest, a flat or a depression.
Lower slope : Adjacent to and above a flat or a depression but not a crest.

LITHOSOLS : Shallow soils showing minimal profile development and dominated by the presence of weathering rock and rock fragments.

RILL : A small channel cut by concentrated runoff through which water flows during and immediately after rain.

RUNOFF : That portion of precipitation not immediately absorbed into or detained upon the soil and which thus becomes surface flow.

SCARP/CLIFF :
A steep slope terminating a plateau or any level upland surface.

SCRUB : vegetation structure consisting of shrubs 2-8m tall.

SHEET EROSION :
The removal of the upper layers of soil by raindrop splash and/or runoff.

SUBSOIL : Sub-surface material comprising the B and C Horizons of soil with distinct profiles; often having brighter colours and higher clay contrasts.

SURFACE CONDITION :
Gravelly : Over 60% of surface consists of gravel (2-69mm).
Hardsetting : Soil is compact and hard.
Loose : Soil that is not cohesive.
Friable : Easily crumbled or cultivated.
Self-mulching : A loose surface mulch of very small peds forms when the soil dries out.

SWALE : A linear level-floored open depression excavated by wind or formed by the build-up of two adjacent ridges.

SWAMP : Watertable at or above the ground surface for most of the year.

TOPSOIL : A part of the soil profile, typically the A_1 horizon, containing material that is usually darker, more fertile and better structured than the underlying layers.

UNDERSTOREY :
A layer of vegetation below the main canopy layer.

BIBLIOGRAPHY

Banks, R.G. 1995. Soil landscapes of the Curlewis 1:100,000 sheet. Department of Conservation and Land Management.

Bates, R.L., and J.A. Jackson (Eds). 1980. Glossary of Geology. Second Edition. American Geological Institute, Virginia.

Clark, I.F., and B.J. Cook. 1986. Geological Science: Perspectives of the Earth. Australian Academy of Science, Canberra.

Cook, D., and W. Kirk. 1991l. Field Guide to the Rocks and Minerals of the World. Kingfisher Books, London.

Cook, K., and D. Garvey. 1999. *The Glint of Gold*. Genlin Investments, Pymble.

Craze, B., and J. Marriot. 1988. 'The Aborigines'. In J. Marriott (Ed.), *Cowra on the Lachlan*, pp.1-8.. Cowra Shire Council, Cowra.

Department of Mineral Resources. n.d. Information Sheet : Sedimentary Rocks.

Department of Mines. 1973. Minerals and their Characteristics. Geological Survey of New South Wales, Number 141.

Desen, J.L., and J. Peterson. 1992. Mapping the Australian Duricrusts: can Distribution be Derived from Terrain Maps. Australian Geographical Studies, 30(1): 87-94.

Dortch, C. 1984. Devil's Lair: a study in prehistory. Western Australian Museum.

Dunnell, R.C. 1971. Systematics in prehistory. Free Press, New York.

Fairbridge, R.W. 1968. Induration. Encyclopaedia of Geomorphology, Encyclopaedia of Earth Science Series, Vol. III, pp.554-55. Reinbold Book Corporation, New York.

Flenniken, J.L., and L.P. White. 1985. Australian flaked stone tools: a technological perspective. Records of the Australian Museum, 36: 131-51.

Gentilli, J. 1968. Duricrust. In R.W. Fairbridge (Ed.), The Encyclopaedia of Geomorphology, Encyclopaedia of Earth Science Series, Vol. III, pp.296-7. Reinbold Book Corporation, New York.

Geography Dictionary. 1985. Longman Group, Harlow.

Gill, M. 1996. Weilmoringle: A Unique Bi-cultural Community. Development and Advisory Publications of Australia, Dubbo.

Mathews, J. 1977. Wurley and Wommera. Collins, Sydney.

Meehan, B. 1982. Shell bed to shell midden. Australian Institute of Aboriginal Studies, Canberra.

Oates, L.F. 1988. The Muruwari Language. Pacific Linguistics, ANU, Canberra.

Triggs, B. 1985. Mammal tracks and signs: a fieldguide for southeastern Australia. Oxford University Press, Melbourne.

Whittow, J. 1984. Dictionary of Physical Geography. Penguin, London.

APPENDICES

APPENDIX i

SITE TYPES

Appendix – Site types

The definitions that follow are for terms used in this report, and do not necessarily apply to their use in different contexts.

Art sites are defined as places where any medium has been applied to a rock surface either as symbols, characters, drawings, paintings, or any other rendition, recognisable as not being a natural discolouration or feature. They also include markings to a rock surface, either by engraving, abrading, or pecking, and which cannot be identified as being a natural feature.

Bora rings are circles of 2-30 metres diameter of compressed earth (from repeated treading or dancing), or stone arrangements, at which men performed initiation ceremonies, and are the most frequently recorded ceremonial sites. Sometimes they occur as two rings joined by a central track in a barbel configuration. They usually occur on level or low-lying country, which is usually the first topographical unit to be cultivated, or utilised for highways and roads, but they may also occur as circular stone arrangements on elevated rock platforms and hilltops. If they are or were present then they are usually either already known and have been recorded, or they have long since been destroyed.

Carved trees are readily recognised by even the untrained observer. The carving is incised either into the outer bark, or more commonly, into the living wood after removal of a section of the bark. The designs frequently consist of 'diamond cross-cuts', but may also consist of stylised animal motifs. Previously unrecorded carved trees are still discovered in relatively remote or inaccessible areas. Carved trees frequently occur near burial sites and/or Bora rings, but in some regions they may have been tribal boundary markers.

Fish traps may occur either in rivers or on seashores. They are recognisable as unnaturally formed stone arrangements that were constructed to trap fish (or eels or turtles) carried into the enclosure in deep water, and which are left stranded within the enclosure as the water level drops. The fish were then caught by nets, hand, or by spear.

Grinding grooves are usually observed on the surfaces of large sedimentary boulders or exposed shelves and outcrops of sedimentary rock along creek banks and beds, or near water. They have been produced by Aborigines using the rock surface to shape and sharpen the edges of stone to produce ground-edged axes, or to sharpen wooden spears (the latter tend to be narrow and deep). Water was used to lubricate the surface of the rock. The grooves frequently occur as linear abraded depressions in the rock, and may each be between 10 and 50 centimetres long, up to 15 centimetres wide, and 2 to 5 centimetres deep. Some sedimentary rock surfaces may exhibit shallow ground depressions of roughly round or elliptical shape, and these are more likely to be associated with seed grinding, root crushing, or other food preparation.

Middens may be identified variously as beach, lagoon, lacustrine, or estuarine, and are most likely to be observed at or above the water line where erosion, topsoil removal, or mining has exposed the shell. The size of the midden can vary enormously, with the smallest comprising a 'one off', "dinner-time camp" (Meehan. 1982), with as few as two or three shells, or a shallow lens of only a few centimetres. The largest middens may extend for many kilometres and may comprise of a number of lenses and layers of shell and ash up to several metres deep. These large middens may be evidence of continuous exploitation of the resource over many thousands of years. Middens of fresh water mussel shell may be found in eroding creek banks or in eroding terraces, particularly near both existing and defunct water holes.

Isolated shell or fragments may occur on any surface and in any situation. A single shell may have been discarded by a bird, but the presence of use-wear would indicate Aboriginal use of the shell as a tool, which was discarded after use. Such occurrence is likely to be where there is no immediate source of stone material suitable for tool manufacture.

Natural Mythological sites are places of significance to Aborigines, either because they are described in mythological stories or songlines, or because they were used in religious ceremonies. They may occur anywhere and while some are more predictable than others – as for example, permanent water holes, waterfalls, rock promontories, etc., others may have no particularly remarkable features. Seldom is there any recognisable artefactual evidence or anything to distinguish it from similar features in the vicinity. These sites must of necessity be identified by Aboriginal people with an association with the place.

Open sites, campsites, knapping floors, scatters, and isolated artefacts, are most likely to occur on eroded and exposed creek banks, particularly where slope wash or stock trails has removed the humic layer, or on eroded ridges and spurs, particularly near the junctions in watercourses.

Open sites are most likely to be present in greatest numbers near a source of either raw stone material, or potential food resources, or in a natural corridor between two differentially preferred environmental zones, or at the contact between two environmental zones containing different resources.

Artefacts in open scatters are likely to be manufactured from the dominant raw material available; i.e. Greywacke on greywacke-sourced soils, quartz on granite-sourced soils, silcrete and chert on relict sedimentary soils.

Artefact assemblages in open scatters are likely to consist predominantly of discard material, i.e., cores, flakes, flaked pieces, and debitage.

Artefacts exhibiting retouch scars and backing are most likely to occur in sites where secondary activity took place peripheral to the central camp site, although this is a generality and can only be observed where there is sufficient surface visibility to identify peripheral sites. Fragments of flakes with retouch or backing may occur on knapping floors indicating breakage occurring during manufacture, or maintenance areas in which damaged tools have been replaced and discarded.

Isolated artefacts are likely to be most frequently observed where the groundcover obscures all but the larger artefacts, such as cores, and large flakes, or where there is little contrast between the texture of artefactual material and the surface upon which it lies. Artefacts of materials contrasting with the matrix may be visible regardless of size; eg. quartz artefacts may be far more visible than much larger basalt artefacts against a background of dark humic terrace soils.

PADs or Potential Archaeological Deposits are deposits, usually in shelters (but they may also be identified where there are intact deposits in open areas), which although not containing any visible archaeological material, are considered likely to contain archaeological material below the surface. These 'sites' are not recorded as sites on the Aboriginal Site Register, but are identified as places that require subsurface testing to establish whether a site exists or not.

Rock shelters with art or occupation deposits, are most likely to occur where the character of the parent rock is sufficiently massive or consolidated for it to retain a structure that weathers differentially to form shelters and overhangs.

Scarred trees are perhaps the most difficult site type to determine as having been caused by deliberate removal of the bark by humans and not as a consequence of natural events; such as abrasion from falling trees or branches, natural branch attrition, fire damage, or contact from vehicles or stock. They may occur in places wherever there are tree species that produce bark suitable for tool and implement manufacture. While some scars are clearly the consequence of deliberate bark removal by Aborigines (either evidenced by stone axe marks, or identified by Knowledge Holders), some scars were made by settlers, and stockmen, and surveyors who frequently blazed trails and property boundaries by scarring the trees, and by timber men who removed a strip of bark to test the suitability of a tree for logging.

Other site types such as hearths, burials, etc., are less easily predicted, although burials are frequently associated with carved trees, and Bora rings, and hearths with campsites, shelters, and shell middens.

APPENDIX ii

NPWS/ABORIGINAL SITES REGISTER

NSW
NATIONAL
PARKS AND
WILDLIFE
SERVICE

23 December 1999

John Appleton
Archaeological Surveys & Reports Pty Ltd
10 Roslyn Ave
Armidale NSW 2350

Our Ref: ASR#6989
Your Ref:

Dear Sir,

RE: Aboriginal sites search for
Eastings 500000-560000 Northings 6303000-6380000

Reference is made to your recent enquiry in respect to whether any Aboriginal sites are registered at the above location.

A search of the National Parks and Wildlife Service's (NPWS) Aboriginal Sites Register database has shown that 60 Aboriginal sites are currently recorded in or near the proposed development area (refer attached Site Register report for details).

The following qualifications apply to the Aboriginal Sites Register database;

- The database only includes recorded sites. Large areas of New South Wales have not been the subject of systematic survey or the recording of Aboriginal history. These areas may contain sites which are not currently listed on the Aboriginal Sites Register.
- Site records come from a variety of sources and are variable in their accuracy. When a database search identifies sites in or near the area it is recommended that the exact location of the sites be determined by relocation on the ground.
- The criteria used to search the database are derived from information provided by the client and assume that this information is correct.

You should be aware that all Aboriginal sites are protected under the *National Parks and Wildlife Act 1974*, regardless of their inclusion on the Sites Register, and it is an offence to damage or destroy them without the prior permission of the Director-General of the NPWS.

If you are considering development, please note the following:-

In determining development applications under the *Environmental Planning and Assessment Act 1979*, local councils must include matters relating to Aboriginal heritage in the decision making process. As part of this process, the NPWS may be asked for advice on whether an area proposed for development should be subject to Aboriginal heritage assessment. NPWS advice is broadly based on the following criteria;

1) The NPWS would normally recommend an Aboriginal heritage assessment under the following circumstances:

43 Bridge Street
PO Box 1967
Hurstville NSW
2220 Australia
Tel: (02) 9585 6444
Fax: (02) 9585 6555
www.npws.nsw.gov.au

The Sites Register identifies sites in or near the development area, and these could be impacted during or after the development (this includes indirect impacts, such as increased run-off or sedimentation, changes in visitation, etc).

- the proposed development is likely to impact areas of bushland or undisturbed ground.

- the proposed development is likely to impact areas containing sandstone outcrops (greater than $1m^2$), rock shelters and overhangs, old growth trees, sand bodies, and ground adjacent to creeks, rivers, lakes and swamps.

- the proposed development is likely to impact an area of importance to the Aboriginal community not included in the above (eg. story places, buildings, missions, etc)

2) The NPWS would **not** normally recommend an Aboriginal heritage assessment under the following circumstances:

- the proposed development is within land previously subject to intensive ground disturbance, such as quarrying, repeated market gardening, earthworks for pipelines, roads, sports fields etc. However it should be noted that sites could still occur in these context for example, ploughing generally impacts the top 20cm of ground and there is potential that *undisturbed archaeological deposit may occur* in areas where soil depth exceeds 20cm. *Scarred trees* may be located within road reserves and adjacent sport fields, etc.

- the development is within an existing residential or industrial area, or the redevelopment of an existing building is proposed, and the above criteria (listed in section 1) do not apply.

An Aboriginal heritage assessment would provide you with information about the location and significance of sites or sensitive areas, as well as advice on appropriate management options for these areas. It is recommended that an Aboriginal heritage assessment be carried out by a person qualified in undertaking Aboriginal heritage assessments. It is also recommended that the Aboriginal community (Local Aboriginal Land Council, Tribal Council etc) be contacted and its views sought on possible impacts to Aboriginal heritage.

If the proposed development area is found to contain an Aboriginal site, reference should be made to the NPWS requirements for Aboriginal heritage under the Integrated Development Approval Process (*Environmental Planning & Assessment Amendment Act 1997*).

If you wish to discuss this further, please contact Archaeologist, Phil Purcell on (02) 6883-5324.

Yours faithfully

Paul Houston
Aboriginal Sites Registrar
Cultural Heritage Services Division

ASR Site Search Criteria

SiteID (like):		Zone:	55	District:		
AMGE:	500000	to	560000	SiteType1:		
AMGN:	6303000	to	6380000	SiteType2:		
Name(like):				SiteType3:		
Recorder:				Contact:		
Date from:		to		DateModified:		to
LGA:						
Local ALC:						

ASR Standard Site List - 6989

20/12/99 17:59:01

SiteID:	SiteName:	Location:	Zone:	AMGE:	AMGN:	Check Method:	Site Type:	Recorder:	Record Date:	Assoc. Report:
35-4-0001	Lara;Boxdale;		55	528911	6363773		Carved Tree	Bell	1/01/79	C-65
35-4-0002	Lara;Condobolin;		55	519739	6367342		Axe Grinding Groov	Brickhill	1/01/75	A-480
35-4-0002	Lara;Condobolin;		55	519739	6367342		Water Hole/Well	Brickhill	1/01/75	A-480
35-4-0003	Meloola;		55	523355	6371489		Open Camp Site	Gresser	1/01/47	
35-4-0004	Meloola;		55	524230	6375610		Open Camp Site	Gresser	1/01/47	
35-4-0005	Kamahi;Yarran Creek;		55	527032	6369239		Scarred Tree	Brickhill	1/01/75	A-480
35-4-0006	Yarran Creek;		55	527493	6368787		Open Camp Site	Gresser	1/01/46	
35-4-0007	Carlisle Mines;Carlisle Hills;		55	538145	6353808		Carved Tree	Bell	1/01/79	C-65
35-4-0009	Derriwong Mtn;Derriwong Mountain;		55	532250	6350110		Scarred Tree	Bluff, W.T.	11/10/92	C-1333
35-6-0086	OS-22;Goobang National Park;		55	524900	6366200		Open Camp Site	Robinson, T	11/06/97	English, Erskine, 1998.
42-3-0008	Con-4;		55	500200	6338500		Quarry	Paton, R.	5/05/84	C-792
43-1-0001	Murri Creek Burials	Condobolin	55	514551	6336218		Burial/s	Witter, D.	29/07/87	A-7590, C-1216,C-662
43-1-0003	Blue Range;Humbug Creek;		55	508342	6316509		Open Camp Site			C-662
43-1-0004	Condobolin;		55	512693	6339399		Stone Arrangement			
43-1-0005	Bogandillon Creek;Condobolin;		55	533942	6315383		Open Camp Site			C-662

SiteID:	SiteName:	Location:	Zone:	AMGE:	AMGN:	Check Method:	Site Type:	Recorder:	Record Date:	Assoc. Report:
43-1-0006	Hall's Burial Site;Condoblin;		55	507132	6337884		Burial/s			C-1020, C-1216, C-662
43-1-0007	Goobang Creek;Hacketts Burials;		55	519205	6336902		Burial/s			C-1216
43-1-0008	Top Black Farm;Boramble Park;		55	528345	6327210		Carved Tree	Ravenscroft, M.	12/05/85	C-65, A-6944
43-1-0008	Top Black Farm;Boramble Park;		55	528345	6327210		Scarred Tree	Ravenscroft, M.	12/05/85	C-65, A-6944
43-1-0009	Edol's Station;Mulgutherie;		55	541156	6325505		Carved Tree			C-65
43-1-0010	Mulgutherie;Coobong ;		55	538727	6331057		Carved Tree	Ravenscroft, M.	13/05/85	C-65
43-1-0011	Waitohi;Waitoki;		55	521398	6336923		Carved Tree			C-65
43-1-0012	Old Forbes Road;Wollongong Hill;		55	532383	6335017		Burial/s			
43-1-0013	Con-5;		55	500089	6338548		Quarry	Paton, R.	6/05/84	C-792
43-1-0014	Con-6;		55	501092	6338741		Scarred Tree	Paton, R.	5/05/84	C-792
43-1-0015	Con-7;		55	501274	6338834		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0016	Con-8;Condobolin;		55	502277	6339117		Quarry	Paton, R.	7/05/84	C-792
43-1-0017	Con-9;Condobolin;		55	502367	6339210		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0018	Con-10;Condobolin;		55	502731	6339396		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0019	Con-11;Condobolin;		55	503006	6339307		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0020	Con-12;Condobolin;		55	503923	6338950		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0021	Con-13;Condobolin;		55	506943	6338613		Scarred Tree	Paton, R.	6/05/84	C-792
43-1-0022	Con-14;Condobolin;		55	507212	6339164		Scarred Tree	Paton, R.	6/05/84	C-792
43-1-0023	Con-15;condobolin;		55	507306	6338891		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0024	Con-16;Condobolin;		55	507300	6339439		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0025	Con-17;		55	507574	6339442		Scarred Tree	Paton, R.	6/05/84	C-792
43-1-0026	Con-18;Condobolin;		55	508119	6339813		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0027	Con-19;Condobolin;		55	508209	6339997		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0028	Con-20;Condobolin;		55	508484	6339908		Open Camp Site	Paton, R.	6/05/85	C-792

ASR Standard Site List - 6989

20/12/99 17:59:01

SiteID:	SiteName:	Location:	Zone:	AMGE:	AMGN:	Check Method:	Site Type:	Recorder:	Record Date:	Assoc. Report:
43-1-0029	Con-21;Condobolin;		55	508668	6339818		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0030	Con-22;Condobolin;		55	508761	6339636		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0031	Con-23;Condobolin;		55	508945	6339455		Open Camp Site	Paton, R.	6/05/84	C-792
43-1-0032	Con-24;Condobolin;		55	509031	6340004		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0033	Con-25;Condobolin;		55	509397	6340008		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0034	Con-26;Condobolin;		55	509300	6339300		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0035	Con-27;Condobolin;		55	509400	6339300		Open Camp Site	Paton, R.	5/05/84	C-792
43-1-0036	Con-28;Condobolin;		55	510225	6339467		Scarred Tree	Paton, R.	6/05/84	C-792
43-1-0037	Con-29;		55	513253	6338125		Scarred Tree	Paton, R.	6/05/84	C-792
43-1-0038	Con-30;Condobolin;		55	515451	6337689		Scarred Tree	Paton, R.	6/05/84	C-792
43-1-0039	Con-31;Condobolin;		55	515363	6337323		Scarred Tree	Paton, R.	5/05/84	C-792
43-1-0040	B-ST-1;		55	526670	6328370		Scarred Tree	Kelton, J.	12/04/96	Guide
43-1-0041	MT-SS-1;		55	512600	6345660		Natural Mythologica	Kelton, J.	12/04/96	Guide
43-1-0042	TM-FC-1;		55	513300	6336500		Open Camp Site	Kelton, J.	12/04/96	Guide
43-1-0043	C-MS-2;		55	513100	6337500		Natural Mythologica	Kelton, J.	12/04/96	Guide
43-1-0044	TM-OS-1;		55	513300	6336500		Open Camp Site	Kelton, J.	12/04/96	Guide
43-1-0045	B-CT-1;		55	526670	6328370		Carved Tree	Kelton, J.	12/04/96	Guide
43-1-0045	B-CT-1;		55	526670	6328370		Scarred Tree	Kelton, J.	12/04/96	Guide
43-2-0001	Warroo;		55	555925	6310110		Midden			
43-2-0007	Burrawong;		55	549124	6333167		Carved Tree	Ravenscroft, M.	13/05/85	C-65
43-2-0011	Yarrabandai;		55	550102	6336009		Carved Tree			C-65
43-2-0012	Black Range;Bogan;		55	557000	6345000		Shelter with Art	Coe LG	24/11/86	
43-2-0014	Tottenham Road;		55	523800	6346900		Scarred Tree	Bluff, W.T.	1/01/91	
43-2-0015	Tottenham Road;		55	523600	6346900		Scarred Tree	Bluff, W.T.	1/01/91	

NSW National Parks and Wildlife Service

***** End of Report *** Site Count: 60**

APPENDIX iii

CORRESPONDENCE FROM WESTERN DIRECTORATE NPWS (#35-4-1)

11/04 '00 TUE 11:17 FAX 61 2 68849382

WESTERN DIRECTORATE

National Parks & Wildlife Service, Western Zone, 48-52 Wingewarra Street, Dubbo.
Phone: (02) 68835330 Fax (02) 6884 8675

Facsimile

To	John Appleton			
From	Allan Hutchins			
Fax No.	67726512	*Date*	11.04.00	*No. of Pages*
Subject	**Carved Trees**			

Dear John

Please find attached a copy of the directions to the site of one of the carved trees relevant to your survey area. The only other record we have indicates that the tree is/was held in the Condoblin Community Centre but it does not give any directions to the actual site where it originated other than the site name Boxdale 35.4.1. Hope this is of some help.

Regards Allan

APPENDIX iv

FAX FROM NPWS H.O. ('MULGUTHRIE, COOBONG')

Description of site.

Site name(s): Mulguthrie , Coobong

1:250,000 map name: Forbes

Grid reference: 5444 . 9011

Other map references:

Air photo reference:

N.P.W.S. District no: 11 Griffith

County: Cunningham

Parish: Mulguthrie Portion: 39

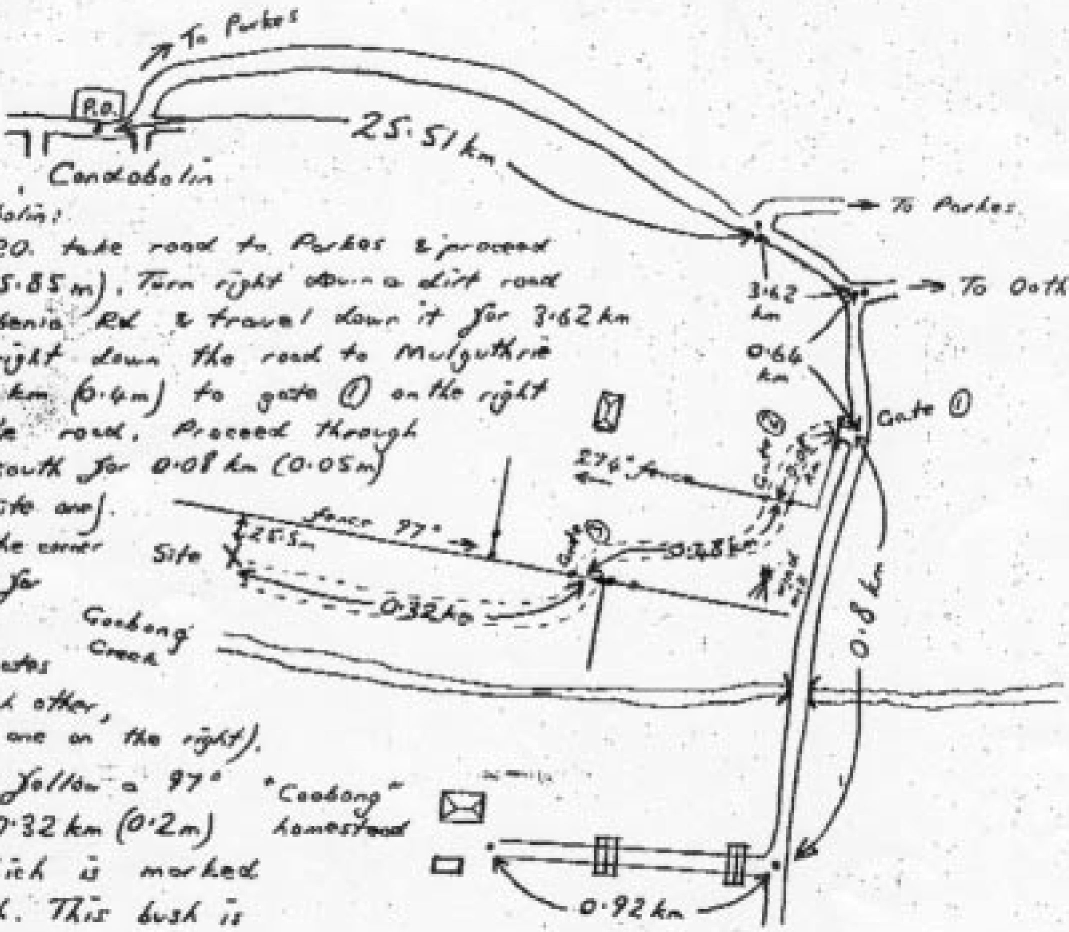
Owner: Mr. J. Hall

Lessee/Manager:

Address: "Coobong" via Condobolin

Attitude to site: Co-operative

Access to site: Sketch of site location:



ccess from Condobolin:
om Condobolin P.O. take road to Parkes & proceed 25·51 km (15·85 m). Turn right down a dirt road lled Berewombenia Rd & travel down it for 3·62 km (2·25m). Turn right down the road to Mulguthrie travel 0·66 km (0·4m) to gate ① on the right nd side of the road. Proceed through ate & travel south for 0·08 km (0·05m) gate ② (a kite one). roceed SW (to the corner the paddock) for ·48 km (0·3 m) Gate ③ (2 gates e next to each other, o through the one on the right). rom gate ③ follow a 97° fenceline for 0·32 km (0·2m) the site which is marked , a small bush. This bush is 5·5 metres from the fence.

20/04 '00 THU 14:28 FAX 61 2 95856325 AHD OPERATIONS @002

/ Boxdale/Lara carved tree now in ...

Centre. Moved 17/6/81. see A8958

Griffith Dist

Site recorded 25-6-79

Site No: 35-4-1 C65

Site classification: Carved tree

Description of site.

Site name(s): Boxdale

1:250,000 map name: Narromine

Grid reference: 534·937

Other map references:

Air photo reference:

N.P.W.S. District no: 11

SITE TRANSFERRED TO ~~[illegible]~~ GRIFFITH D/O ON 20/8/82

County: Cunningham

Parish: Elsmore

Portion: 27

Owner: Bede Hall

Lessee/Manager:

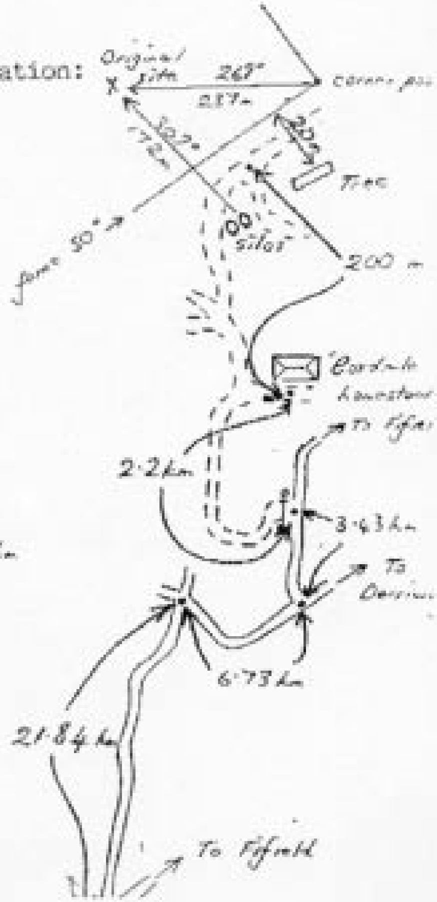
Address: "Boxdale" via Condobolin

Attitude to site: Co-operative

Access to site:

Access from Condobolin: From Condobolin P.O. travel 6.84 km (4.25 miles) along the main road to Parkes. Turn left up the road which runs between the airport & the agricultural research station. Travel 4.67 km (2.90 miles) to a fork. Take the left fork & proceed a further 21.84 km (13.57 miles) to a cross-road junction. Turn right & proceed a further 6.73 km (4.18 miles). Turn left along the road to Fifield. Travel 3.43 km (2.13 miles) to the main gate into "Boxdale" on the left hand side of the road. Travel 2.2 km (1.37 miles) to the homestead. Travel a further c.200 metres (c220 yards) to 2 metal silos, north of the homestead. The original site of the carved tree is marked by a dead tree standing in a cleared paddock. This dead tree is 172 m from the middle of the northern most silo,

Sketch of site location:



APPENDIX v

FAX FROM NPWS H.O. – TABLE OF CARVED TREES
(REPORT C-65)

APPENDIX C: Continued

LOCATION OF SITE				HISTORY OF SITE					
.	N.P. & W.S. district in which site occurs	Site Name(s)	Map Sheet (1:250,000 series) & grid reference	Original source of information on site	Published/ unpublished references	N.P. & W.S. investigation by whom & when	Site Use	Original no. of trees	Present cond location of
	Forbes 3-1-0009 (43-1-0009)	Edol's Station	Forbes c.547.895	E. Milne	Etheridge (1918:39, no. 9, pl xxiv, fig 4)	D. Bell and A. Urquhart 1979	Burial	1	Not known
0	Forbes 3-1-0010 (43-1-0010)	Mulguthrie, Cooborg	Forbes 5444.9011			D. Bell A. Urquhart 1979	Burial possibly	1	Tree removed "Coobong" homestead
1	Forbes	Waitohi, Waitoki	Forbes 5255.9077		Black (1941:pl xxii, no. 9)	D. Bell and A. Urquhart 1979	Burial	1	Tree removec 1940's. Loc and conditic not known
4	Forbes	Riversleigh	Forbes 5819.8706		Black (1941:28, pl xvii, no. 17)	D. Bell and A. Urquhart 1979		1	Tree is now Forbes Hist
7	Forbes	Burrawong	Forbes 5558.9033			D. Bell and A. Urquhart 1979	Not known	1	Dead standi <u>in situ</u>

LOCATION OF SITE			HISTORY OF SITE					
.P. & W.S. istrict in hich site occurs	Site Name(s)	Map Sheet (1:250,000 series) & grid reference	Original source of information on site	Published/ unpublished references	N.P. & W.S. investigation by whom & when	Site Use	Original no. of trees	Present condition location of trees
oonabara-ran	Wallaby Ranges	Narromine c.630.000	E. Milne 1910	Etheridge (1918:46, no. 35, pl xxiv, fig 1, plvi, figs 3a-d)	D. Bell and A. Urquhart 1979	Burial	5	Not known
oonabara-ran	Woodlands	Narromine c.639.012		Black (1941: plxiv, no. 14)	D. Bell and A. Urquhart 1979	Burial	1	Not known
oonabara-ran	Killowen, Myall Plains	Narromine 6321.0180			E. Edmondson	Not known	1	Living
oonabara-ran	Kaloombi	Narromine c.641.001			D. Bell and A. Urquhart 1979	Not known	1	Tree is now in the Macleay Museum, Univ. of Sydney (P1001)
orbes	Boxdale	Narromine 534.937			B. Thornhill 1977, D. Bell and A. Urquhart 1979	Burial	1	Tree removed to "Boxdale" homestead

35-4-1

(35-4-0001)

APPENDIX vi

CORRESPONDENCE FROM MR R. WILLIAMS

SITE CURATOR, WIRADJURI RALC

Wiradjuri Branch
New South Wales Aboriginal Land Council

153 Docker Street, Wagga Wagga 2650. P.O. Box 5515, Wagga Wagga 2650
Telephone: (069) 21 6544 - 21 6339, Fax: (069) 21 7903

John Appleton
Archaeological Surveys and Reports Pty Ltd
10 Roslyn Avenue
ARMIDALE NSW 2350

Dear John

Re: ARCHAEOLOGICAL SURVEY AND MANAGEMENT RECOMMENDATIONS FOR THE SYERSTON NICKEL-COBALT PROJECT CONDOBOLIN/FIFIELD AREA WESTERN NSW

I have read your Draft Report of the above survey which I participated in and I wish to inform you that I concur with the Management Recommendations as contained in the Report.

I also agree that the proposed project be allowed to proceed as long as the Management Recommendations are adhered to.

However should you wish to discuss this matter further then please do not hesitate to contact me.

Yours sincerely

RSWilliams.

Roland Williams
SITES CURATOR
12 July 2000

SYERSTON NICKEL COBALT PROJECT

EUROPEAN HERITAGE SURVEY AND ASSESSMENT

PREPARED BY

HERITAGE MANAGEMENT CONSULTANTS

JULY 2000

EHR01-G.DOC

INSERT LETTER FROM HERITAGE MANAGEMENT CONSULTANTS

SYERSTON NICKEL COBALT PROJECT
EUROPEAN HERITAGE SURVEY AND ASSESSMENT

Contents

1. INTRODUCTION

1.1 Background

Black Range Minerals Ltd is undertaking the Environmental Impact Statement for the Syerston Nickel Cobalt Project at Fifield, NSW, which addresses the mine, associated water and gas supply, road upgrades, limestone quarry and railway siding development in the surrounding district. Heritage Management Consultants has been engaged to undertake a European heritage survey of the mine and ancillary infrastructure areas.

The areas surveyed and assessed in this report are:

- the proposed mine site
- the proposed limestone quarry on route 64
- the route 64 railway siding site
- the gas pipeline route
- the water pipeline route
- the water borefields
- road upgrades for
  - route 64
  - rail siding access
- Fifield bypass road

The assessment of the heritage values of sites is undertaken within the criteria framework established by the Heritage Office of NSW, as outlined in section 3 below.

1.2 Authorship

The research and survey were undertaken by Dr Michael Pearson, Director of Heritage Management Consultants.

2. HISTORICAL BACKGROUND

Exploration

John Oxley's party undertook the first European exploration of the area, and passed south of Fifield and probably north of Trundle in 1817. In 1835 Thomas Mitchell travelled down the Bogan River to the east, and searched the area north of Fifield looking for Richard Cunningham (confused with his more famous brother, Allen Cunningham, in some of the local histories), who had gone missing from the party, and was later found to have been killed by Aborigines about 13 miles north-east of Tottenham[1]. There are no early descriptions or events identified relating to exploration occurring within the various areas effected by the Syerston project.

Settlement, grazing and agriculture

Original pastoral runs at **Condobolin** were established by William Lee from 1844, and Benjamin Boyd from 1847. The town was gazetted in 1859 and incorporated in 1890.[2]

Trundle was taken up as a run in 1853 by William Cummings, located so as to exploit the water supply in Trundle Lagoon[3]. Initially settlement was based on grazing, but after the arrival of the railway in 1907 the area was opened up for wheat growing[4].

George Simmons (1864-1943), who also held Portion 6 and 8 in the Fifield mining lease area (refer to Figure 1), selected 'Grassdale' near Trundle, where his family settled in 1887[5].

Fifield township, named after one of the consortium that discovered rich gold deposits there in 1893, came into being in that year when A.T. Medcalf, from 'Gillenbine' property between Fifield and Trundle, opened a store and butchers shop to serve the miners. J.A. Pike also opened a store, and Thomas Paton opened a hotel[6].

Fifield Provisional School was opened in July 1894, and became a Public School from October 1894 to December 1995, then a half-time school (a school sharing a single teacher with another school) with Platina from February 1896 to June 1896, and again a Public School from July 1896 to August 1973, with Platina, three miles to the south, continuing as a Provisional School until 1904. For Provisional Schools to be established there needed to be a minimum of 10 children, and for a Public School a minimum of 20 pupils was required, which suggests the size of the population at the time[7]. One estimate is that there were 300 people at Fifield at its peak, and a Cobb and Co coach service ran from the diggings to Parkes[8].

The allocation of Portions and mining leases on the Project Site is shown in Figure 1 and 2.

Mining

Platinum

Department of Mines geologist J.B. Jaquet reported on the Fifield platinum discovery in 1895 as follows:

> 'For the last two decades it would appear that the country around Fifield has been intermittently prospected for alluvial gold, and a little platinum must from time to time have been obtained, though there is no record of this metal being discovered previous to 1887.

> In this year Mr J.F. Connelly, who received aid from the Government to prospect in the district, reported having discovered alluvial platinum and presented a sample to the Geological Museum. Nothing appears to have been done in the way of further developing the field until 1893 when Messrs Fifield, Rand and Party discovered rich alluvial gold near the site of the present township of Fifield. Upon the news of the discovery becoming known a rush set in to the district, and the lead which is now being worked was found soon afterwards...'[9]

The Fifield/Platina Lead, a buried palaeochannel, ran north-south for a little over a mile (1.6 km), and was from 60 to 150 feet (18-46 m) wide. The platinum/gold drift was buried on the bed rock, beneath 60-70 feet (18-21 m) of loam. The Fifield/Platina platinum lead is located south and east of Fifield village, outside the project area, but adjacent to the road Route 64 (refer Figure 3).

The pay dirt from the mines was separated in horse-driven puddling machines, then passed through sluice boxes to capture the platinum and gold. At the time of Jaquet's visit, drought had largely suspended work, and 7,000 loads of washdirt were dumped around the various shafts awaiting puddling.

The discovery at Platina was known as 'Simmons Rush' as it was located on the property of H. Simmons, 'Roseneath'[10]. The Fifield Platinum Field was Australia's first significant producer of platinum, and remains (1991) the only area from which platinum has been produced as a primary product. From its discovery in 1887 the field was worked intermittently until the mid-1960s, producing 639.5 kg of platinum. 179 kg of gold has also been produced over this period from this area. Three leads were eventually located at Fifield, these being the Platina Lead, the Fifield Lead and the Girilambone Tank Lead.[11]

Tin

Tin deposits were found at Burra 7-10 miles north-west of Fifield in 1874, and were first mined between 1900 and 1911, then again in 1925-26 and 1978-80. Copper was mined in the Gobondery Ranges. Gold was mined at Spring Creek near Burra Burra village site (15 miles west of Tullamore), where it had been found at the same time as tin in 1874, and at Lightning Paddock.[12]

Magnesite

Magnesite was discovered north of Fifield in the early 1900s by Tom Bird, Frank Wyner and J. Lee, and they took up leases at the Red Hole, and was still being mined in the 1980s by Harbison ACI. Fifield produced magnesite for the Newcastle steel works when they set up in 1915, it being used to line the furnaces. BHP took out its own leases at Fifield from 1921, and BHP and Fifield Magnesite and Refractory Company (FMRC) were the main producers during the 1920s and 1930s, with BHP gradually overtaking FMRC in production from the early 1930s[13] (refer Figure 2).

The material was at first removed from the quarries by horse dray, and carted to the railway at Tullamore and Gobondery. BHP employed 10 horse-teams on this work. A power shovel was introduced in 1938, together with screens and conveyor belts, and in that year 80 men were engaged in magnesite mining at Fifield. In 1943 BHP introduced crawlers and Le Tourneau scrapers, motor lorries and tractors, with the mine operating its own workshops to maintain the equipment.[14]

Australia's major sources of supply of magnesite were Fifield and Thuddungra [near Young] in NSW, Marlborough in Qld, Port Germein, Copley and Crozier in SA, and Bulong and Bandalup in WA, but NSW appears to have been the major producer.[15]

The Syerston Nickel Cobalt Project area, taking in Portions 4, 5, 6, 7, 8, 9, and 10 (refer Figure 1), and associated mining leases and reserves, Parish Tout, County Kennedy, includes along its northern edge a number of old mining leases, which show up as mining scars on the 1958 air photograph of the area[16]. Magnesite mining continued during the 1980s with the company Causmag-Devex in the north-eastern section of the proposed mine site. This company completed mining in the late 1980s and conducted rehabilitation works subsequently. Causmag-Devex relinquished their leases to Department of Mineral Resources in 1997. Little intact surviving mining evidence or infrastructure remain from mining periods described.

Transport infrastructure

The Bogan Gate to Condobolin railway line was completed in 1898, with a link to Broken Hill completed in 1927. The extension north the Trundle opened in 1907, with stations at Trundle and Botfield. The line was then extended north towards Tottenham, with Tullamore and the Troffs sidings and station being opened in December 1908. The Troffs was named after a local property. A quarry at 'Ticehurst' near the Troffs was developed in 1906 to provide ballast for the line. [17]

3. MINING AND INFRASTRUCTURE SITE SURVEYS AND ASSESSMENTS

3.1 Legislative and assessment background

Legislative and planning background

The NSW *Heritage Act 1977* contains various legal measures to protect buildings, sites and archaeological resources of heritage importance. The Act operates at several levels, and is closely linked to the State's environmental planning processes. Sites of heritage significance can be identified and given legislative protection in several ways. Local councils are required to develop Local Environmental Plans (LEPs), which include schedules identifying heritage places. If a place is listed in a LEP, local planning controls are applied to any development application affecting the place. At present the LEP for Lachlan Shire does not include any places dealt with in this report.

Places of importance at the State level can be entered in the NSW Heritage Register, which applies a greater level of planning control and approvals mechanisms over development proposals. At present no place in the Lachlan Shire is entered in the Heritage Register, and no places identified in this survey would have sufficient significance to be registered.

The *Heritage Act* also provides protection for historical artefacts ('relics' in the Act). A 'relic' is defined as:

> any deposit, object or material evidence—(a) which relates to the settlement of the area that comprises New South Wales, not being Aboriginal settlement; and (b) which is 50 or more years old.

Section 139 of the *Heritage Act 1977* provides that:

> A person shall not disturb or excavate any land for the purpose of discovering, exposing or moving a relic, not being a relic subject to a conservation instrument, except in accordance with an excavation permit.

While no items demonstrably older than fifty years have been identified on the Project Site, it is possible such items might be located during works, and the mine manager needs to be aware of the obligations imposed by the *Heritage Act*. The pine telephone poles along the gas pipeline route and the nearby pine log structure (see 3.6 below), are probably older than fifty years and therefore 'relics', and their disturbance by ground works would be subject to the *Heritage Act*.

Background to the assessment process

The assessment of the significance of heritage sites for listing within Local Environment Plans by local councils, and in the NSW Heritage Register established under the *Heritage Act,* is guided by criteria established by the NSW Heritage Office. The criteria, listed at Table 3.1, were used as the basis for assessment in this study.

The distinctions are made in the report between places of local, regional and state significance. This ranking is based on the context within the place is important, and can be applied to the interpretation of the assessment criteria for that particular context. The three levels are simply defined as follows:

> Local significance—Comprises items significant in a local historical or geographical context or to an identifiable contemporary local community.
>
> Regional significance—Comprises items significant in a regional historical or geographical context or to an identifiable contemporary regional community.
>
> State significance—Comprises items significant in a state-wide historical or geographical context or to an identifiable contemporary state-wide community.

Table 3.1	**NSW State Heritage Register Criteria**
Criterion A:	an item is important in the course, or pattern, of NSW's cultural or natural history;
Criterion B:	an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history;
Criterion C:	an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW;
Criterion D:	an item has strong or special associations with a particular community or cultural group in NSW for social, cultural or spiritual reasons;
Criterion E:	an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history;
Criterion F:	an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history;
Criterion G:	an item is important in demonstrating the principal characteristics of a class of NSW's • cultural or natural places; or • cultural or natural environments.

3.2 The Mine and Processing Site

The mine and processing site covers a large area of land north-west of the village of Fifield (see Figures 3 and 4). The mine and processing site can be divided into two main areas, a northern zone where earlier mining activities took place, and a southern zone where pastoral and cropping has predominated, comprising ploughed paddocks separated by belts of remnant and regrowth vegetation. (All assessments are summarised at Table 3.2)

Table 3.2 Summary of significant sites

Project area	Item of significance	Level of significance (and relevant criteria (Table 3.1 above))	Recommended Mitigation measure
Mine and process area	Magnesite mining area	Local (Criterion A)	Include the historic mining landscape in mine planning processes and retain if practicable and feasible.
	Shearing outstation	Local (Criteria A, G)	Retain items in situ if possible
Gas pipeline route	Pine trunk telephone poles along road reserve edge	Local (Criteria F, G)	Avoid and retain poles wherever possible.
	Log hut or shed	Local (Criteria A, F)	Avoid and retain. 15 m buffer zone.
Fifield bypass road	Tree plantings along abandoned road	Local (Criteria A, C)	Retain trees sufficient to reflect the historical landscape element

Mining heritage

The distribution of areas disturbed by historical mining is shown in Figure 4. The mining area in the north of the Project Site is the outcome of magnesite mining (refer Figure 4, Site 1), the history of which is outlined above. The mining disturbance consists of large open-cut pits with associated overburden mounds, and areas of scraped land. These features have been extensively rehabilitated by surface sculpting and revegetation. The 1958 aerial photographs (National Library of Australia, Fifield/Derriwong I55-3-653) show two main areas of disturbance within the Project Site, and one large area immediately to the east across the Fifield-Tullamore Road (the Burra open-cut). Today there are six major pits and many smaller areas of disturbance within the Mine Site, indicating that the majority of mining activity has occurred since the late 1950s.

The surviving mining landforms have been substantially impacted by rehabilitation activities, which occurred throughout the 1990s. A small amount of material from the processing plant remains on site, probably from the 1980s era, but this appears not to be *in situ*, and is not sufficiently intact to be of heritage importance. This includes a small conveyor belt and unidentified piece of machinery on the edge of the paddock c.1 km south-west of the mining area. The nature of the magnesite extraction process, being simple shallow open-cuts excavated by drag-line and scraper vehicles, has left little evidence of technological interest, which has been further removed by rehabilitation works. The earlier mining activities have been largely removed by later mining, and the remaining pits would seem to reflect 1980s mining activity and rehabilitation.

The 1937 Parish map covering the Project Site (Parish of Tout, County of Kennedy) shows mining leases in the north-west sector of the Project Site as well. However, no evidence of mining activity was identified on the ground in this area during the site survey.

While the magnesite mining at the site is of regional historical interest and importance, the physical evidence of that history is substantially impacted by rehabilitation, and little fabric of heritage significance survives. The mining site is therefore assessed as being of local significance, but degraded. The sites themselves are not relics under the Heritage Act, as the current landscape appears to have been totally re-worked since the earliest mining activities, and hence is less than 50 years old. The new development should consider these sites within mine planning decisions and where practicable and feasible avoid disturbance to these sites until such time as it was demonstrated that they were needed for mining works.

The proposed Syerston project open cuts will incorporate wholly or in part one of the large pits shown in the 1950s air photos. The remaining open cuts and processing plant locations are to the south, but the proposed waste dumps will encroach on most of the previous historic mining area located within the Project Site. Remnants of magnesite mining located east of Fifield-Tullamore Road would not be affected by the proposed development.

Pastoral heritage

To the south and west of the historical mining area the Project Site is predominantly grazing and cropped land, with belts of remnant and regrowth vegetation separating paddocks along a north-south line, and along a water course running to the south-west. A hill in the south of the Project Site is also vegetated. The 1958 aerial photographs show that the current vegetation pattern echoes that of 1958, but is now denser in some areas such as in the former mining area. The paddock fencelines currently evident across the Project Site largely existed by 1958, and as much of the fencing is along the portion boundaries, has probably existed since the land was first cleared. The Kingsdale homestead and woolshed are shown in the 1958 air photos, while the Syerston homestead is not (ie. it post-dates 1958). Kingsdale appears to be similar to, but not an outstanding representative example of, the many small farmsteads in the region and the state, and within that context neither it nor Syerston are of heritage significance.

On the western boundary of the Project Site, (southern boundary of Portion 6 Parish Tout) are located the remains of a number of buildings near a dam (refer Figure 4, Site 2; and Figure 5). The site is divided into two sections, which are assumed to have been connected in their use. The northern section consists of a collapsed building, 3 x 8 m in extent with a verandah on its northern side. This may have been a bunk house/ quarters. Thirty metres to the south are what are interpreted as being a loading ramp, engine mounting and stumps for a small shed. To the east is a standing building housing a single pan toilet. A trailer chassis is abandoned adjacent to the ramp area. A rural dam is located 40 m south east of the site. The southern section of the site is located approximately 30 m to the south-east of the dam, and consists of a small ruined two-stand woolshed, consisting of a standing timber frame, sections of slatted floor, and two sheep-chutes, and associated sheep and horse yards. These buildings and yards do not show on the 1958 aerial photographs, and are interpreted as being a post-1958 pastoral outstation for small-scale shearing operations.

The site, whilst not yet a relic under the Act, is locally significant in this context (ie. it has the level of significance to be entered in a Local Environmental Plan), and efforts should be made to retain it in the new development. If the site cannot be retained in part or in total, those areas and structures impacted by the development should be recorded by plan, text and photographs before disturbance, and this information lodged in a public repository (such as the Condobolin library).

The paddocks throughout the west and south of the Project Site were inspected by vehicle and on foot, and no evidence of other landuses or developments of heritage interest were identified.

3.3 Limestone Quarry

The Limestone Quarry site is located north of Route 64. Of the two potentially effected paddocks immediately north of the road, the western-most paddock is a ploughed and cropped field, with no evidence of historic remains within it. The eastern-most paddock has been extensively cleared of stones, which are gathered into numerous piles of field stone scattered over the paddock. There is a dump of building materials in the paddock, but this appears to be relatively recent in date, and does not appear to be from an *in situ* demolished building. Again, there was no evidence of historical interest identified, and any earlier evidence would have been disturbed by the harrowing for stone removal.

The paddock immediately north of these contains a large outcrop of limestone, and has been less disturbed because of the extent of stone at ground level. This area was traversed on foot, and while there were two areas with dumped building materials, no evidence of heritage significance was identified. The northernmost paddock has been ploughed and cleared of stone, and appears similarly free of evidence of other landuses or activities.

No evidence of earlier utilisation of the limestone, such as for limeburning, was located within the surveyed paddocks, though such use may well have occurred elsewhere in the past given the easy access to loose limestone rock on the outcrop. The dumped construction material in several paddocks may have been associated with former buildings that have now been obliterated, or may come from outside the quarry area. No evidence was located of earlier or alternate uses of the paddocks that might be of historical heritage interest. Aerial photographs of 1958 (National Library of Australia, Trundle I55-3-654) show the geology of the limestone outcrop clearly, and show no evidence of workings or buildings on the quarry site at that time.

3.4 Route 64 Railway Siding Site

The Route 64 rail siding area occupies a space between the railway line and a roadway to the east of it, and extends approximately 600 m north-south and a few hundred metre wide at the southern end, narrowing to a point at the northern end, where the road crosses the rail line. The area was inspected on foot.

Other than earthworks associated with both the construction of the railway and the road, no evidence was located of any historical interest within the siding area. Aerial photographs of 1958 (National Library of Australia, Trundle I55-3-654) show the rail siding site free of any development or buildings at that time.

The short section of the Tullamore-Bogan Gate road linking the site to Route 64 has no items of heritage interest on or adjacent to it.

3.5 Route 64 upgrade and Fifield bypass

Route 64 was surveyed from a vehicle, with foot inspection where needed.

Route 64 connects the proposed railway siding, via the limestone quarry site and a bypass of Fifield, with the Project Site. The existing Route 64 road reserve is a typical country road, and no sites of historical interest were located within it. South of Fifield the road runs close to the Platina mining area, which lies west and south of the road. This mining area does not lie in the path of any road widening or realignment works for the Project (refer Figure 3).

The Fifield bypass follows a former road alignment, with lineal tree plantings and remnant vegetation along it, which marks the former roadway in the landscape. The tree plantings form a landscape feature echoing earlier landuses and activities in the local area, and as such have local heritage interest. Where possible, these trees should be retained and avoided by the new roadworks, and replacement plantings should be undertaken along the new road if the pattern of old trees is thinned to the extent that the line in the landscape is lost. If the roadway needs widening, the landscape character of the line of trees might be retained by removing trees on one side of the road only. No other sites of historical interest were located along the general route, or in the paddock at the western end of the bypass. A concrete tank occupies a hilltop near the north-south route section at the western end of the bypass area, the history of which is unknown. It appears to be for relatively recent pastoral water supply and is not assessed as being of heritage significance.

In general, the roads that are the routes of the gas and water pipelines, or that require upgrading for haulage purposes, have mature trees along their reserves that contribute to the local and regional cultural landscape. While these are not identified as specific sites in this report, road reserve trees should be retained as far as is possible.

3.6 Gas Pipeline route

The Project Gas Pipeline leaves the existing Sydney to Moomba gas pipeline south of Condobolin and generally runs north via Condobolin to the Project Site. The pipeline route is within the road reserve for most of that distance, crossing farm paddocks between Springvale Road and the Project Site at the extreme northern end of the route.

Along MR 57 south of Condobolin there are sections of old pine trunk telephone poles, now no longer in use, located on one or other side (and sometimes both sides) of the road reserve, along the alignment of the reserve fence. There are also sections of pine poles along the reserve fence alignment on Springvale Road north of Condobolin. These old telephone poles are a landscape element of historical interest, reflecting an earlier technological age, and should be avoided and left undisturbed wherever possible (refer Figures 6 and 7).

An historic site is located near the fenceline marking the southern boundary of the paddocks through which the pipeline would run. The site is located 700 m along the fenceline from Springvale Road, and is a pine log structure. The pine logs, notched at the corners, have been built up into a ‘log-cabin’ type structure, 5.7 by 4.1 m and standing 6 logs high (1.2 m) along the southern wall, but with the northern wall completely removed. The structure is either a small sheep fold, or a hut. No roofing structure or iron remain on the site, but these may have been removed. A Currajong tree is growing within the structure. While the history of this structure is not known, it is likely to be older than 50 years, and hence a relic under the Heritage Act, and is assessed as having local heritage significance (able to be confirmed only with additional historical information). The site should be protected from disturbance. The pipeline should be placed no nearer than 15 m from this site, as there is evidence that artefacts may be spread around the site. If it is not possible to keep the pipeline or support tracks etc 15 m from the site, the immediate surrounds of the site (say 5 m from its centre) should be fenced to exclude disturbance, and the unavoidable disturbance minimised within the 15 m radius (see Figure 8).

Other than the features referred to above, there were no sites of historical interest identified within the road reserve or along the route where it crosses the paddocks in the northern end of the route.

3.7 Water Pipeline route and borefield

The Water Pipeline runs north from the borefield near the Lachlan River, along road reserves crossing the Condobolin - Parkes highway at Ootha and running on north to Route 64, then along that route to the Project Site. The road reserve in some locations south of the Condobolin - Parkes highway appears to be within a three chain wide stock route. As with the Gas Pipeline, the road reserves are typical country roads, with remnant vegetation and roadway contained between fences which separate it from the paddocks beyond. No sites of historical interest were identified within the road reserve along which the pipeline would run.

As it approaches the Lachlan River, the pipeline route passes through the former Mulguthrie and Burrawang Stations, which were early pastoral holdings in the district. Burrawang was leased by Thomas Kite of Bathurst in 1848, while J.O. Balfour leased the adjoining ‘Mulguthary’. The two stations appear to have been combined at an early date, and changed hands many times through the nineteenth century[18]. Their owners were invariably absentee pastoralists, the properties being run by managers, so the elaborate homesteads found on some other owner-occupied stations do not appear to have been constructed.

The exact location of the borefields had not been finalised at the time when field assessment was undertaken. The existing test bore locations and the general area between them was surveyed. There are no sites of historical interest near them. Given that the general borefield area is open paddocks with no evidence of former homestead or shed developments, there would be little likelihood of sites of historical interest being located there.

4. CONCLUSIONS

The former magnesite mining areas at the Project Site are of regional historical interest and importance, but the physical evidence of that history is substantially impacted by rehabilitation, and little fabric of heritage significance survives.

The Syerston homestead post-dates the 1958 air photos, while the Kingsdale homestead and woolshed pre-dates them. The Kingsdale homestead complex appears to be similar to, but not an outstanding representative example of, the many small farmsteads in the region and the state, and within that context neither it nor Syerston are of heritage significance. The shearing outstation (Site 2) is locally significant (ie. it has the level of significance to be entered in a Local Environmental Plan), and efforts should be made to retain it in the new development.

The Gas and Water Pipelines occupy, for most of their length, typical country road reserves. Some sections of early pine telephone poles survive along the fenceline marking the edge of the road reserve along the gas pipeline route, and a log structure of heritage interest is located near the northern section of the gas pipeline route. These routes also have some patches of remnant vegetation which are of some historical interest as landscape markers of transport routes and land subdivision. The Limestone Quarry site is located in agricultural paddocks, with no areas of specific historical interest within them.

Specific recommendations are:

- mine planning should consider the locally significant mining landscape at Site 1 and if practicable retain examples.
- if possible avoid disturbance of the shearing outstation complex at Site 2 within the Project Site;
- where possible retain trees along the former roadway in the Fifield bypass area;
- where possible avoid the pine telephone poles along the Gas Pipeline route;
- minimise removal of trees along the road reserves, which contribute to the cultural landscape of the region, during the laying of both the gas and water pipelines;

- place the Gas Pipeline no nearer than 15 m from pine log structure off Springvale Road unless absolutely necessary, in which case closer fencing (c. 5m radius) should demark the protected area and particular care should be taken to limit damage in the 15 m area.

5. BIBLIOGRAPHY

Chisolm, A.H. (ed) 1958. *The Australian Encyclopaedia*, The Grolier Society of Australia, Sydney.

Clemens, R. 1982. *The way it used to be: A history of Tullamore*, the author, Tullamore.

Elliott, S.J. 7 Martin, A.R. 1991. *Geology and mineralisation of the Fifield Platinum Province, New South Wales*, Sixth International Platinum Symposium, guidebook for the pre-symposium field excursion, CSIRO Division of Exploration Geoscience, Wembley, WA

Feeken, E.H.J. & Feeken, G.E.E. 1970. *The discovery and exploration of Australia*, Nelson, Melbourne.

Government Schools of New South Wales 1848 to 1993, 1993. New South Wales Department of School Education, Sydney.

Jaquet, J.B. 1895. 'Report on the occurrence of Platinum at Fifield', NSW Department of Mines *Annual Report*, 1895: 181-183.

Jervis, J. 1993. *Condobolin: The story of its development*, Cumberland Newspapers, Parramatta (reprinted Fred O'Reilly's Printing Services, Young).

Watts, J.P. & Wright, C.F. 1987. *The story of Trundle: A country town and its people*, Ian Berry and Judith Curr, Parramatta.

FOOTNOTES

[1] Watts, J.P. & Wright, C.F. 1987. *The story of Trundle: A country town and its people*, Ian Berry and Judith Curr, Parramatta: 3-5; Feeken, E.H.J. & Feeken, G.E.E. *The discovery and exploration of Australia*, Nelson, Melbourne, 1970: 90; Chisolm, A.H. (ed) *The Australian Encyclopaedia*, The Grolier Society of Australia, Sydney, 1958: vol 3:147.

[2] Chisholm 1958: vol 2: 495.

[3] Watts and Wright 1987: 14.

[4] Watts and Wright 1987: 127.

[5] Watts and Wright 1987: 53.

[6] Watts and Wright 1987: 106.

[7] *Government Schools of New South Wales 1848 to 1993*, New South Wales Department of School Education, Sydney, 1993; 156.

[8] Watts and Wright 1987: 106.

[9] J.B. Jaquet, 'Report on the occurrence of Platinum at Fifield', NSW Department of Mines *Annual Report*, 1895: 181-183.

[10] Watts and Wright 1987: 103.

[11] Elliott, S.J. 7 Martin, A.R. 1991. *Geology and mineralisation of the Fifield Platinum Province, New South Wales*, Sixth International Platinum Symposium, guidebook for the pre-symposium field excursion, CSIRO Division of Exploration Geoscience, Wembley, WA.: 9.

[12] Clemens, R. 1982. *The way it used to be: A history of Tullamore*, the author, Tullamore: 55-57.

[13] NSW Mines Department *Annual Reports*, 1925-1939; Clemens 1982.

[14] Clemens 1982: 55-57.

[15] Chisholm 1958: vol 5: 459.

[16] Air Photo I55-3-653, run 5 photo 128-5032, 1958, National Library of Australia

[17] Watts and Wright 1987: 125-126; Clemens 1982.

[18] Jervis, J. 1993. *Condobolin: The story of its development*, Cumberland Newspapers, Parramatta (reprinted Fred O'Reilly's Printing Services, Young): 20-21.

FIGURES

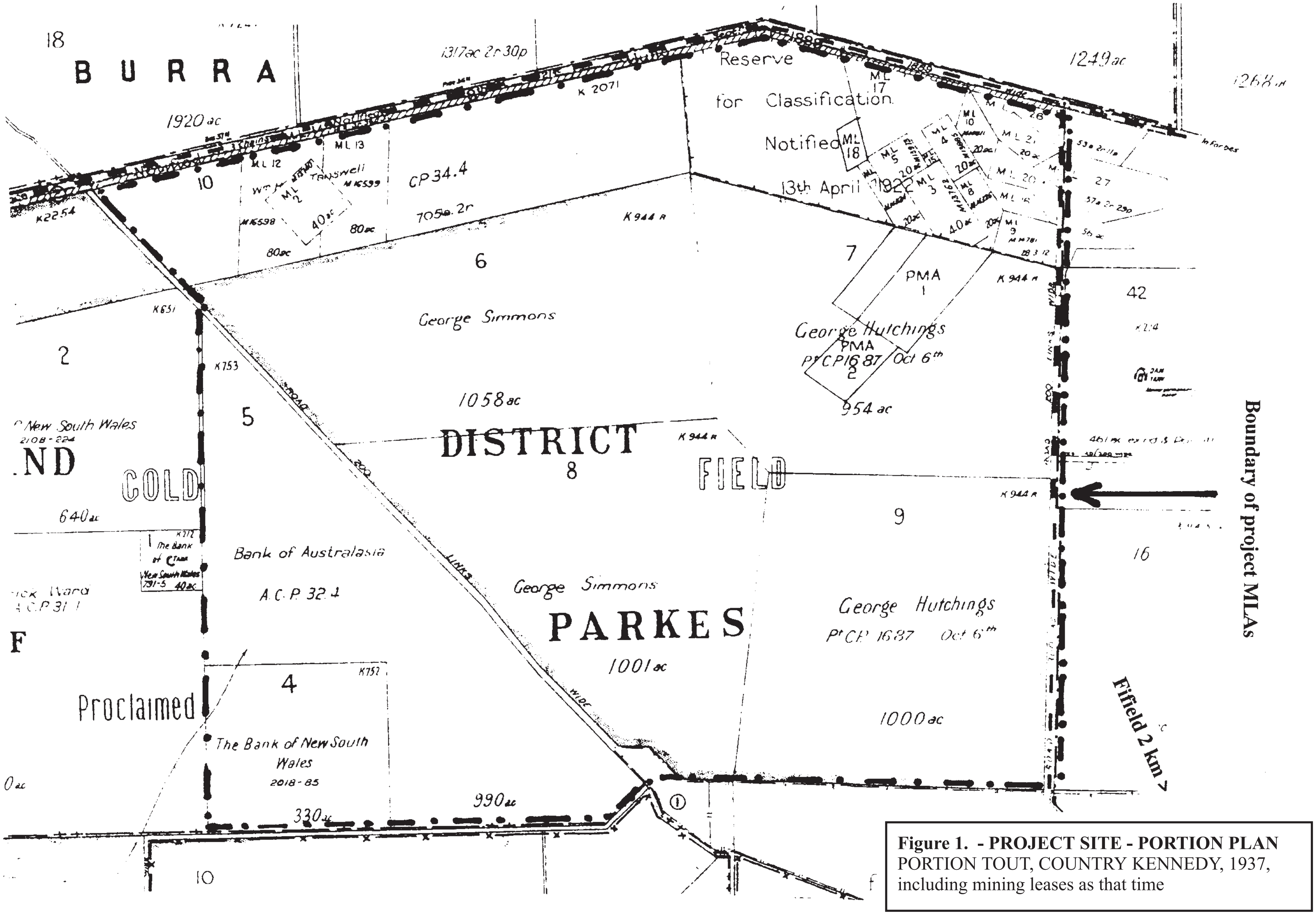


Figure 1. - PROJECT SITE - PORTION PLAN
PORTION TOUT, COUNTRY KENNEDY, 1937,
including mining leases as that time

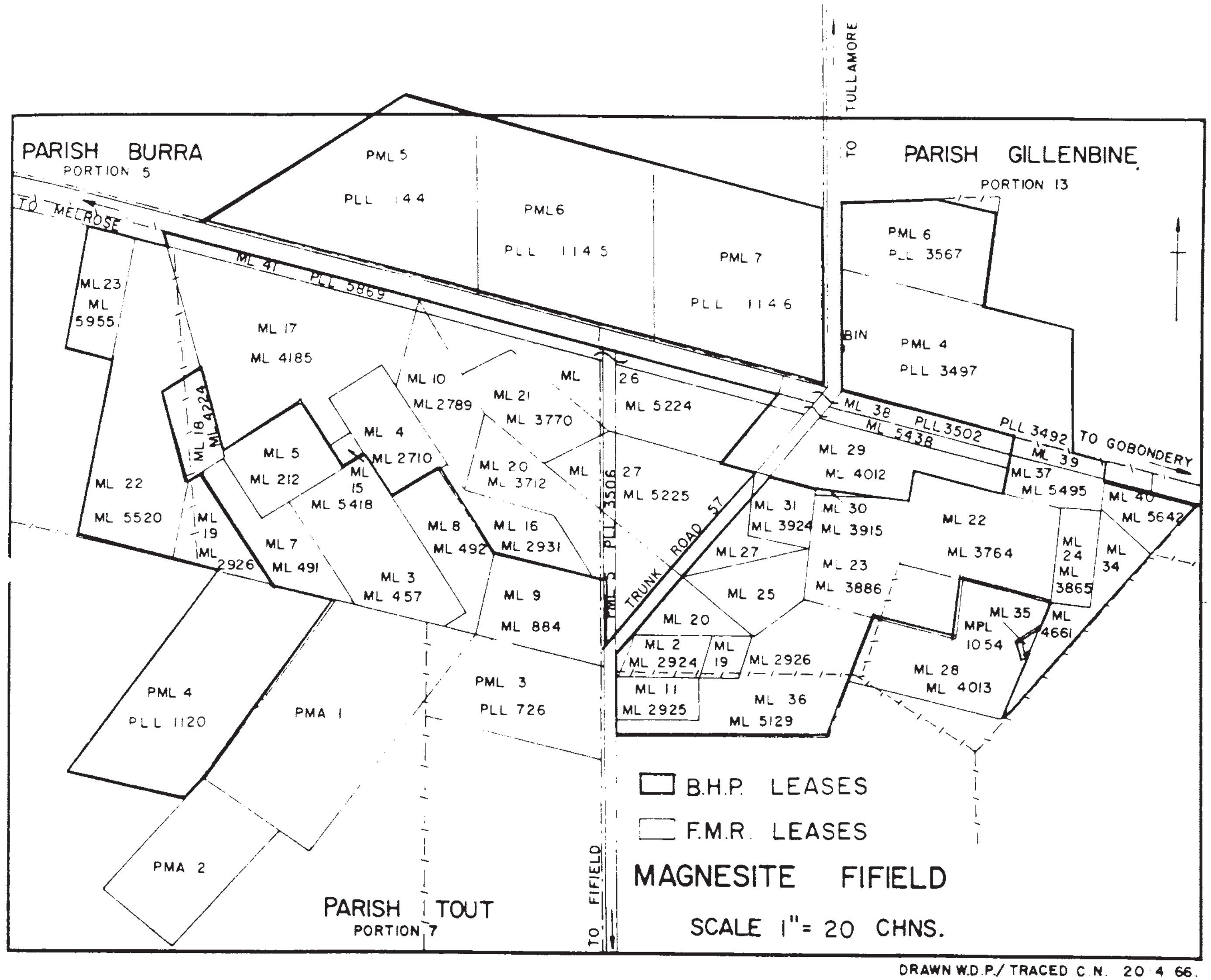


Figure 2 - FIFIELD MAGNESITE MINING LEASES
as they were in 1996, showing extent of mining interest at that time.

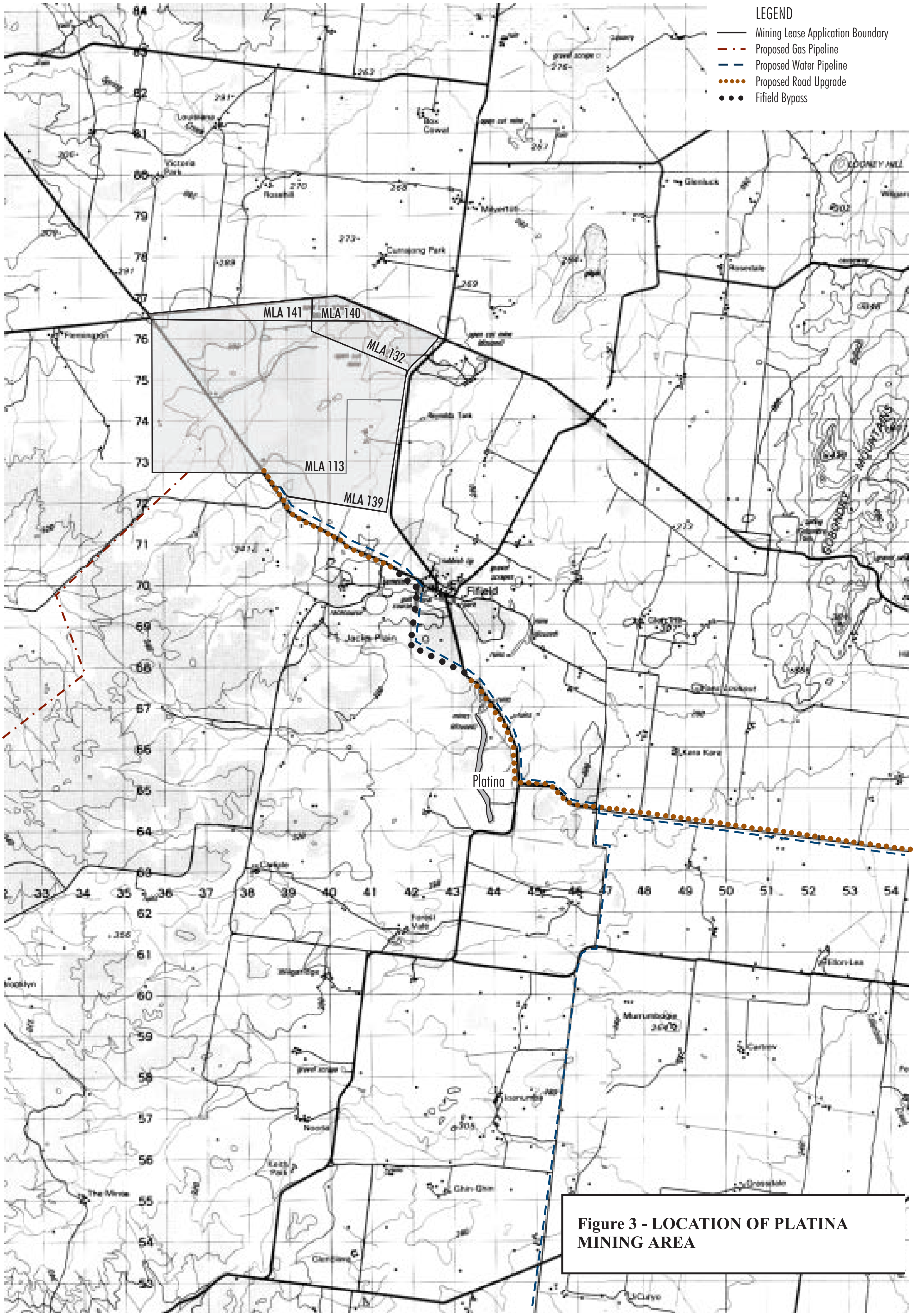
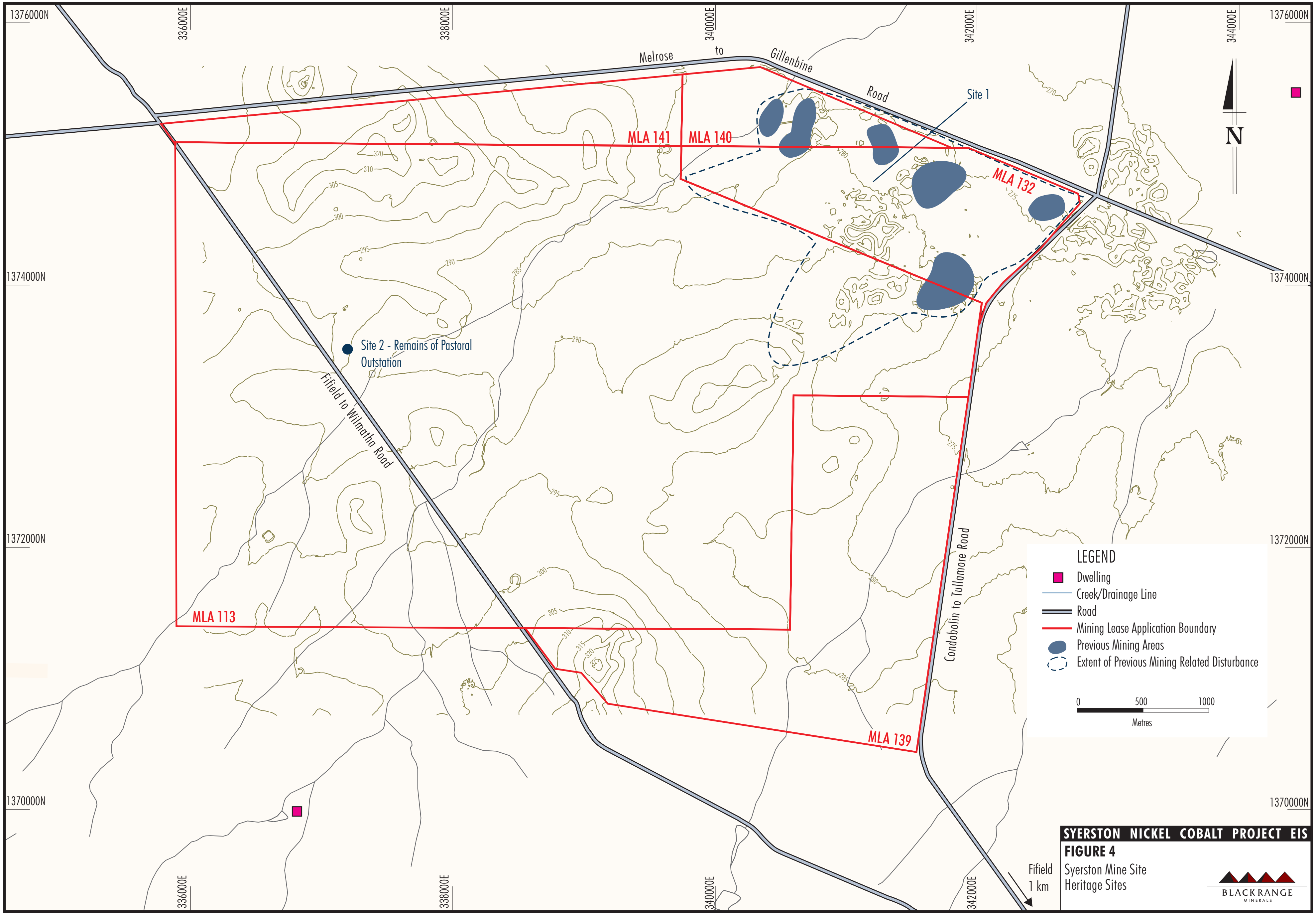


Figure 3 - LOCATION OF PLATINA MINING AREA



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 4

Syerston Mine Site Heritage Sites

BLACK RANGE MINERALS

BRM-98-01-EH_001E

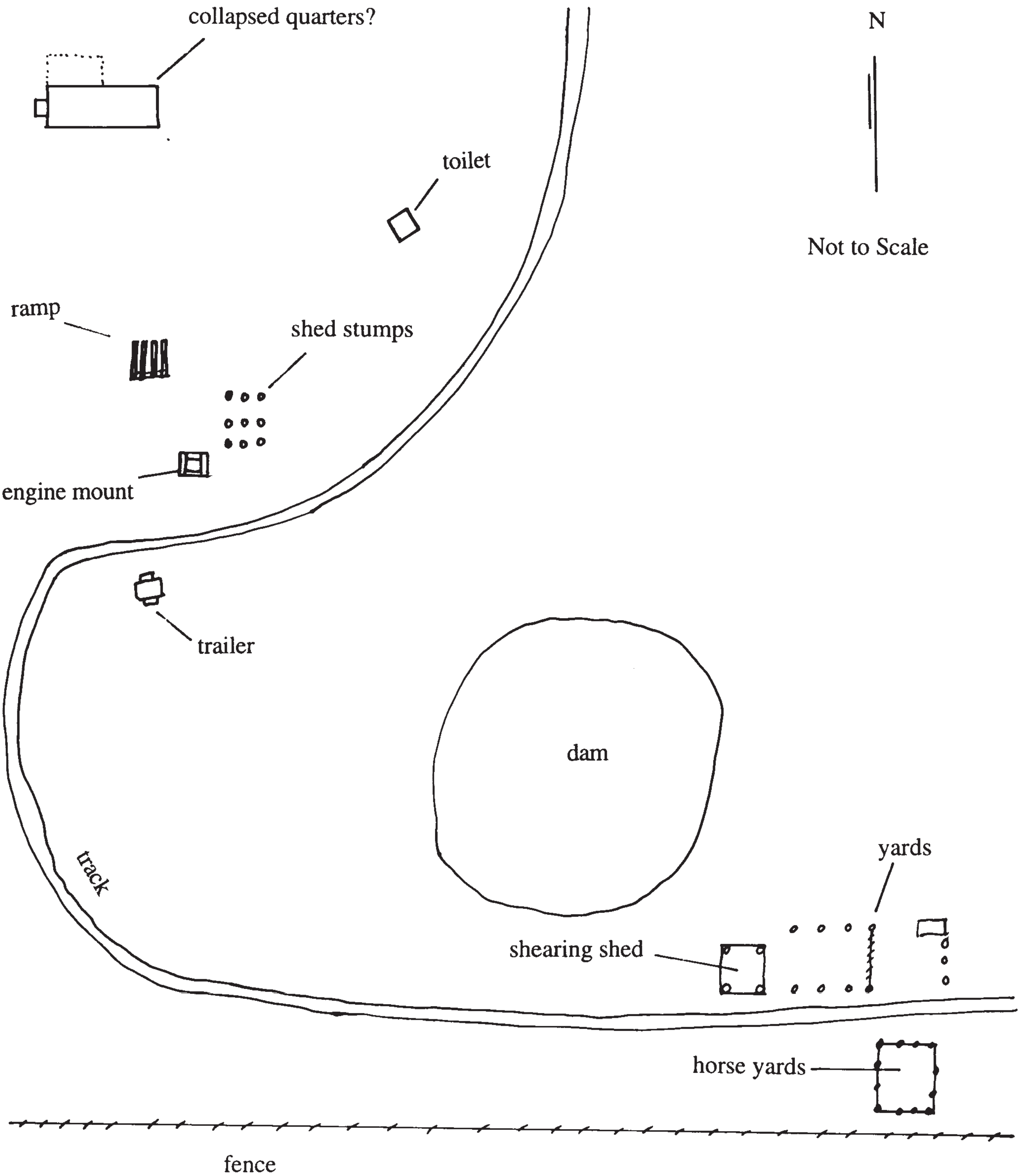


Figure 5 - SHEARING COMPLEX - PROJECT SITE NO.2

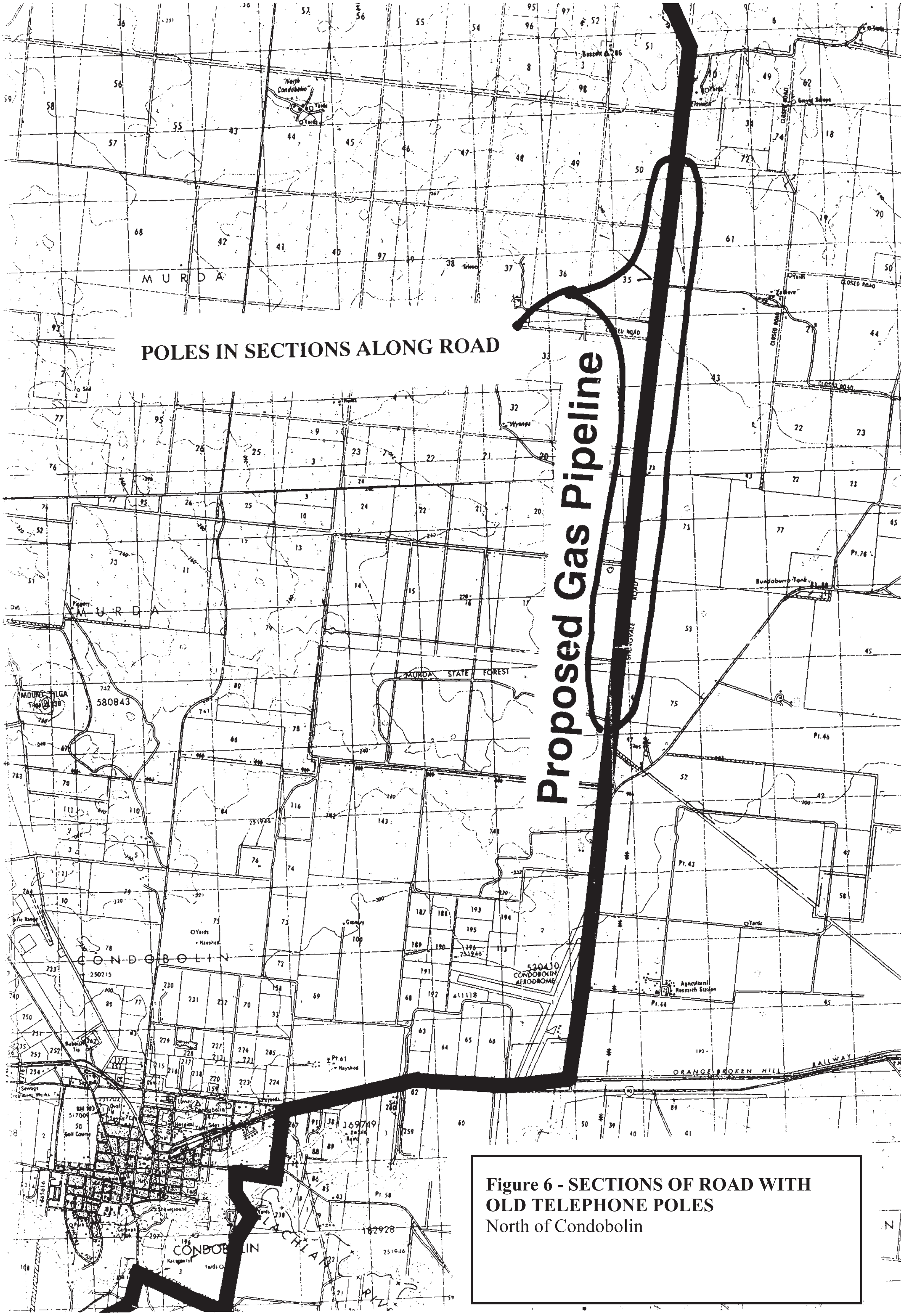


Figure 6 - SECTIONS OF ROAD WITH OLD TELEPHONE POLES
North of Condobolin

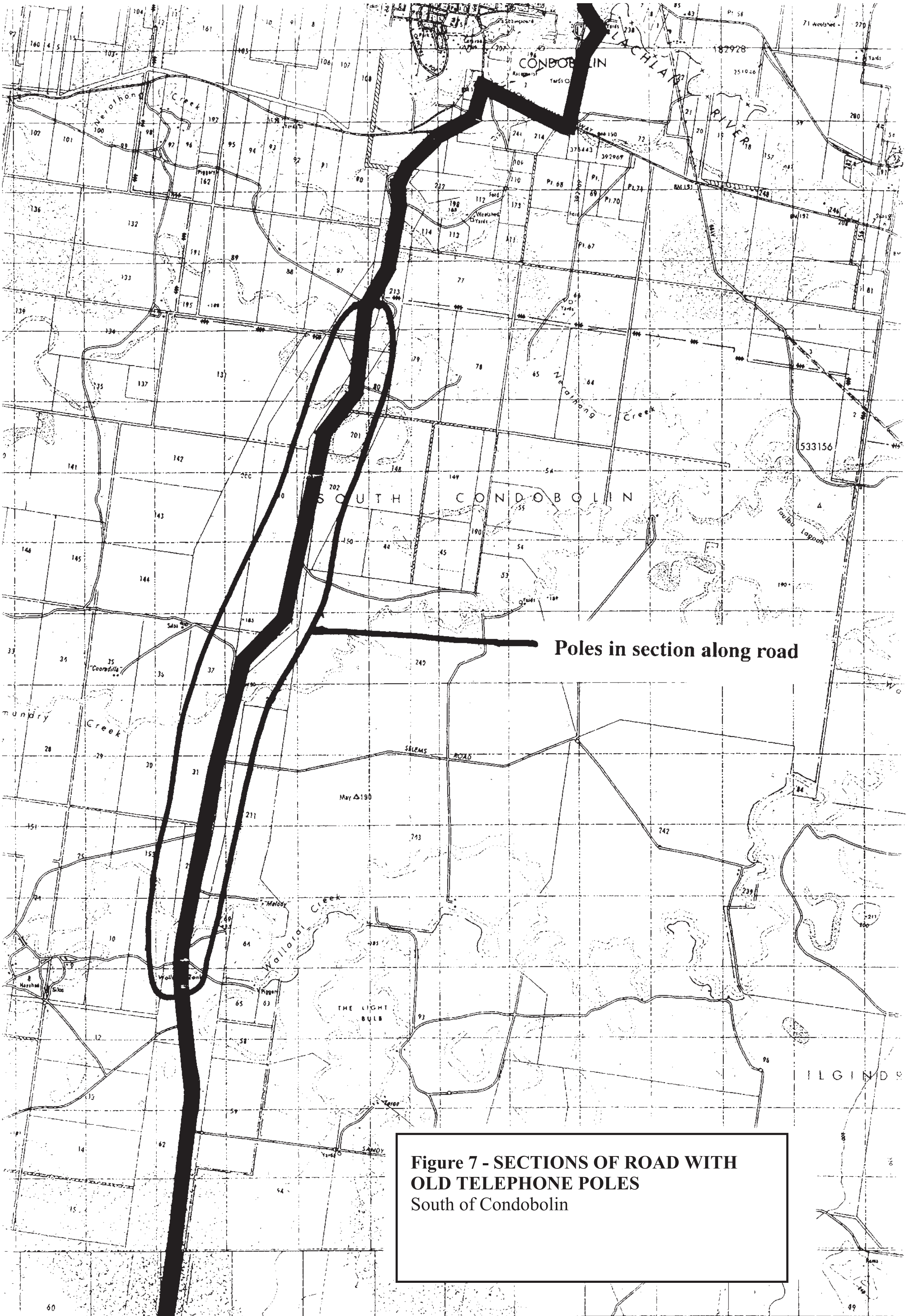


Figure 7 - SECTIONS OF ROAD WITH OLD TELEPHONE POLES
South of Condobolin

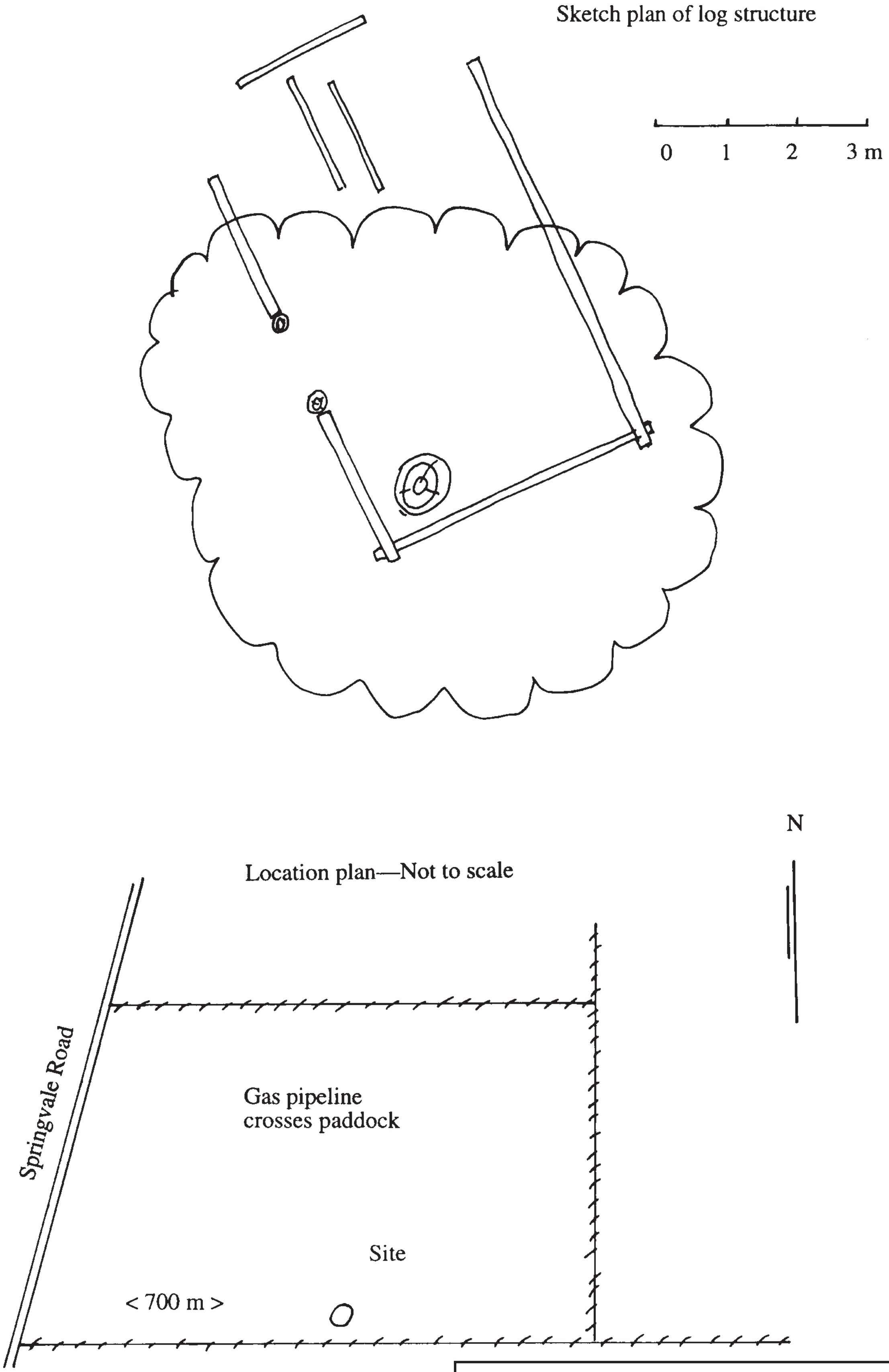


Figure 8 - HERITAGE SITE ON THE GAS PIPELINE OFF SPRINGVALE ROAD.

APPENDIX N

SYERSTON NICKEL COBALT PROJECT
VISUAL ASSESSMENT

PREPARED BY
RESOURCE STRATEGIES PTY LTD

OCTOBER 2000
Project No. BRM-01\3.4
Document No. VISUAL-R01-D.DOC

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

1 INTRODUCTION

1.1 BACKGROUND TO THE DEVELOPMENT

Black Range Minerals Ltd (BRM) is proposing to mine an average of 2 million tonnes per annum (tpa) of nickel laterite ore and establish a nickel and cobalt extraction plant at Syerston, 45 km north-east of Condobolin and 80 km north-west of Parkes in the Central West of New South Wales.

An average of approximately 20,000 tpa of metal or up to 42,000 tpa of mixed nickel-cobalt sulphide precipitate products would be produced for sale to international markets. Annual metals production would peak at approximately 20,000 tonnes of nickel and 5,000 tonnes of cobalt.

In addition to the proposed mine site, BRM propose a number of components which when combined make up the Syerston Nickel Cobalt Project (the Project). In summary, the Project would involve:

- the mine and processing facility (MPF) including ore processing, acid, power and industrial gas plants, water treatment plant, open pit mining areas and mine waste disposal facilities (eg. waste emplacements, tailings storage facility and evaporation ponds);
- a raw water supply borefield some 60 km to the south of the mine site;
- a water supply pipeline from the borefield to the mine site;
- a natural gas pipeline from the existing Sydney-Moomba gas-line located approximately 80 km south south-west of the mine site
- quarrying, crushing and transport of limestone from a quarry approximately 20 km south-east of the mine site;
- a rail siding on the Bogan Gate-Tottenham Railway approximately 25 km to the south-east of the mine site; and
- road and access upgrades and construction of a road bypass.

Locations of the Project components are shown on Figure 1. A Project life in excess of 30 years is possible.

This report presents an assessment of the potential visual impacts of the Project for the EIS term (21 years) and has been prepared as EIS supporting information. The following assessment process has been employed:

- description of the visual character of the main components of the Project;
- identification of the viewshed of the Project and potentially sensitive viewing locations within its vicinity (eg private residences);
- assessment of the potential visual impacts of the project;
- description of proposed and potential mitigation measures designed to reduce the potential visual impacts of the Project.

This assessment methodology is detailed in Section 1.2 and has been applied to the following main Project visual aspects:

- MPF
  - open pits;
  - waste emplacements;
  - topsoil stockpiles;
  - evaporation ponds, evaporation surge dam and tailings storage facilities;
  - processing plant and associated infrastructure; and
  - ore stockpiles.

These items are shown for Year 5 and Year 20 on Figures 2a and 2b.

- Limestone Quarry
  - crushing plant and associated infrastructure;
  - ore, product and topsoil stockpiles;
  - waste emplacement; and
  - open pit.

These items are shown for Year 5 and Year 21 on Figures 3a and 3b.

- Rail Siding (Figure 4)
  - administration office and equipment compound;
  - hardstand area;
  - train operational area (container storage).

1.2 ASSESSMENT METHODOLOGY

Visual impacts were assessed by the evaluation of proposed visual modifications to the existing landscape as a result of the Project. The assessment was conducted from viewing points including homesteads and public roads.

The study method consisted of three phases:

- the existing visual landscape of the Project area was characterised in terms of topography, vegetation and landuse;
- viewpoints to the Project area were identified; and
- the level of sensitivity to visual change and potential visual impact from these viewpoints was assessed.

Visual sensitivity was assessed in order to determine the landscape's ability to absorb proposed Project alterations and therefore the degree of potential visual impact.

The degree of potential visual impact was assessed by considering the degree of visual modification (ie. main visual aspects outlined above) and visual sensitivity. A low visual sensitivity indicates that change could be readily absorbed, whereas a high sensitivity indicates that change would result in a substantial alteration to an existing visual condition. Impact levels would vary according to the combination of visual modification and sensitivity.

2 VISUAL CATCHMENT

The existing landscape of the Project area and its environs is characterised by cleared lands which reflect long term use for cropping and sheep and cattle grazing, and previous mining operations. It is considered to be highly modified from its woodland origins.

The visual catchments of the MPF, limestone quarry and rail siding are described in relation to the local setting (views within a 1 km radius) and regional setting (views beyond a 1 km radius). Figure 5 shows the extent of local and regional settings.

2.1 REGIONAL CONTEXT – VIEWS BEYOND 1 KM RADIUS

2.1.1 Mine and Processing Facility

The regional area surrounding the MPF site is characterised by cleared cropping and grazing land with an area of remnant bushland to the south-west and previous mining areas to the north-east and south-east. The small village of Fifield is located approximately 2 km south-east of the proposed processing facility, with Condobolin (the largest nearby town) located 45 km to the south-west. The topography of the area is relatively flat with the greatest expressions of relief being Boona Mountains, approximately 20 km to the west, and Gobondry Mountains approximately 10 km to the east.

Views of the MPF site from the surrounding region are limited due to the lack of public vantage points, the relatively flat topography and the obscuring roadside vegetation.

The southern portion of the MPF site is visible from Condobolin to Tullamore Road when heading north from Fifield. In addition, the site is visible on Fifield to Wilmatha Road from both the northern and southern approaches to the MPF site. The view looking south from this road is limited due to the vegetation along the northern boundary of the MPF site.

Of the surrounding residential properties (Figure 5), “Wanda Bye” has the only clear view which looks through sparse vegetation to the proposed tailings storage facility and evaporation pond sites.

Partially obscured views of the MPF site are available from the residences at “Slapdown”, “Brooklyn”, “Currajong Park” and “Sunrise”. The views from “Slapdown” and “Currajong Park” are partially obscured by vegetation between the residences and the mine site (mainly in the road reserves). Views from “Sunrise” are obscured by roadside vegetation along Hogarths Lane and Fifield to Wilmatha Road and a heavily vegetated rise in the south-western corner of MLA 139 blocking the view to the proposed tailings storage facility and evaporation pond sites.

The view from “Brooklyn” looks across cleared paddocks to the previous mining areas directly east of MLA 132 and onto the section of State Forest in the north-eastern section of the mine site (MLA 132 and 140). Vegetation within the road reserve obscures the view to the mine site.

2.1.2 Limestone Quarry

The limestone quarry is located approximately 20 km south-east of the MPF site.

The regional environment surrounding the limestone quarry (Figure 5) incorporates the proposed rail siding (4.5 km to the east) and is surrounded by cleared cropping and grazing land and patches of remnant vegetation. Elevation in the area is undulating with the exception of Gobondry Mountains approximately 5 km to the north-west. Melrose to Gillenbine Road crosses the Gobondry Mountains however no views of the quarry are possible from this road due to its alignment and the surrounding vegetation.

The limestone quarry site is visible from Fifield to Trundle Road.

Residential properties surrounding the quarry MLA ("Reas Falls" and "Moorelands" – Figure 5) would have partially obscured and distant views of the site. The driveway to "Westella" is vegetated with rows of mature trees which partially obscure views from "Moorelands" and vehicles travelling on Fifield to Trundle Road west of the quarry. The other surrounding residential properties including "Lesbina", "Gillenbine", "Hillsdale", "Glen Rock" and "Three Trees" (Figure 5) do not have views of the site due to the distance, flat topography and obscuring vegetation. "Westella" and "The Troffs" properties would be purchased by BRM should the Project proceed.

2.1.3 Rail Siding

The visual characteristics of the region surrounding the rail siding (Figure 5) include mainly cleared cropping and grazing lands with remnant vegetation in bands along roadsides and property boundaries, and vegetation "clumps" and individual trees scattered on properties.

There are no regional views of the site from public viewpoints due to the alignment of public roads and the relatively flat topography of the area, which minimises vantage points.

Two other rail sidings are located in close proximity to the proposed Project rail siding site. The Troffs rail siding and grain silos are approximately 5 km to the north and the Trundle siding and silos approximately 5 km to the south.

2.2 LOCAL CONTEXT – VIEWS WITHIN A 1 KM RADIUS

2.2.1 MPF

Views of the MPF site from within a 1 km radius are available from the following surrounding roads (Figure 5):

- Fifield to Wilmatha Road;
- Melrose to Gillenbine Road; and
- Condobolin to Tullamore Road.

Melrose to Gillenbine Road runs along the northern boundary of the site, however views of the site are blocked due to vegetation along the length of the northern MPF boundary.

Views to the site from Fifield to Wilmatha Road and Condobolin to Tullamore Road are partially obscured by scattered vegetation in most areas.
No homesteads are located within 1 km of the MLA boundaries.

2.2.2 Limestone Quarry

Local views of the limestone quarry are available from Fifield to Trundle Road and the laneway on the eastern end of the MLA linking Fifield to Trundle Road and Melrose to Gillenbine Road (Figure 5).

Views of the proposed plant and administration areas on the quarry site would be obscured due to the vegetation surrounding the existing “Westella” homestead, sheds and bordering the driveway. Of the surrounding properties within a 1 km radius, two are abandoned (“Danganmore” and “Rockleigh”) and “Westella” and “The Troffs” would be purchased by BRM should the Project proceed.

2.2.3 Rail Siding

Local views of the rail siding site are available from both the northern and southern approaches on Tullamore to Bogan Gate Road and the eastern end of Fifield to Trundle Road (Figure 5).

Views from the “Glen Rock” property adjacent to the siding are also available. There is minimal vegetation obscuring the line of sight between the property and rail siding.

No other residences are located within a 1 km radius of the rail siding.

3 PROJECT DESCRIPTION – VISUAL CHARACTER

The major visual components of the proposed MPF, limestone quarry and rail siding and the potential level of visual modification prior to implementing mitigation measures are described below.

3.1 MPF

The main visual elements of the MPF are:

- open pits;
- waste emplacements;
- topsoil stockpiles;
- evaporation ponds and tailings storage facilities;
- processing plant and associated infrastructure; and
- ore stockpiles.

Figures 2a and 2b show the development of these elements at Year 5 and Year 20. The main visual components of the MPF operations are:

- vegetation clearance over proposed disturbance areas;
- topsoil stripping and stockpiling;
- construction of elements with elevations higher than the surrounding topography including waste emplacements, tailings storage facilities and stacks at the processing facility;
- progressive rehabilitation works;
- establishment of vegetation screens on site boundaries; and
- lighting of the processing facility at night (including stack flares).

Waste material removed from the open pits during mining would be stored in two waste emplacements (western waste emplacement and eastern waste emplacement) adjacent to the open pits and located along the northern and eastern MLA boundaries (Figures 2a and 2b). After 20 years the waste emplacements would have reached heights of approximately 30 m. Topsoiling and rehabilitation of the waste emplacements would be undertaken progressively and as soon as practicable after work is completed.

The tailings storage facility would be constructed in the south-east of the Project area and would be stage-constructed with a southern cell constructed first, followed by a northern cell three years later. Embankment lifts of the cells would occur each year alternately after the third year of operations. Maximum embankment heights would be some 30 m by Year 20.

The processing facility is composed of numerous ancillary plants and associated infrastructure. Components of this infrastructure visible from outside the MLA due to their height would include four stacks, two of which could have a maximum height of up to 80 m. The processing facility and associated infrastructure buildings would be approximately 20 m high and located on slightly raised ground.

Ore stockpiles would be constructed north of the processing facility and would be maintained at a relatively constant height of approximately 15 m throughout the Project site. They are generally surrounded by the waste emplacements, open pits, processing facility and topsoil stockpiles.

Topsoil would be stripped and stockpiled from proposed disturbance areas during construction and as open pits and waste emplacements develop. The location of stockpiles are shown on Figures 2a and 2b. The stockpiles would be revegetated with grasses after completion.

A vegetation screen would be established around the boundary of the MLAs during the construction phase of the Project (Figure 2a).

Night lighting would be required at the processing plant area, security gate house, active mine and waste dump areas and along the access road.

The site would also contain small elements contributing to the mining character such as:

- internal roads for operational access;
- overhead services such as power and telephone;
- signage; and
- buildings and amenities.

3.2 LIMESTONE QUARRY

The main visual elements of the quarry are:

- the crushing plant and associated infrastructure;
- ore, product and topsoil stockpiles;
- waste emplacement; and
- open pit.

Figures 3a and 3b show the development of these elements at Year 5 and Year 21.

The main visual components associated with the establishment and operation of the quarry are:

- vegetation clearance over the areas of the open pit, waste emplacement and crushing plant and associated infrastructure areas;
- topsoil stripping and stockpiling;
- establishment of a vegetation screen on the site boundary;
- excavation of the open pit and construction of the waste emplacement during mining; and
- night lighting for truck loading.

The crushing plant area would contain a crushing and screening plant, ROM pad, final product stockpile and diesel storage. The administration area would be located at the existing "Westella" homestead with a workshop area adjacent to the homestead (Figures 3a and 3b).

The existing vegetation along the "Westella" driveway would be retained and a vegetation screen would be established for a section along the southern boundary of the site.

Topsoil would either be temporarily stored in one of two topsoil stockpiles (Figures 3a and 3b) or used directly in site rehabilitation. The stockpiles would be grassed as soon as practicable following completion.

The ROM limestone and product stockpiles would be located adjacent the crushing plant and be constructed to a maximum height of approximately 5 m. These areas would be lit at night for truck loading operations.

The low grade limestone and waste rock would be placed in a waste emplacement located around the margins of the open pit (Figures 3a and 3b). The outer batters of the waste emplacement would be constructed to final elevation initially, thereby allowing progressive rehabilitation on visible areas to occur first. Further construction of the waste emplacement and mining in the open pit would then occur behind this elevated perimeter of the waste emplacement, hidden from view. Views of mining activity would be available during the first five years of operation when the elevation of the top of the existing hill is above the top of the waste emplacement. After this, as the pit gets deeper, views of the open pit works from public vantage points would be obscured by the waste emplacement.

3.3 RAIL SIDING

The main visual elements of the rail siding are:

- administration office;
- equipment compound;
- hardstand area; and
- train operational area (container storage).

Figure 4 shows these elements. The main visual components associated with the establishment and operation of the siding are:

- clearing vegetation during the construction of the site;
- container stacking at the container storage area during operation of the siding; and
- night lighting for container or truck loading.

4 VISUAL SENSITIVITY

As mentioned in Section 1.2 the level of the visual sensitivity of the proposed Project from various landuses is used to assess visual impact. Impact assessment presented in Section 5 assumes:

- views from surrounding rural residences would have high visual sensitivity;
- views from roads would have moderate sensitivity; and
- views from rural landuse (eg paddocks) would have low sensitivity.

5 VISUAL IMPACTS AND MANAGEMENT STRATEGIES

The visual impacts of the proposal are determined by the scale and massing of buildings and the degree of landscape change that is proposed, be it through altering vegetation patterns or substantial landform change. These changes are assessed based on views from adjoining properties or public access areas and the visual sensitivities discussed in Section 4. In each of the following sections, the proposed landform changes are discussed, followed by assessment of potential visual impact and their management strategies.

The ability to absorb the proposed changes in terms of visual quality is dependent on the extent to which the existing landform is altered. This may include the protrusion of mine support facilities into the skyline above the backdrop of the vegetation and landform, the colour and massing of the proposed facility, and the degree to which it can be screened by new plantings and earthforms.

Visual simulations (Figures 6a to 11b) have been prepared to assist in impact assessment. They include simulations of views of mine landforms during early (Year 5) and advanced stages (Year 20) of mining and management measures (eg. rehabilitation to minimise potential visual impact). Figure 5 shows the locations from where these simulations have been prepared.

5.1 MINE AND PROCESSING FACILITY

5.1.1 Landform Change

The MPF is set in a rural environment that in some areas has been previously disturbed by mining activities. Permanent landform changes which result from developments on the MPF site are:

- waste emplacements;
- tailings storage facility;
- open pits (two pits by year 20); and
- evaporation ponds and surge dam.

Other areas on the site (including topsoil stockpile sites, ROM and low grade stockpile sites and processing facility) would be decommissioned at various stages during and after the mine life and rehabilitated to approximate original landforms.

The waste emplacements would have a progressively changing form. The waste emplacements have been designed to minimise their visual impact on the local landscape with 1 in 4 overall graded outer batter slopes, progressive rehabilitation strategy and relatively low elevation (regionally equivalent to the effect of the low hills of Gobondry Mountains approximately 10 km to the east of the MPF).

The tailings storage facility would ultimately fill to form a flat plain that would be rehabilitated at the end of mine life. The outer slopes of embankments of the tailings storage facility would be battered to an overall grade of 1 in 4 with intermediate batter grades of 1 in 3 and revegetated progressively during operations. Screen planting would also be undertaken around the MPF site boundary and would restrict views of the facility.

Multiple open pits would be progressively developed over the mine life and by Year 20 there would be two pits.

The evaporation surge dam could be retained as a farm water dam at the completion of operations. The dam embankment would be revegetated with grasses as soon as possible after construction.

5.1.2 Visual Impact

The MPF has a number of areas that would have a potential visual impact from surrounding viewpoints. These include:

- tailings storage facility;
- evaporation ponds;
- processing facility;
- topsoil stockpiles; and
- waste emplacements.

The tailings storage facility is to be located in the southern section of the MLA between the processing facility and the evaporation pond. Views of the tailings storage facility from nearby residences (“Wanda Bye” and “Sunrise”) for Year 5 and Year 20 are simulated on Figures 6a, 6b, 7a and 7b. These simulations show the limited visibility of the facility from these residences. Views of the storage facility would also be available from the Fifield to Wilmatha Road to the south and a small section along the Condobolin to Tullamore Road along the eastern boundary of the MLA.

Factors limiting visibility of the tailings storage facility are the location of the evaporation ponds and scattered tree cover on adjoining properties and road reserves. The evaporation ponds would be visible through the roadside vegetation along the Condobolin to Tullamore Road and from “Wanda Bye” and Fifield to Wilmatha Road to the south of the MLA. Visual simulations of the view from “Wanda Bye” in Year 5 and Year 20 are presented on Figures 6a and 6b.

The processing facility is located approximately 500 m from the Fifield to Wilmatha Road. Views of sections of the plant would be available from both the “Sunrise” and “Wanda Bye” homesteads and the Fifield to Wilmatha and Condobolin to Tullamore Roads. Views of the facility from both roads would be obscured due to the location of the Project related structures and landforms (eg. evaporation ponds, tailings storage facility and topsoil stockpiles) within the MLA (Figures 2a and 2b). Views from “Sunrise” would include the tops of stacks above the treeline approximately 3 km to the north-east of the homestead, however this visibility at such a large distance would be limited. Figures 7a and 7b present visual simulations from “Sunrise”.

Lighting and flares associated with the stacks would be visible from greater distances and a night glow above the MPF would also be visible from distant vantage points.

Of the two waste emplacements (western and eastern) views of the eastern emplacement would be available from selected surrounding residences and viewpoints. The eastern waste emplacement would be located in the north-eastern corner of the MLA. Views of the eastern waste emplacement would be available from both “Brooklyn” homestead (to the north-east) and “Currajong Park” (directly north). Visual simulations of the views from “Brooklyn” and “Currajong Park” homesteads in Year 5 and Year 20 are presented in Figures 8a and 8b and 9a and 9b. Views from both of these homesteads would be obscured by vegetation within the Melrose to Gillenbine Road corridor and that runs along the northern boundary of the site. The relatively long distance (approximately 1 km to "Currajong Park" and 2 km to "Brooklyn") from these residences and tree areas in front of these viewpoints would limit the visual impact of the waste emplacement. The impacts would be further reduced by the establishment of a rehabilitation cover, which would occur progressively over the mine life.

Discussion of potential night lighting impacts of the MPF is presented in Section 5.4.

5.2 LIMESTONE QUARRY

5.2.1 Landform Change

Permanent landform changes associated with the quarry would be the waste emplacement and quarry open pit (described in Section 3). The waste emplacement outer batters would be graded to 1 in 4 and revegetated progressively during mining. The final height of the emplacement would not exceed that of the original hill present on the site.

5.2.2 Visual Impact

The location and construction methodology of the waste emplacement would minimise the potential visual impacts of the quarry site. Visible components of the site would include the crushing plant and associated infrastructure and ROM limestone and product stockpiles which, although set back from the Fifield to Trundle Road, would be visible when travelling east along the road.

Views from Fifield to Trundle Road towards the proposed plant area and the quarry are presented for Year 5 and Year 21 in Figures 10a and 10b and 11a and 11b respectively.

Views of the quarry and processing area from "Reas Falls" and "Moorelands" would be obscured due to distance and existing vegetation within the road corridor and scattered on the properties.

Discussion of potential night lighting impacts at the quarry is presented in Section 5.4.

5.3 RAIL SIDING

5.3.1 Landform Change

Permanent landform changes associated with the rail siding would be minor and include an additional rail track and hardstand area.

5.3.2 Visual Impact

Views of the proposed rail siding would be available from the intersection of Fifield to Trundle Road with the Tullamore to Bogan Gate Road and the northern and southern approaches of the Tullamore to Bogan Gate Road to the proposed siding. Views of the siding would be obscured in part by vegetation on land adjacent to the site however views of the siding would be available at close proximity due to the lack of screening vegetation between the road, rail line and proposed siding.

Views from "Glen Rock" homestead (approximately 1 km south-west of the siding) of the proposed rail siding would be available, however, the level of visual impact would be minimal due to the proposed lowset rail siding infrastructure.

Discussion of potential impacts due to night lighting at the siding is presented in Section 5.4.

5.4 NIGHT LIGHTING

Lighting at the quarry and rail siding would be restricted due to low levels of night activities and is considered to be of minor impact. Lighting of the MPF and active pits and waste emplacement areas would be required for 24 hour operations.

The significance of night lighting impacts is due to the contrast between light and dark in a rural landscape. The main regional impact of the light emissions is that a glow would be seen in the night sky above the MPF from the surrounding region and residences. Locally, fixed (buildings and stacks) and mobile light, such as used on the waste emplacement, would be seen from some roads and on occasions at some of the surrounding properties. The general lighting and flare associated with the higher stacks are likely to be visible from select portions of "Wanda Bye" and "Sunrise".

5.5 MITIGATION MEASURES

The limited population residing in the vicinity of the proposed development assists in reducing the potential for visual impacts.

5.5.1 MPF

In general, views of the MPF site would be limited by the proposed boundary vegetation screen, existing vegetation surrounding the MPF site (eg. roadside vegetation) and the absence of elevated public viewpoints surrounding the site (Figure 2a). Figures 6a and 6b and 7a and 7b show the mitigating effect of the proposed vegetation screen in Year 5 and Year 20.

Progressive rehabilitation of the waste emplacements would minimise their visual impact and would reduce contrast with surrounding areas. Views of the progressive waste emplacement rehabilitation in Year 20 from properties to the north ("Brooklyn" and "Currajong Park") are shown on Figures 8b and 9b.

Revegetation (grasses) of the evaporation ponds and tailings storage facility outer batters would be undertaken and would further limit the visual impact in addition to the MPF site perimeter vegetation screen.

The architectural detailing of proposed buildings is important in moderating the visual impact of the facilities and their relationship with the surrounding environment. The general massing of all the proposed buildings is fixed by the functional requirements of the processes and equipment located within the buildings. The application of a consistency of detailing and careful colour selection, however, would maximise the appropriate fit of these industrial buildings into their adjoining landscape.

Colour plays a significant role in the visibility of the proposed infrastructure. It is recommended that beige colours be used where possible to help the infrastructure blend in with the surrounding grasslands.

The impacts of night lighting would be minimised by only lighting areas required and using directional lighting where possible in order to control light spill.

5.5.2 Limestone Quarry

The proposed mitigation measures for minimising the potential impacts of the limestone quarry focus on using the existing vegetation along the proposed access road to screen the processing plant, development and placement of the waste emplacement to shield views of the operation and establishing a vegetation screen along a section of the MLA to act as a visual screen. The vegetation screen would be established in the section between the quarry access road and the waste emplacement and would screen views of the plant area and associated infrastructure. Simulated views of this area in Year 5 and Year 21 are presented as Figures 10a and 10b.

Progressive rehabilitation of the waste emplacement would also be undertaken. Figures 11a and 11b show the mitigating effect of initial revegetation of the outer waste emplacement batter in Year 5 and Year 21.

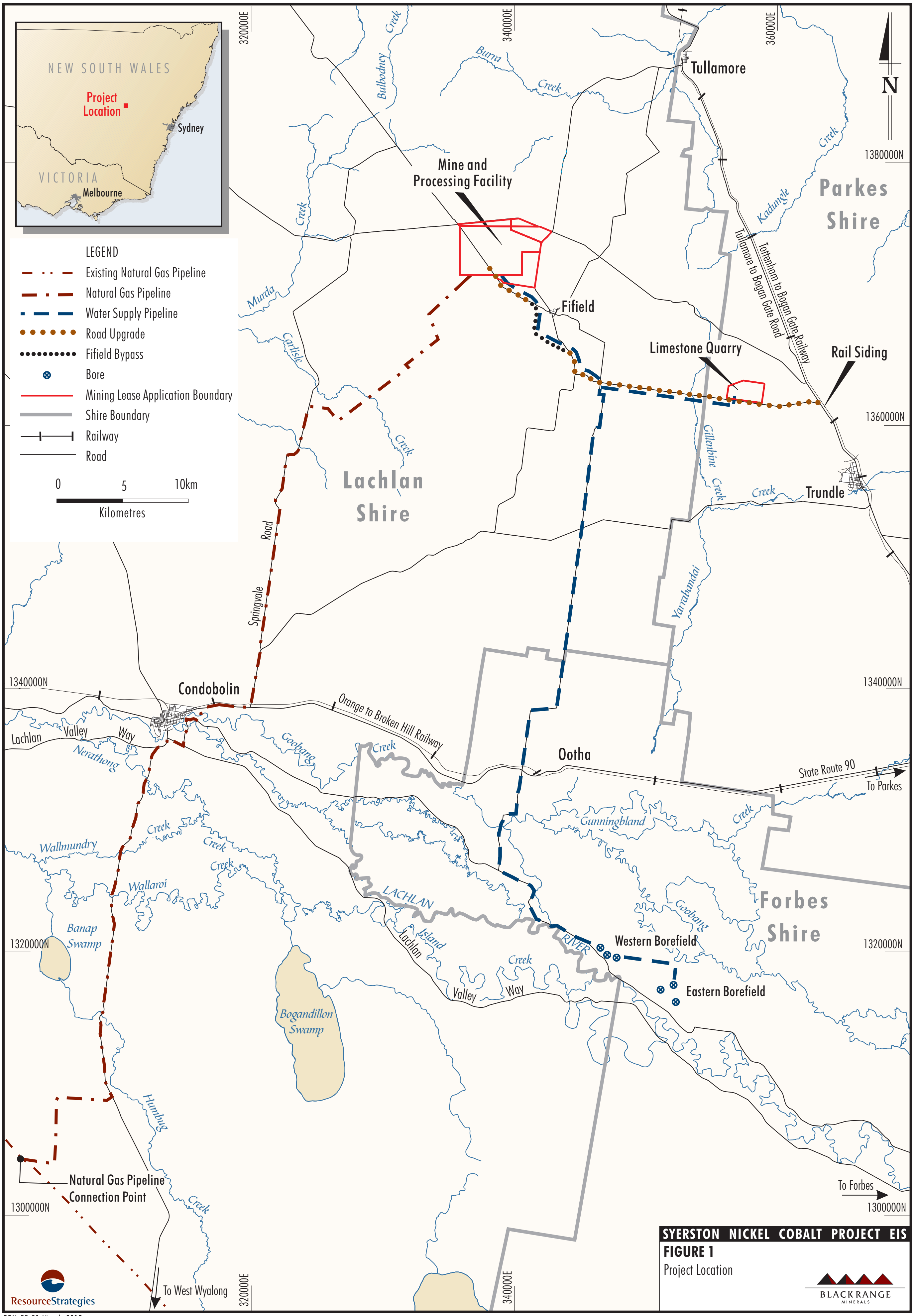
Night lighting would be required during the loading of limestone into trucks. The existing vegetation, proposed vegetation screen and distance of the loading area from the road and surrounding residences would minimise light emission impacts from the site.

5.5.3 Rail Siding

The establishment of vegetation screens at either end of the site is recommended as it would reduce the extent of views from the northern and southern approaches on the Tullamore to Bogan Gate Road.

Lighting required for the proposed facility would include focussed beams to reduce the potential for light spillage.

FIGURES

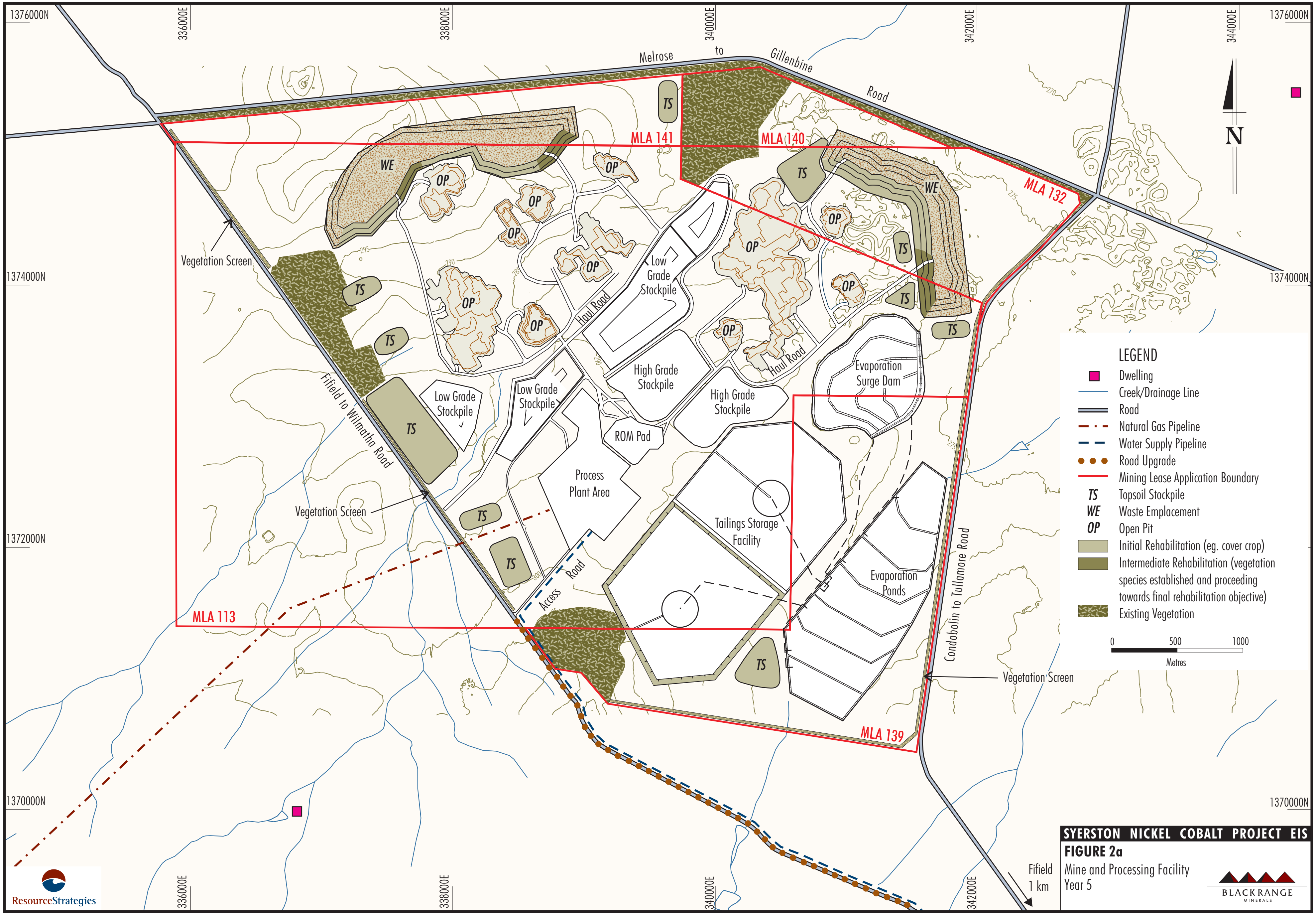


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 1

Project Location

BRM-98-01-Visual_001B

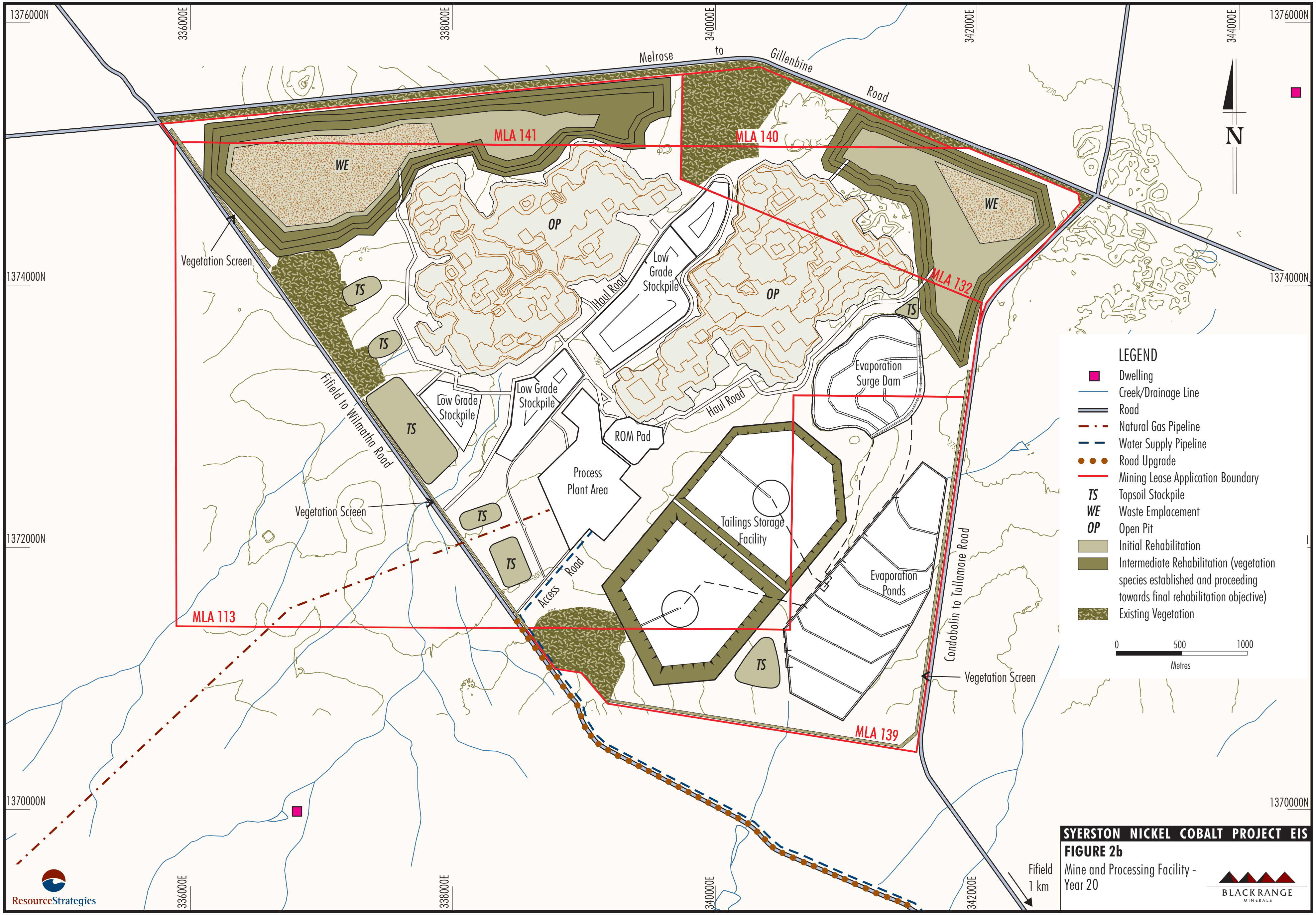


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 2a

Mine and Processing Facility
Year 5

BRM-98-01-Visual_019D

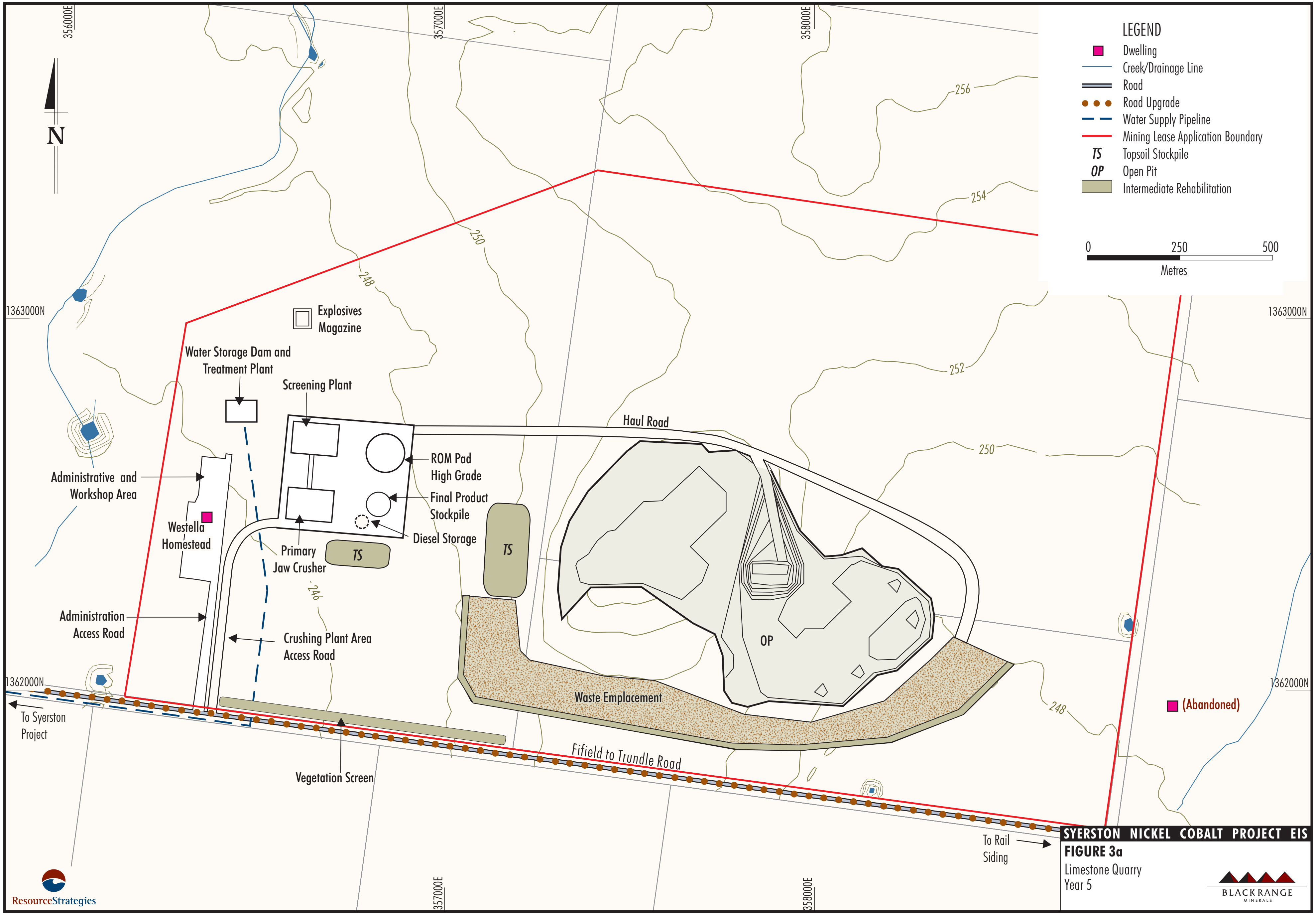


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 2b

Mine and Processing Facility - Year 20

BRM-98-01-Visual_002D

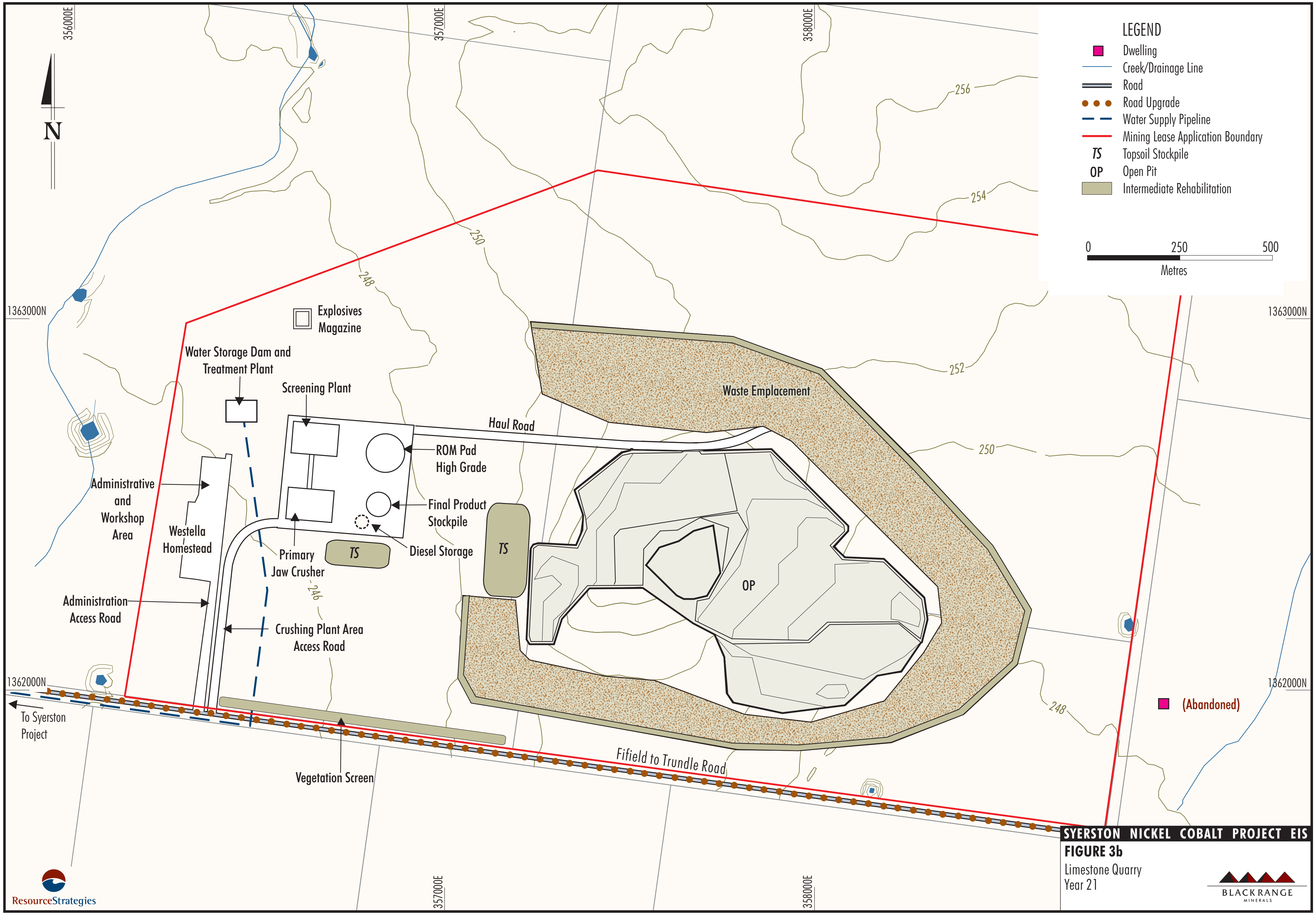


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 3a

Limestone Quarry
Year 5

BRM-98-01-Visual_020B

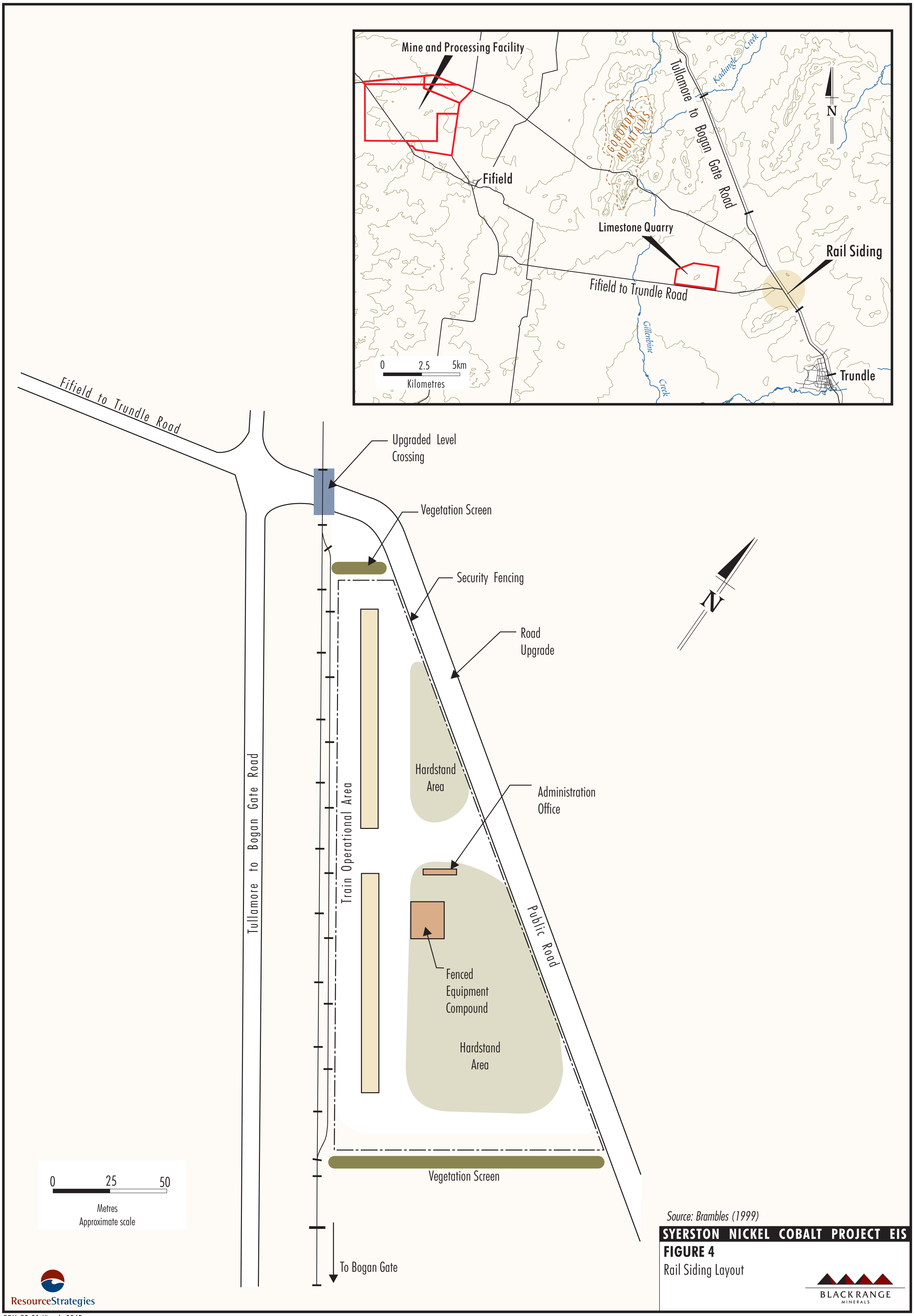


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 3b

Limestone Quarry
Year 21

BRM-98-01-Visual_003C

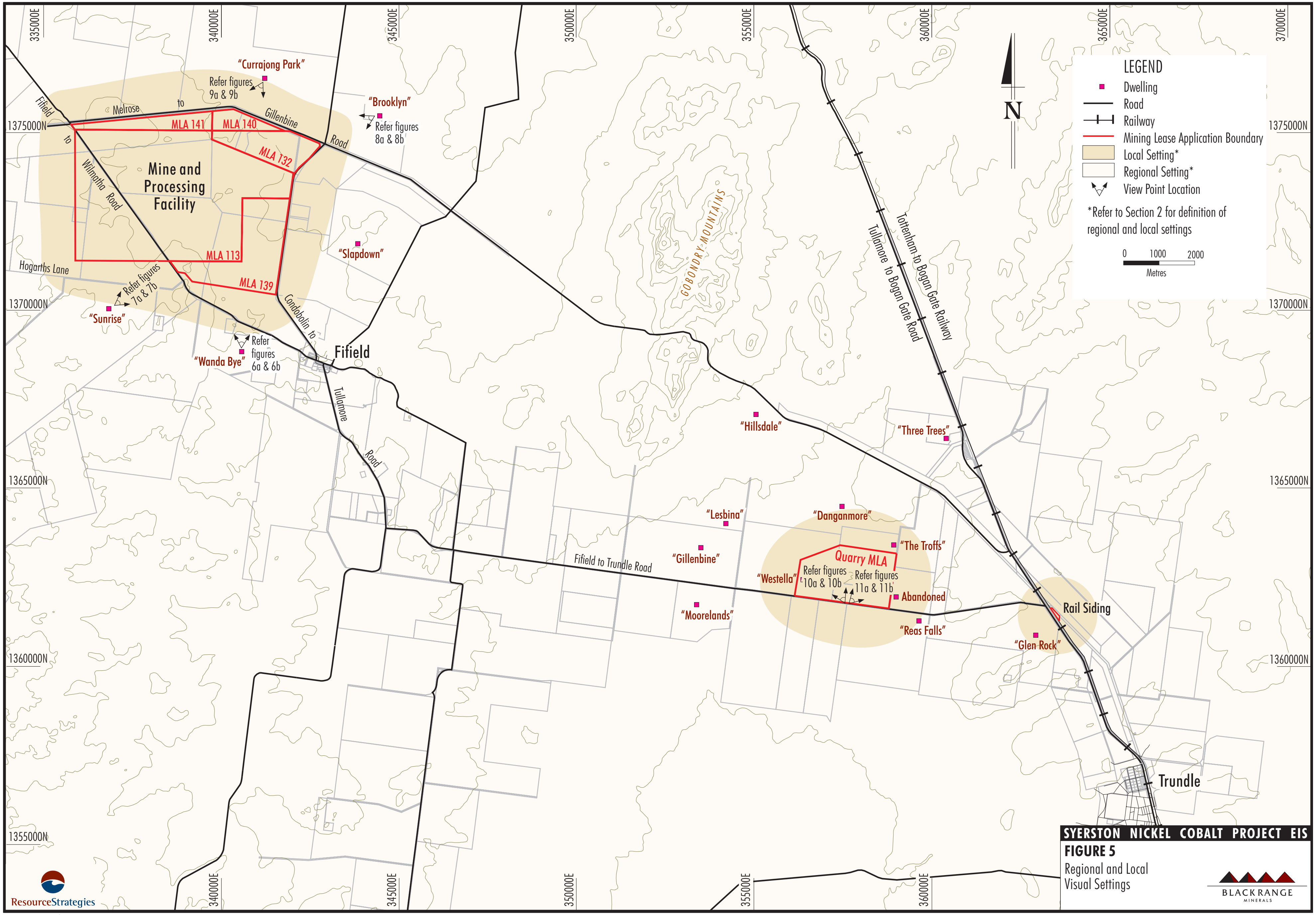


Source: Brambles (1999)

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 4

Rail Siding Layout



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 5

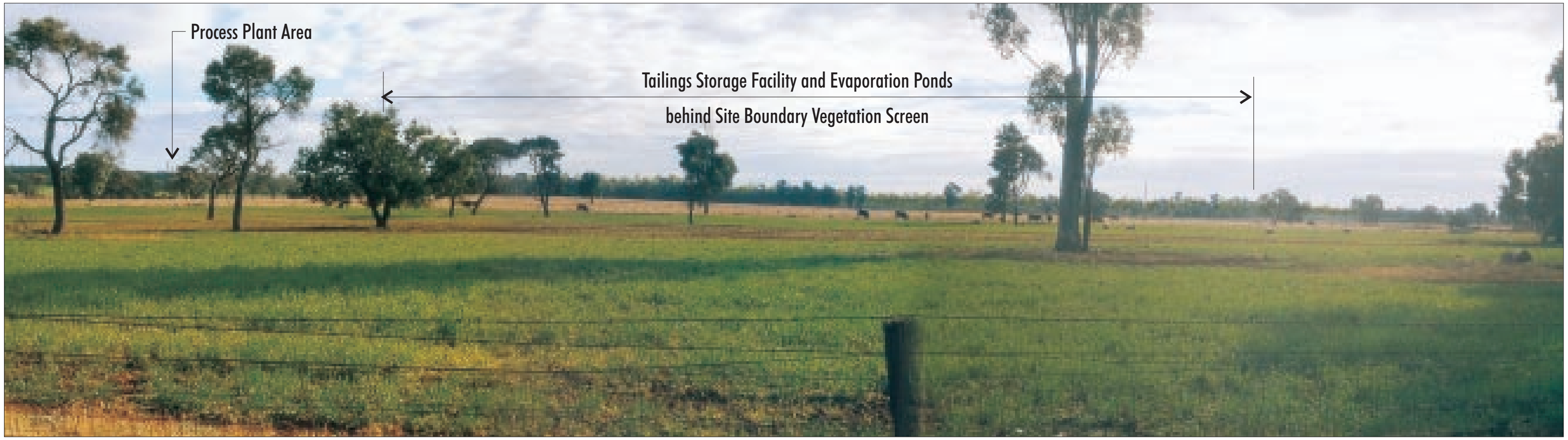
Regional and Local Visual Settings

ResourceStrategies

BLACK RANGE MINERALS

BRM-98-01-Visual _005D

Existing View



Simulated View Year 5 Tailings Storage Facility and Process Plant Area

SYERSTON NICKEL COBALT PROJECT EIS

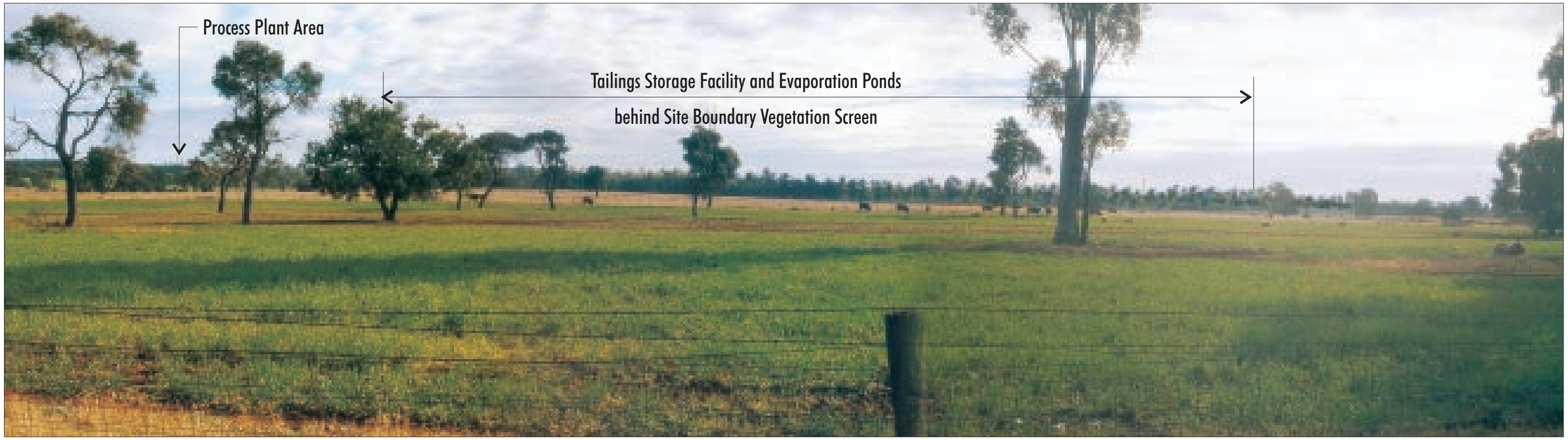
FIGURE 6a
Views from "Wanda Bye" -
Existing and Year 5

BLACK RANGE MINERALS

Resource Strategies

BRM-98-01-Visual_008B

Existing View



Simulated View Year 20 Tailings Storage Facility and Process Plant Area

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 6b

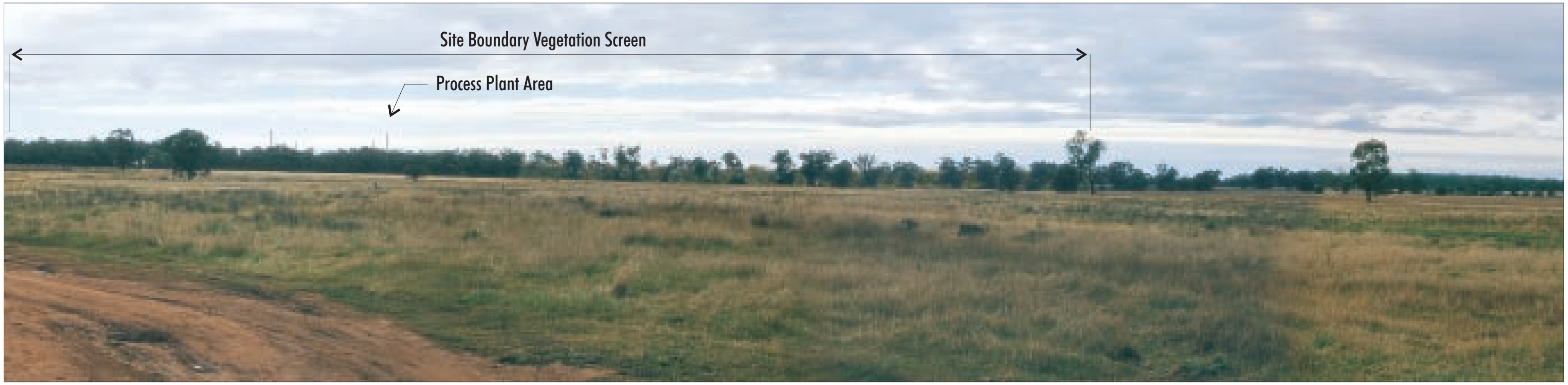
Views from "Wanda Bye"
- Existing and Year 20

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_009B

Existing View



Simulated View Year 5 Process Plant Area

SYERSTON NICKEL COBALT PROJECT EIS

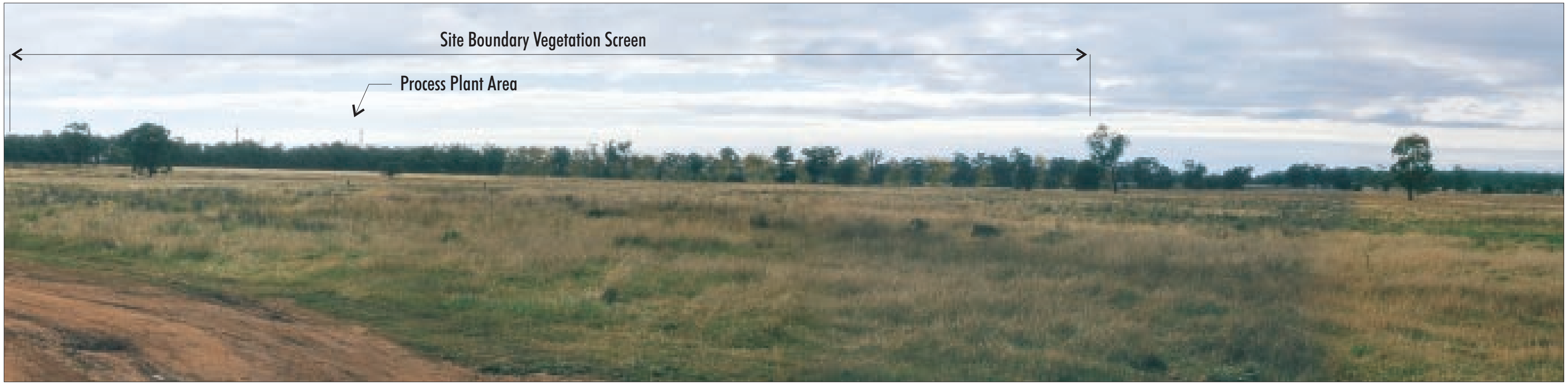
FIGURE 7a
Views from "Sunrise"
-Existing and Year 5

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_012B

Existing View



Simulated View Year 20 Process Plant Area

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 7b

Views from "Sunrise"
- Existing and Year 20

ResourceStrategies

BLACK RANGE MINERALS

BRM-98-01-Visual_013B

Existing View

Simulated View Year 5 Eastern Waste Emplacement

ResourceStrategies

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 8a
Views from "Brooklyn"
- Existing and Year 5

BLACK RANGE MINERALS

BRM-98-01-Visual_010B

Existing View

Simulated View Year 20 Eastern Waste Emplacement

SYERSTON NICKEL COBALT PROJECT EIS

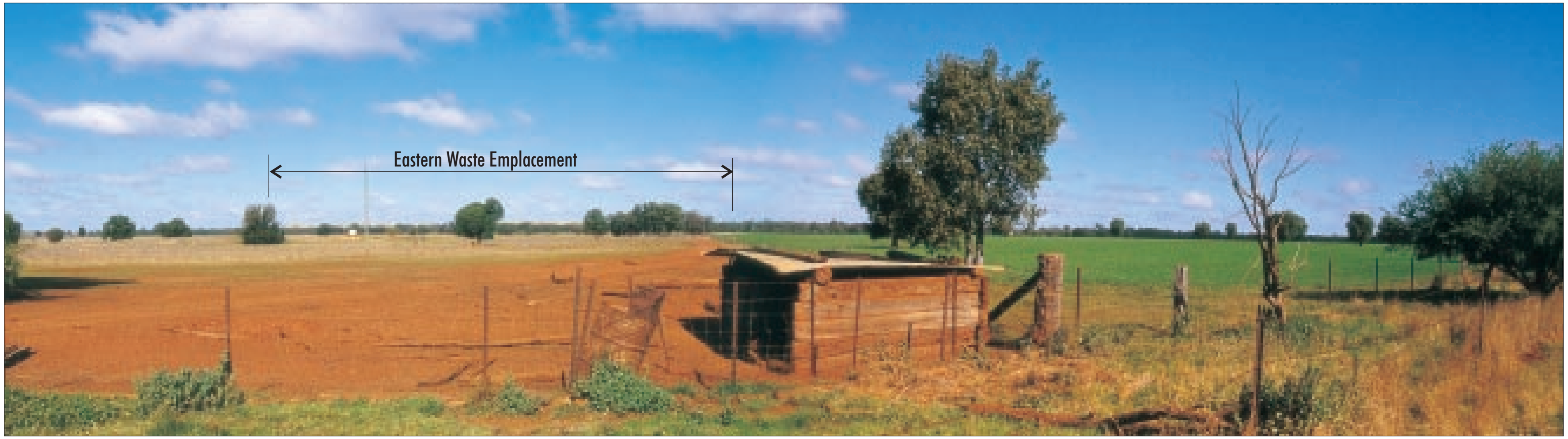
FIGURE 8b
Views from "Brooklyn"
- Existing and Year 20

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_011B

Existing View



Simulated View Year 5

SYERSTON NICKEL COBALT PROJECT EIS

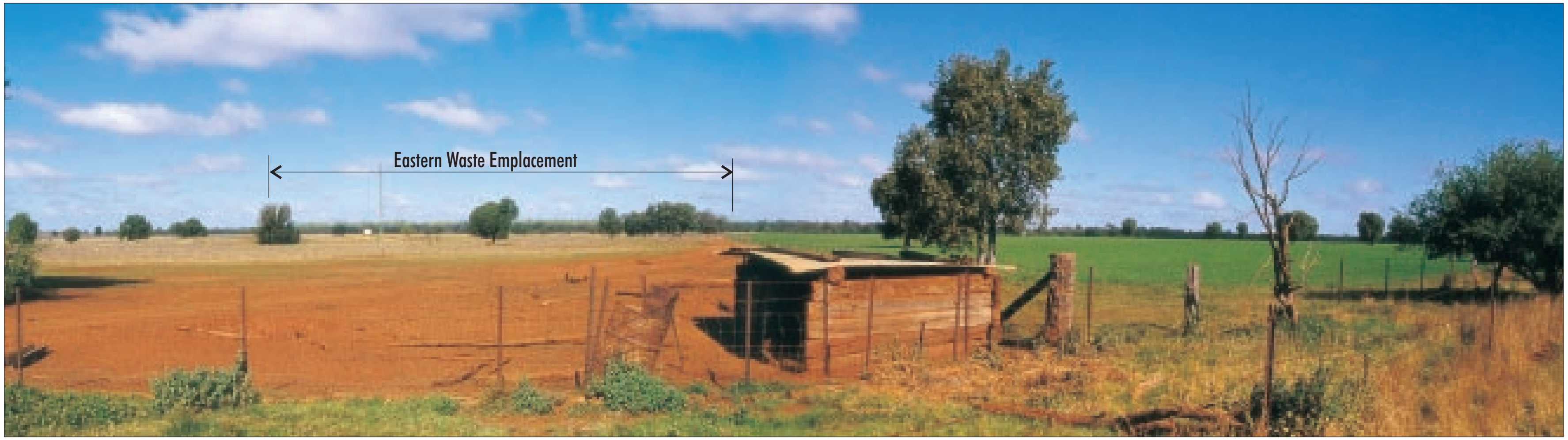
FIGURE 9a
Views from "Currajong Park"
- Existing and Year 5

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_018B

Existing View



Simulated View Year 20

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 9b

Views from "Currajong Park"
- Existing and Year 20

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_007B

Existing View

Simulated View Year 5

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 10a

Views from Fifield to Trundle Rd to "Westella" -Existing and Year 5

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_014C

Existing View

Simulated View Year 21 Waste Emplacement

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 10b

Views from Fifield to Trundle Rd to "Westella" - Existing and Year 21

ResourceStrategies

BLACK RANGE MINERALS

BRM-98-01-Visual_015C

Existing View

Simulated View Year 5

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 11a

Views from Fifield to Trundle Rd to the Limestone Deposit - Existing and Year 5

BLACKRANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_017C

Existing View

Simulated View Year 21

SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 11b

Views from Fifield to Trundle Rd to the Limestone Deposit - Existing and Year 21

BLACK RANGE MINERALS

ResourceStrategies

BRM-98-01-Visual_016C

APPENDIX O
SYERSTON NICKEL COBALT PROJECT
SOIL, LAND CAPABILITY AND
AGRICULTURAL SUITABILITY ASSESSMENT REPORT

PREPARED BY
RESOURCE STRATEGIES PTY LTD

OCTOBER 2000
Project No. BRM-98-01\3.19
Document No. APPENDIX O-C.DOC

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ATTACHMENTS

EXECUTIVE SUMMARY

A soil, land capability and agricultural suitability survey was conducted by Resource Strategies for the Syerston Project area. The survey draws upon information from site survey as well as published departmental information. The Syerston Project area includes the:

- mine site;
- limestone quarry site;
- rail siding;
- water borefield; and
- natural gas and water pipelines to the mine site.

Major soil types (Great Soil Groups) of the Project area include:

- red earth;
- brown clay; and
- lithosol.

Descriptions of the soil types are presented in Section O3.

Agricultural suitability classification was conducted in accordance with the five class system adopted by NSW Agriculture. Three agricultural suitability classes were identified in the Project area including Classes 3, 4 and 5.

Class 3 agricultural suitability is defined as:

> *Grazing land or land well suited to pasture improvement. It may well be cultivated or cropped in rotation with pasture but the overall level of production is moderate as a result of edaphic or environmental constraints. Erosion hazard or soil structural breakdown limit the frequency of ground disturbance and conservation or drainage works may be required* (Cunningham *et al.* undated).

Class 4 agricultural suitability is defined as:

> *Land suitable for grazing but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic* (*ibid.*).

Class 5 agricultural suitability is defined as:

> *Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors, which preclude improvement* (*ibid.*).

Land capability assessment was conducted in accordance with the standard NSW eight class system (as adopted by DLWC).

Four land capability classes were identified in the Project area including Classes III, IV, VI and VII.

Class III Capability is defined as:

> *Land capable of being regularly cultivated with structural soil conservation works such as diversion banks, graded banks and waterways, together with soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations* (Cunningham *et al.*, undated).

Class IV Capability is defined as:

> *Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation with soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture* (Cunningham *et al.*, undated).

Class VI Capability is defined as:

> *Land not capable of being cultivated but suitable for grazing with soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works* (*ibid.*).

Class VII Capability is defined as:

> *Other lands best protected by green timber* (*ibid.*).

Recommendations for soil resource management are also included within the report. The soil resource management strategy includes the stripping, stockpiling and re-application of soils whilst sustaining soil resource viability and integrating with the site rehabilitation plan. Conceptual locations of topsoil stockpiles are recommended. Soil stripping depths are recommended based on rehabilitation suitability considerations and an approximate soil volume of 4.4 M m^3 is calculated as available for re-application during rehabilitation. This volume is assessed as adequate for topsoil re-application to a depth of 0.5m on the tailings storage facilities, evaporation ponds and surge dam, and 0.2 m on other Project landforms including decommissioned infrastructure areas.

Details of the above management strategies and practices including timing of implementation and relevant methodology should be included in the Mining Operations Plan for the Project.

01 INTRODUCTION

This report details the soil resources, agricultural suitability and rural land capability of the Syerston Nickel Cobalt Project area (the Project) as part of land resource studies for the Syerston Nickel Cobalt Project Environmental Impact Statement (EIS). The Project area consists of a number of component areas which are detailed in Section O1.1. The Project area is located approximately 45 km north-east of Condobolin in central west New South Wales (Figure 1). The general landscape of the Project area is cleared, gently inclined country with land use dominated by grazing and broad acre cropping.

The objectives of the study are to:

(i) provide land resource information useful for the formulation of the Project rehabilitation strategy;

(ii) characterise the soil resources, rural land capability and agricultural suitability of Project areas which are currently used for agricultural purposes;

(iii) detail soil resources of relevant Project areas through a summary of existing information supplemented by survey of surface soils in areas proposed for larger scale, long term surface disturbance;

(iv) detail the rural land capability of relevant Project areas in accordance with the standard NSW eight class system (Emery, 1985) using existing information and supplementary results from a survey of the Project area; and

(v) detail the agricultural suitability of relevant Project areas in accordance with the five class system (Riddler, 1996) using existing information and supplementary results from a survey of the Project area.

The soil resources, land capability and agricultural suitability of the Project area and areas in the vicinity of the Project area have been documented in the following publications/studies:

- Soil Landscapes of the Forbes 1:250,000 Sheet. Soil landscape descriptions compiled by the NSW Department of Land and Water Conservation in 1998 (King, 1998).
- Soil Landscapes of the Dubbo 1:250,000 Sheet. Soil landscape descriptions compiled by the NSW Department of Land and Water Conservation in 1998 (Murphy and Lawrie, 1998).
- Department of Land and Water Conservation (DLWC) 1:100,000 Rural Land Capability mapping.
- NSW Agriculture 1:100,000 Agricultural Suitability mapping.

01.1 General Description of the Study Sites

The Project area comprises the following:

- mine site;
- limestone quarry;
- rail siding;
- borefield;
- road upgrade; and
- natural gas and water pipelines to the mine site.

These elements are shown on Figure 1.

General landform descriptions for the Project area are presented in Table O-1.

Table O-1
Landforms of the Project Area

Project Area	Landform	Geology	Dominant Soils
Mine Site	Gently inclined Elevations: 280–300 m AHD Average Slopes: 3^0 Local relief: 20m	Alluvium, dominantly red silt with some pebble bands and quartz grit, silcrete and undifferentiated multiple deformed quartzite and phyllite with numerous quartz veins	Red earths on mid and lower slopes and flats. Lithosols on ridgelines
Limestone Quarry	Gently inclined Elevations: 260-280m AHD Average Slope: 4^0 Local relief: 10m	Siltstone, mudstone and marl	Red earths on lower slopes and flats. Brown clays on crest and midslopes.
Gas Pipeline (section outside road reserve)	Flat to gently inclined Elevation: 200-300 m AHD Average Slope: 3^0 Local relief: 10-20m	Quaternary alluvium comprised of sands, silts, clays and gravel, minor colluvium, Ordovician sediments, Ordovician, Silurian and Devonian metasediments.	Red earths on well drained flats and midslopes. Brown clays on imperfectly drained flats (including alluvial flats). Lithosols on ridgelines.
Fifield Bypass (section outside the road reserve)	Flat Elevation: 300 m AHD Average Slope: 0^0 Local relief: 0m	Quaternary residual deposits with alluvium, dominantly red silt with some pebble bands and quartz grit	Red earth
Rail Siding	Flat Elevation: 280m AHD Average Slope: 0^0 Local relief: 0m	Quaternary residual deposits with alluvium, dominantly red silt with some pebble bands and quartz grit	Red earths on flats.
Borefield	Flat Elevation: 200 m AHD Average Slope: 1^0 Local relief: 0 m	Quaternary alluvium comprised of sands, silts, clays and gravel.	Brown clays on alluvial flats.

The mine site study area is some 2,700 ha with land use dominated by sheep grazing and cropping (generally wheat). It is generally characterised by two drainage lines which flow across the site in a south-west to north-east direction and are defined by three low ridges also trending in the same direction across the site. The north-eastern corner of the site is dominated by historic mine landforms including open pits and re-profiled waste dumps. The previous lease holders relinquished the leases covering these areas to the Department of Mineral Resources (DMR) in 1997. This mine site area is covered by mining lease applications MLA's 113, 132, 139, 140 and 141.

The limestone quarry area is some 330 ha. It is located approximately 20 km south-east of the mine site along the Fifield to Trundle Road (Figure 1). The site is dominated by a low hill in the middle of the proposed MLA with two unnamed drainage lines running north-south, immediately east and west of the site. Land use within the site area is dominated by sheep grazing and cropping. This area is covered by the quarry MLA.

The rail siding is an approximate 4 ha area. It is a flat area located on the eastern side of the existing Tottenham to Bogan Gate Railway adjacent to the Fifield to Trundle - Tullamore Bogan Gate Road intersection approximately 5 km east of the proposed limestone quarry (Figure 1). It is currently used for grazing.

The borefield is located approximately 55 km south of the proposed mine site (Figure 1). Water pumped from the bores would be piped via a buried pipeline to the proposed mine site (with an offtake provided to the limestone quarry). Two groups of 3 bores each would make up the borefield. Land use is dominated by grazing and irrigated cropping. The water pipeline route would follow existing road reserves from the borefield to the mine site and limestone quarry and would be approximately 65 km long and buried (Figure 1). Accordingly, no land resource assessment of the water pipeline route is presented.

The road upgrade works include road construction, road capacity improvements and the like, within the existing road reserve from the mine site to the rail siding (Figure 1). This study assesses the small section of the proposed Fifield bypass which is outside the existing road reserve near the township of Fifield. This area is currently used for grazing purposes.

Natural gas would be used on site for power and steam generation and would be supplied to the mine site from a lateral of the Moomba to Sydney gas pipeline approximately 75 km south-southwest of the mine site. The pipeline would be approximately 90 km long and buried (Figure 1). The majority of the line would run within existing road reserves and would cross the Lachlan River near Condobolin. This study assesses that section of the pipeline which is outside existing road easements. Land use within this area is predominantly grazing and cropping.

02 METHODOLOGY

02.1 Field Soil Survey

Field soil survey and mapping was conducted for the major areas of the Project where relatively large soil disturbance areas are proposed (ie. the limestone quarry and mine site). This was accomplished using a combination of full soil profile descriptions and soil profile observations (Attachments OA and OB) along with aerial photographic interpretation. The locations of soil profile description and observation sites are shown on Figures 2 and 3. Aerial photographic interpretation was used to confirm mapping delineations. Aerial photographs were interpreted at the approximate scale of 1:25,000 for the mine site and 1: 20,000 for the limestone quarry. Field survey was generally conducted at a scale of 1:25,000 for these two main Project areas. Mapping of the remaining significant assessment areas (outlined above) (ie. gas pipeline outside the road easement and Fifield bypass outside the road reserve) employed existing land resource mapping and aerial photographic interpretation.

02.2 Laboratory Soil Testing

Analytical results (physical and chemical) for representative soils encountered in the Project area are presented in Attachment OC. These include major and micronutrient levels as well as measures of salinity and erosion hazard. These results have been used for a preliminary assessment of material suitability for rehabilitation works and to formulate management strategies for material storage (stockpiling).

03 SOILS OF THE PROJECT AREA

Soil types mapped for the Project area are based on the Great Soil Group System (Stace *et al.*, 1968). This system is a broad classification of soils, each Great Soil Group referring to a range of soils in the field.

Major soils types of the Project area include:

- Lithosol;
- Red earth; and
- Brown clay.

A summary of the major Soil Groups as described by Stace *et al.* (1968) for the Project area is presented below (Section 3.1). The locations of soil types over the mine site and quarry areas are shown on Figures 2 and 3. Soil types for those sections of the gas pipeline and Fifield Road bypass that are not on road easements have been interpreted from existing land resource mapping and aerial photographs.

03.1 Great Soil Group Descriptions

03.1.1 Red Earths

Red earths are the dominant soil type of the Project area. They were encountered at the mine site and quarry site and are documented (King, 1998 and Murphy and Lawrie, 1998) along the gas pipeline and Fifield road bypass. They typically occur on well drained areas and are mainly associated with sedimentary deposits. They are characterised by weak profile differentiation, weak structure, uniform texture with a gradual increase in clay content with depth and slightly acidic profile meanings. The A1 horizon[1] of the red earths of the Project area was typically absent due to sheet erosion with the light reddish brown weakly developed A2 horizon forming the surface horizon. The profile was generally moderately deep around 0.8m to parent material. The general nutrient status of these soils is low to moderate with land use dominated by wheat cropping and improved pasture sheep grazing. Variants of the red earth soil type within the Project area included a shallow, stoney variant common on midslopes, a moderately structured, deep variant found in association with the northern drainage line on the mine site and a variant with an A1 topsoil horizon found in well vegetated areas of the State Forest in the north-east of the mine site.

03.1.2 Brown Clays

The brown clays were encountered on the quarry site and are documented (King, 1998) along the gas pipeline route. They have an A horizon of friable loams to clayey loams, with dark reddish brown light clay to medium clay B horizons[2]. Clay content gradually increases with depth and surface cracking is present . Soil reaction can vary. The brown clays encountered on the quarry site displayed generally alkaline trends which reflects the limestone parent material.

These soils are moderately fertile and are commonly used in the area for improved pasture and wheat cropping.

The brown clays on the quarry site were encountered on the crest of the low hill in the middle of the site with intergrades to red earths found on the mid and lower slopes of the hill.

---

[1] A horizons consist of one or more surface mineral horizons with some organic accumulation and usually darker than underlying horizons, or consist of surface and subsurface horizons lighter in colour but with lower clay content than underlying horizons (Macdonald *et al*., 1990).

[2] B horizons consist of one or more mineral soil layers characterised by a concentration of clay and stronger colours than the A horizon (Macdonald *et al*., 1990).

03.1.3 Lithosol

These soils are generally less than 30 cm deep and display high coarse fragment content and weak (if any) horizon development. They were found on the crests of the low ridges traversing the mine site and often intergrade with red earth soils. Dominant land use in the study areas on these soils is native and improved pasture.

04 AGRICULTURAL SUITABILITY

This section draws on information from the Project area soil survey, NSW Agriculture, Agricultural Suitability mapping, King (1998) and Murphy and Lawrie (1998) soil landscape mapping and aerial photograph interpretation. It complements soils information along with rural land capability assessment (Section O5) to provide an overall land resource appraisal. The agricultural suitability assessment was conducted by Resource Strategies in accordance with the five class system (Riddler, 1996), which classifies land according to its productivity for a wide range of agricultural activities.

Three agricultural suitability classes (Classes 3, 4 and 5) have been identified in the Project area and are illustrated on Figures 4, 5 and 6. Figure 4 and 5 show the suitability of site-surveyed areas. Figure 6 shows NSW Agriculture suitability class mapping for areas of the gas pipeline and the Fifield bypass outside existing road reserves .

Class 3 agricultural suitability is defined as:

> *Grazing land or land well suited to pasture improvement. It may well be cultivated or cropped in rotation with pasture but the overall level of production is moderate as a result of edaphic or environmental constraints. Erosion hazard or soil structural breakdown limit the frequency of ground disturbance and conservation or drainage works may be required* (Cunningham *et al.* undated).

The land surrounding the low hill on the quarry site and land on flat areas associated with the northern drainage line on the mine site are mapped as Suitability Class 3 land. The areas are characterised by flat to gently inclined cropping and grazing land. They are currently cropped on a rotational basis for fodder crops and grain and grazed by sheep on improved pastures. Erosion hazard, soil structural breakdown plus other factors such as climate, limit the capacity for cultivation. No Class 3 land was identified on the gas pipeline route or Fifield bypass.

Class 4 agricultural suitability is defined as:

> *Land suitable for grazing but not cultivation. Agriculture is based on native pastures or improved pastures established using minimum tillage techniques. Production may be high seasonally but the overall level of production is low as a result of a number of major constraints, both environmental and edaphic* (Cunningham *et al*., undated).

The majority of the Project area is classified as Suitability Class 4. Class 4 areas are characterised by lower fertility land and include lower slopes and flats on the mine site, upper slopes and the crest of the low hill on the quarry site, midslopes and flats on the gas pipeline route and the Fifield bypass route. Sheep and cattle grazing on improved and native pasture dominates land use in these Class 4 areas.

Class 5 agricultural suitability is defined as:

> *Land unsuitable for agriculture or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors, which preclude improvement* (Cunningham *et al*., undated).

Suitability Class 5 areas were identified along sections of the gas pipeline and in small areas on the mine site. These areas are generally characterised by ridgelines with shallow soils and high erosion potential.

Current land use on these areas includes State Forest on the mine site, historic mine workings at the mine site, grazing (mine site and pipeline) and native bushland (pipeline).

05 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). This section draws on information from Project area soil survey, King (1998) and Murphy and Lawrie (1998) soil landscape mapping and aerial photograph interpretation. It should be noted that no regional DLWC Rural Land Capability mapping which included the Project area had been conducted prior to the submission of this report. The capability assessment complements soils information along with the agricultural suitability assessment (Section O4) to provide an overall land resource appraisal.

Four land capability classes were identified in the major Project areas, *viz*. classes III, IV, VI and VII. These classes are shown on Figures 7 and 8 for the mine site and quarry.

Class III Capability is defined as:

> *Land capable of being regularly cultivated with structural soil conservation works such as diversion banks, graded banks and waterways, together with soil conservation practices such as strip cropping, conservation tillage and adequate crop rotations* (Cunningham *et al.*, undated).

Class III land occurs along areas associated with the northern drainage line on the mine site and lower slopes and flats on the quarry site. These areas are currently used for cropping. Limiting factors for this Class include erosion hazard and climate.

Class IV Capability is defined as:

> *Land not capable of being regularly cultivated but suitable for grazing with occasional cultivation with soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture* (Cunningham *et al.*, undated).

Class IV land represents the highest quality grazing land of the major Project areas which are occasionally cultivated for grain and fodder crops. This capability class occurs over the majority of the mine site area and in a small north-west portion of the quarry site. Factors limiting higher capability include erosion hazard and rockiness. These areas are currently used for grazing with occasional cropping.

Class VI Capability is defined as:

> *Land not capable of being cultivated but suitable for grazing with soil conservation practices including limitation of stock, broadcasting of seed and fertiliser, prevention of fire and destruction of vermin. This class may require some structural works* (Cunningham *et al*, undated).

Class VI land is characterised by steeper grazing lands. These occur along ridgelines in the mine site area and the upper slopes and hill top in the limestone quarry area. Limitations include rockiness, shallow depth of soil, erosion hazard and high degree of slope. These areas are currently used for grazing.

Class VII land Capability is defined as:

Other lands best protected by green timber (Cunningham *et al.*, undated).

Class VII land is restricted to the State Forest area of the mine site and historical mine workings on the mine site.

06 SOIL RESOURCE MANAGEMENT

Soil resource management for the Project will follow the general strategy of stripping and stockpiling soil resources prior to proposed Project-related ground disturbance. This general strategy will be employed for those disturbance areas which will be rehabilitated either progressively or at the completion of the Project. Accordingly, topsoil resources will be stripped and stockpiled from the following Project disturbance areas:

- pipeline routes (topsoil would be re-applied immediately following pipe burial);
- open pits, waste rock emplacements, process plant area, tailings storage facilities, evaporation ponds and surface infrastructure areas on the mine site which will be decommissioned at the completion of mining; and
- open pit, waste rock emplacement and surface infrastructure areas on the quarry site which will be decommissioned at the completion of the Project.

The following outlines conceptual soil resource management strategies proposed for the Project area. Further detail with respect to quantification of soil resource, stripping and re-application schedules and stockpiling inventories would be included as part of the Mining Operations Plan (MOP) which would be prepared for the Project as part of the regulatory requirements of the Department of Mineral Resources (DMR).

The following topsoil management strategy is proposed:

- Formulation of stripping guidelines including nomination of appropriate depths, scheduling and locating areas to be stripped.
- Stripping operations to be undertaken during the construction phase of the Project.
- Progressive rehabilitation of final landforms as soon as practical after completion or when areas are no longer required.
- The storage of topsoil in a manner which maintains the long term viability of the resource.
- Selective stockpiling of soil according to soil type (eg. Great Soil Group, topsoil or subsoil) and/or seed source from stripped area (ie. native pasture area, native woodland area, improved pasture area).

Topsoil stockpiles would be managed to ensure long term viability through implementation of the following management practices:

- Stockpiles to be located outside proposed mine disturbance areas.
- Construct stockpiles with a “rough” surface condition to reduce erosion hazard, increase drainage and promote revegetation.
- Fertilise and seed stockpiles to maintain organic matter levels, soil structure and microbial activity.

Stockpile heights will be dictated by available space as well as fertility maintenance strategies. Where required, stockpiles would be deep ripped and fertilised prior to re-application to improve structural and fertility characteristics. Figures 2 and 3 show conceptual locations of topsoil stockpiles. It is recommended that appropriate temporary sediment control structures (eg. silt fences) be constructed around stockpiles to control potential stockpile erosion prior to vegetative stabilisation.

Recommended soil stripping depths are presented in Table O-2.

Table O-2
Recommended Soil Stripping Depths

Soil Type	Recommended Stripping Depth (mm)
Red earths	0 – 500
Brown clays	0 – 100
Lithosol	0 – 100

Recommended depths are based on an assessment of soil suitability for rehabilitation (including fertility and stability considerations). For example horizons below the A_1 of the brown clay soil types (ie. below 0.1 m) are not recommended for stripping due to potential nutrient deficiencies (as demonstrated by high Ca:Mg ratios which could indicate a potential Mg deficiency). Analytical results for representative soil types occurring in the Project area are presented in Attachment O3. Analyses include rehabilitation suitability parameters.

Preliminary material balance calculations based on the recommended stripping depths outlined in Table 0-2 indicate an approximate topsoil volume of 4.4 Mm^3 would be available for rehabilitation over the Project area. This topsoil would be stripped from proposed disturbance areas including the open pits, waste rock emplacements and process plant area. This volume is assessed as adequate for topsoil re-application to a depth of 0.5m on the tailings storage facilities, evaporation ponds and surge dam, and 0.2m on other Project landforms including decommissioned infrastructure areas. Assessment of appropriate cover strategies for mine landforms would be the subject of research over the mine life. The depths of cover stated above are considered a conservative estimate of material requirements for rehabilitation works.

Details of the above management strategies and practices including timing of implementation and relevant methodology should be included in the Mining Operations Plan for the Project.

07 REFERENCES

Cunningham, G.M., Higginson, F.R., Riddler, A.H.M. and Emery, K.A. (undated) *Systems Used to Classify Rural Lands in New South Wales.* Soil Conservation Service of NSW and NSW Department of Agriculture.

Emery, K.A. (1985) *Rural Land Capability Mapping.* Soil Conservation Service of New South Wales.

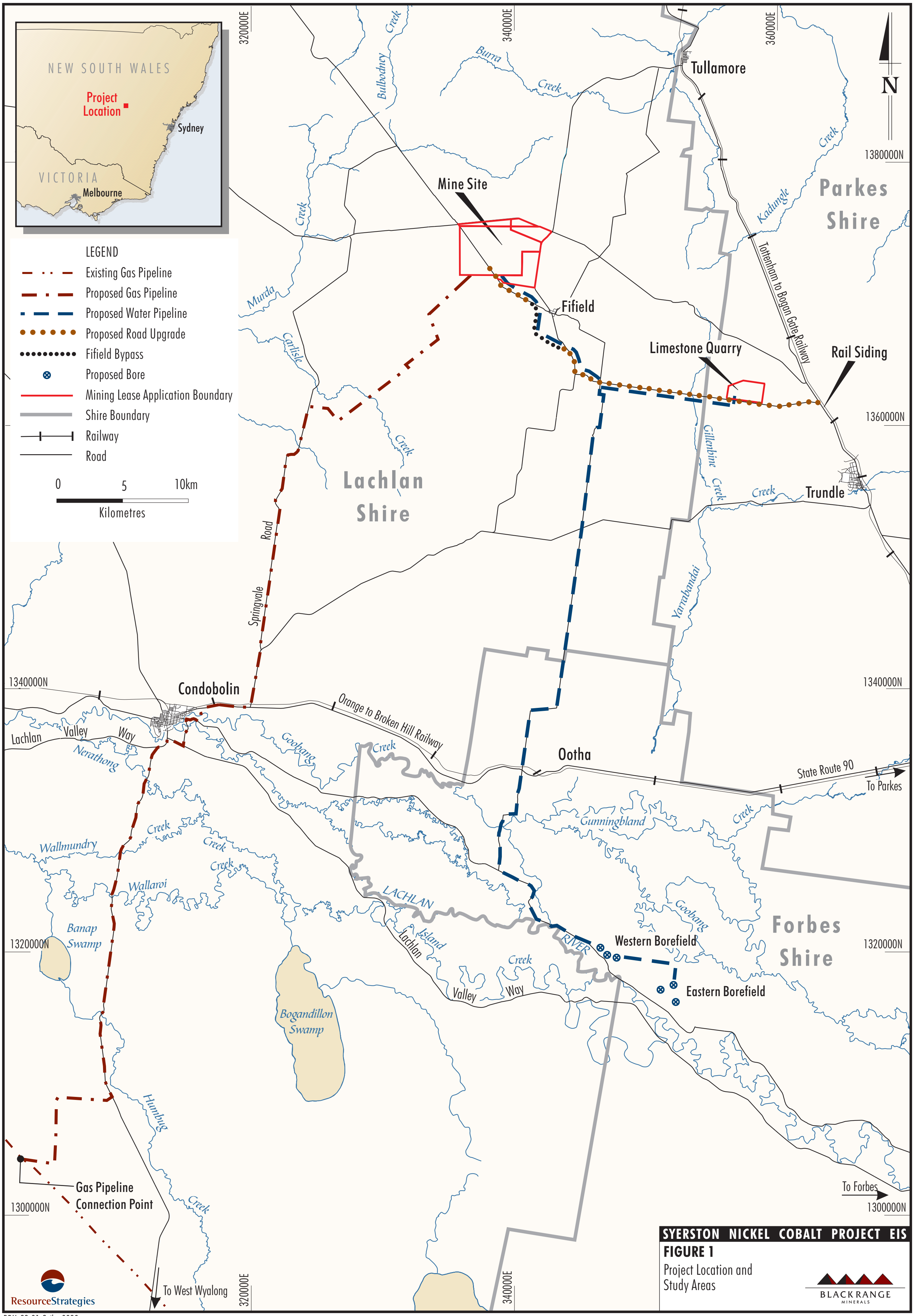
King, D.P. (1998) *Soil Landscapes of the Forbes 1:250,000 Sheet (Condobolin – West Wyalong – Parkes – Grenfell).* Department of Land and Water Conservation of NSW, Sydney.

Murphy, B.W. and Lawrie, J.W. (1998) *Soil Landscapes of the 1:250,000 Sheet (Dubbo, Wellington, Gulgong, Mudgee).* Department of Land and Water Conservation of NSW, Sydney.

Riddler, A.M.H. (1996). *Agfact SCG Agricultural Suitability Maps – Uses and Limitations.* NSW Agriculture, Orange.

Stace, C.T., Hubble, G.D., Brewer, R., Northcote, K.H., Sleeman, J.R., Mulcahy, M.J. and Hallsworth, E.G. (1968) *A Handbook of Australian Soils*. Rellim Technical Publications, South Australia.

FIGURES

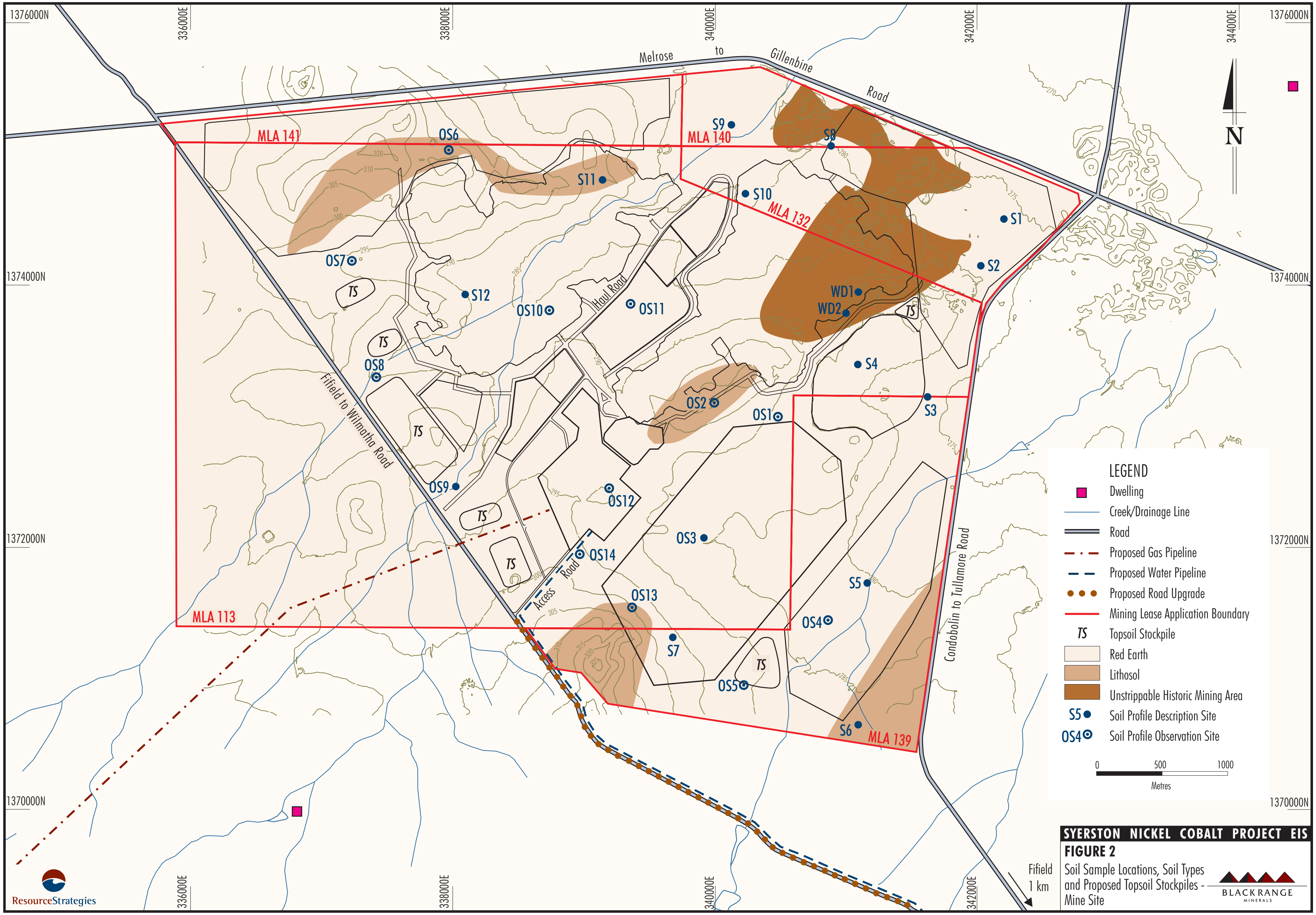


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 1

Project Location and Study Areas

BRM-98-01-Soils_008C

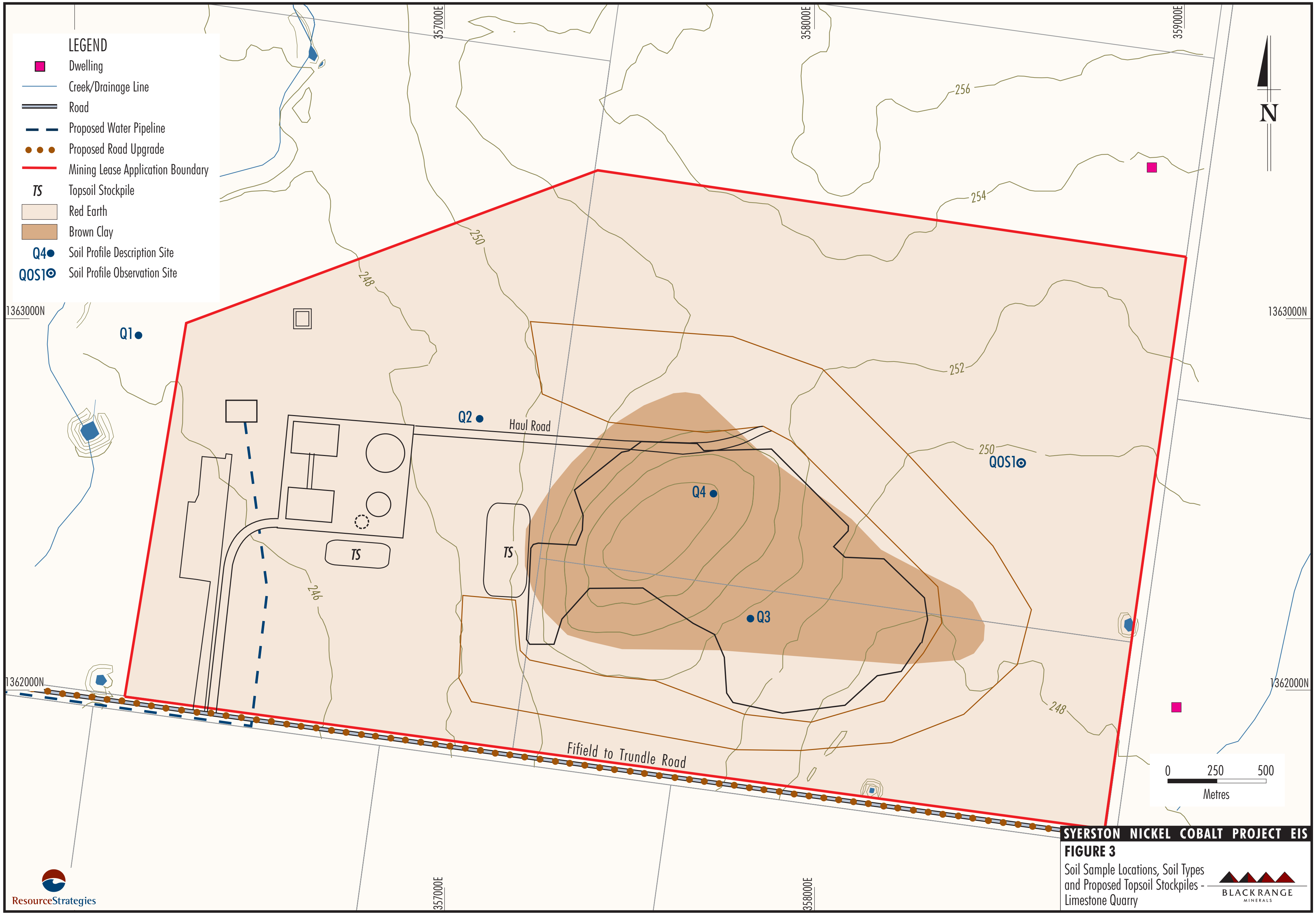


SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 2

Soil Sample Locations, Soil Types and Proposed Topsoil Stockpiles - Mine Site

BRM-98-01-Soils_001F



SYERSTON NICKEL COBALT PROJECT EIS
FIGURE 3
Soil Sample Locations, Soil Types and Proposed Topsoil Stockpiles - Limestone Quarry

BRM-98-01-Soils_002D

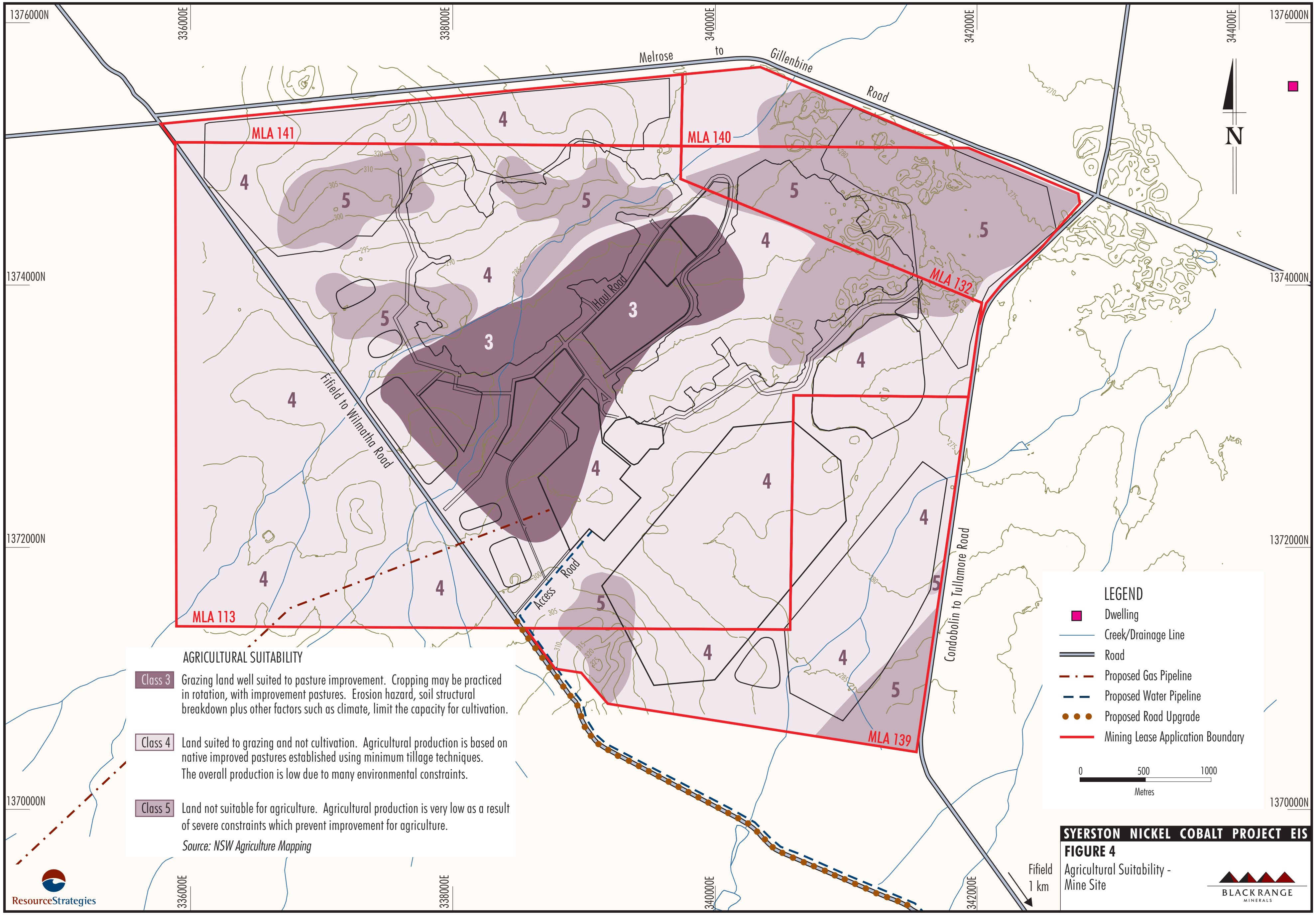
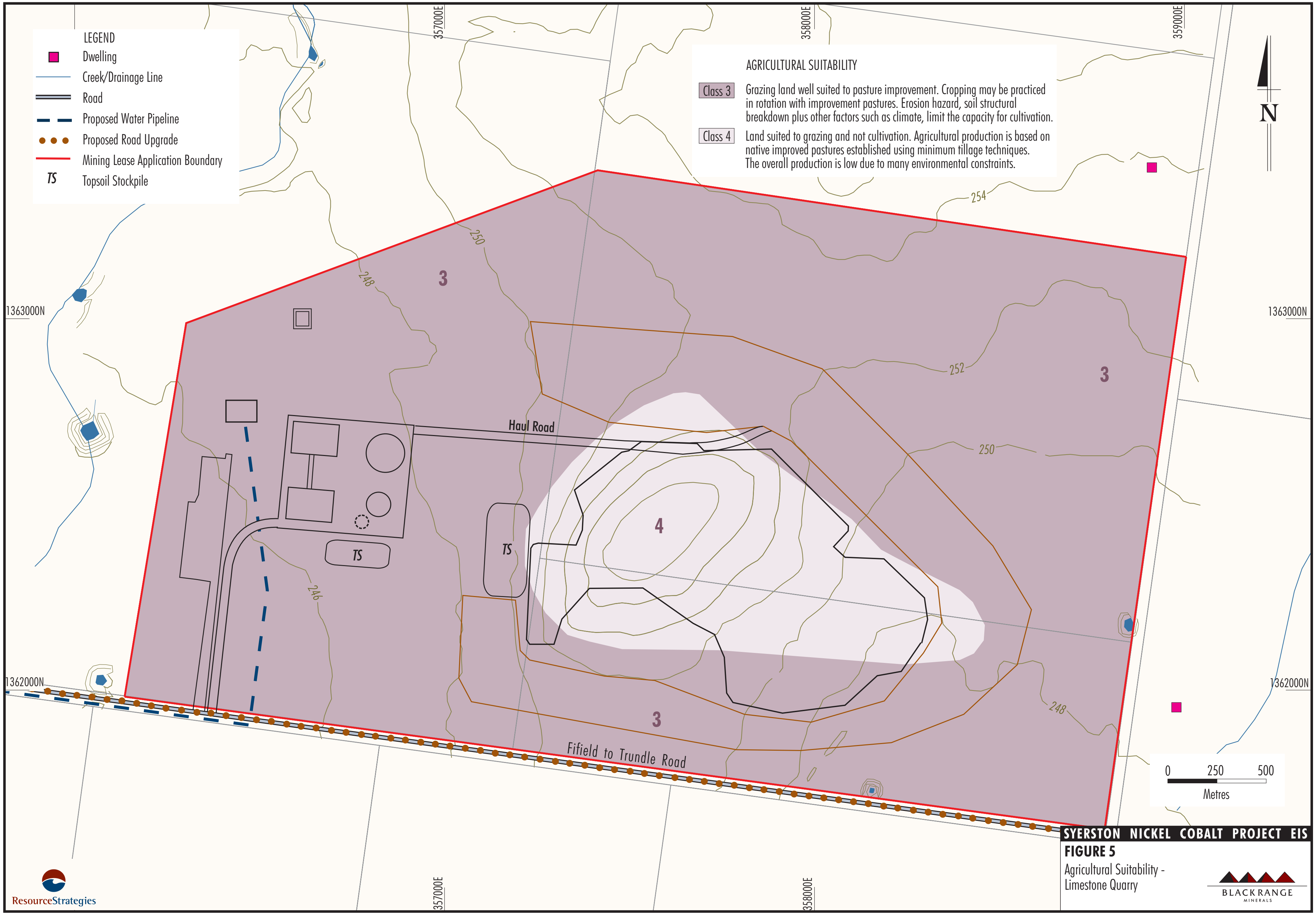
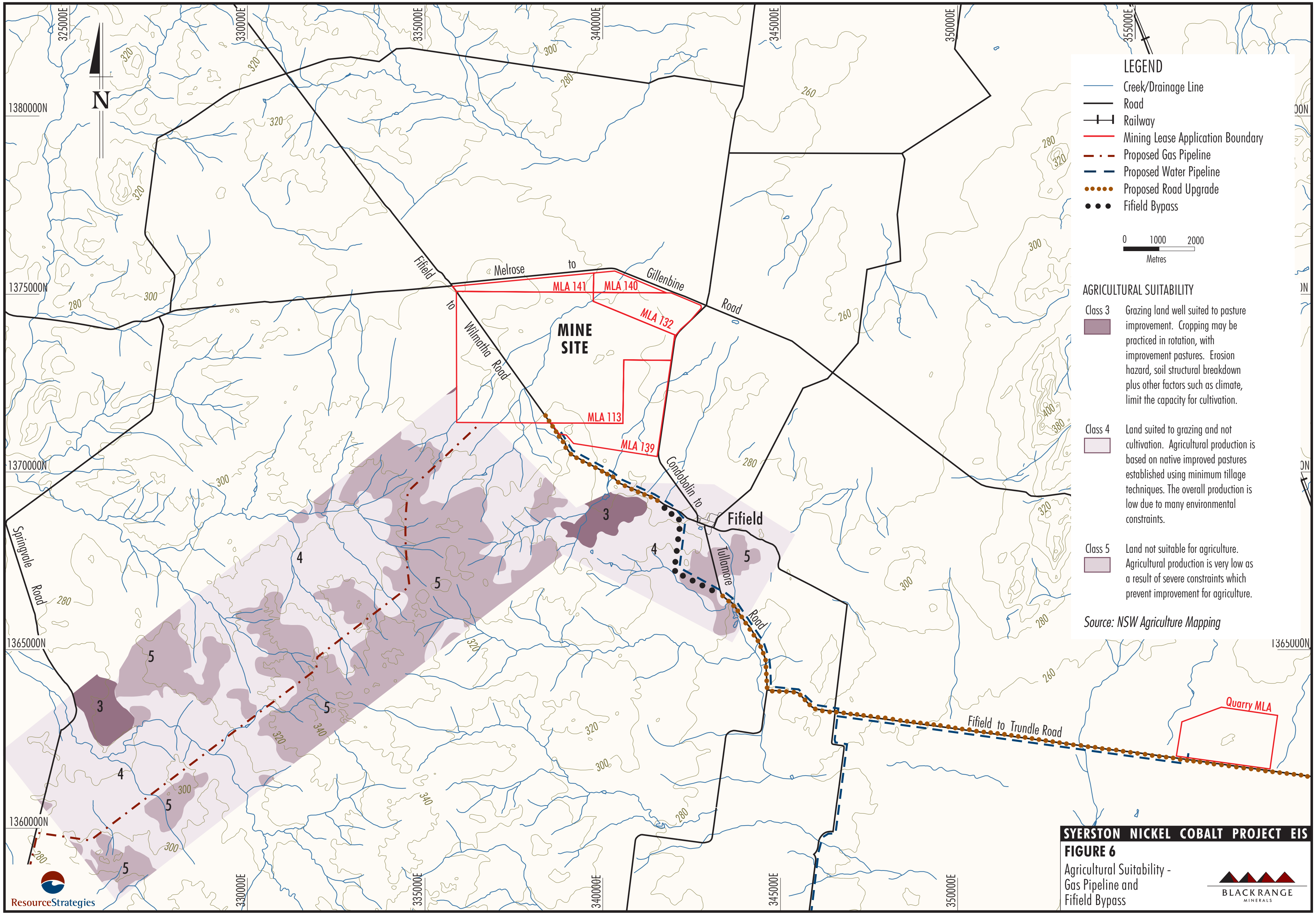


FIGURE 4
Agricultural Suitability - Mine Site

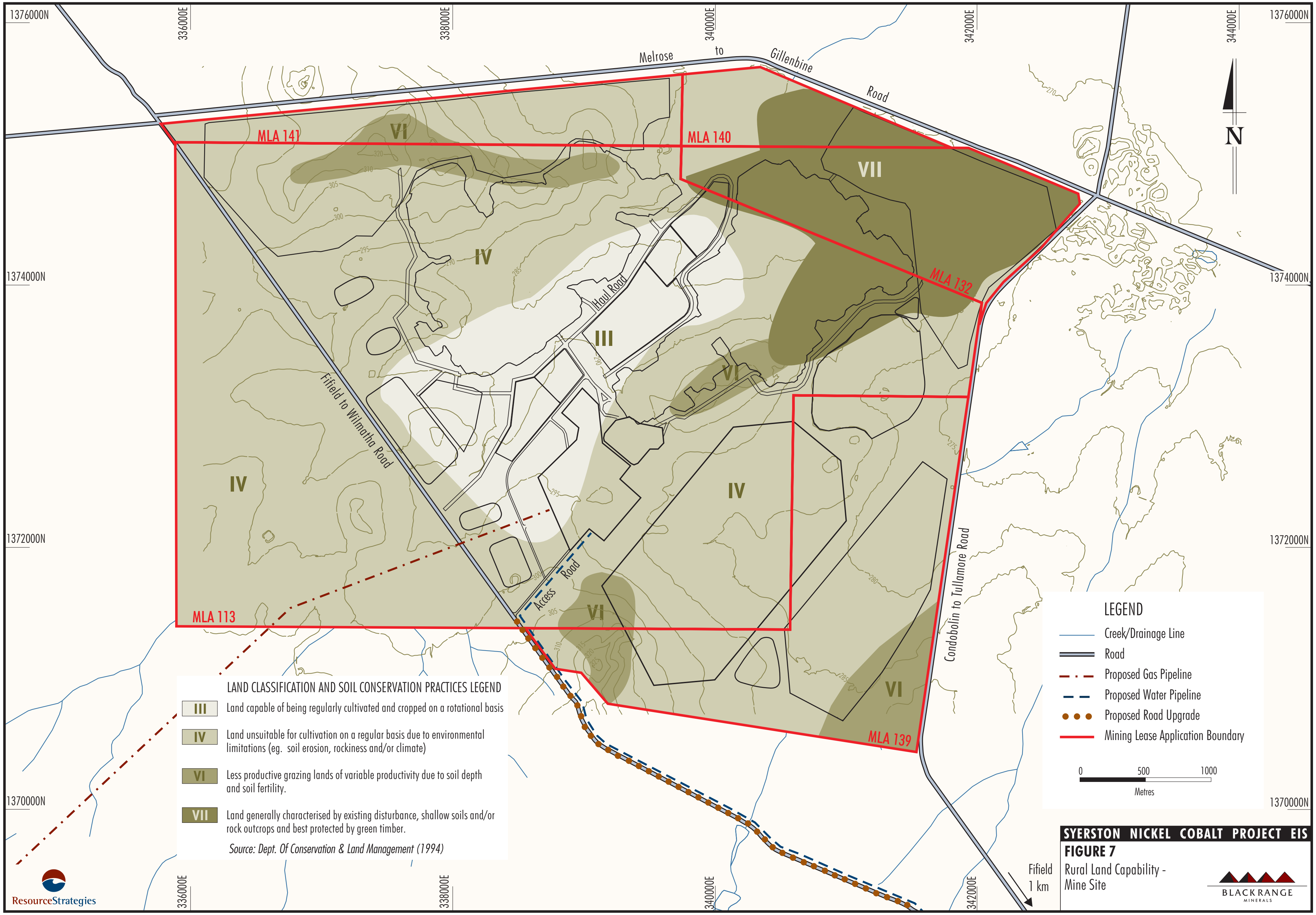
BRM-98-01-Soils_003E



BRM-98-01-Soils_005C



BRM-98-01-Soils_004E



SYERSTON NICKEL COBALT PROJECT EIS

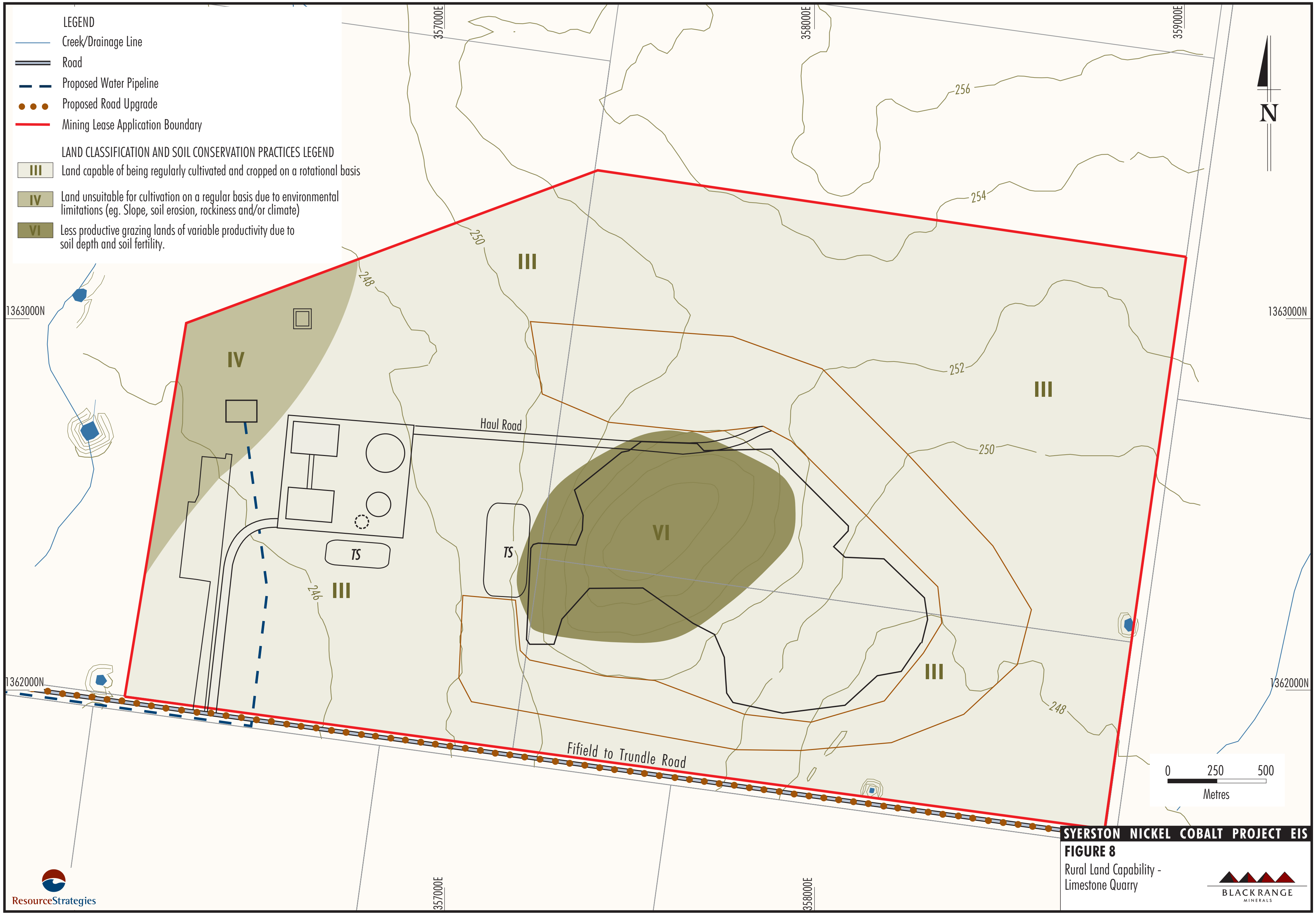
FIGURE 7

Rural Land Capability - Mine Site

ResourceStrategies

BLACK RANGE MINERALS

BRM-98-01-Soils_007E



SYERSTON NICKEL COBALT PROJECT EIS

FIGURE 8

Rural Land Capability - Limestone Quarry

BRM-98-01-Soils_006C

ATTACHMENT OA

FULL SOIL PROFILE DESCRIPTIONS

Site No:		**S1**	**S2**	**S3**	**S4**
Runoff:		Rapid	Slow	Slow	Slow
Permeability:		Fast	Fast	Slow	Moderate
Drainage:		Imperfect	Imperfect	Well drained	Imperfect
Landform:		Flat	Flat	Simple slope	Lower slope
Site Disturbance:		Previously cleared for logging	Previously cleared for logging.	Cleared for cropping	Previously cleared for grazing
Land Use:		State Forest - regrowth	State Forest	Cropping (wheat)	Cropping and grazing
Slope:		0^0	0^0	1^0	1^0
Vegetation:	Dom. spp./stratum	Callitris sp./ Eucalyptus spp.	Callitris sp./ Eucalyptus spp.	Wheat (stubble)	Callitris sp / Eucalyptus spp.
	Height	15m	15-20m	-	10-15m
	FPC	60%	80%	100%	100%
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type	Sheet	Sheet	Sheet	Sheet
	Degree	Major	Minor	Minor	Minor
Surface Coarse Fragments:		70%	80%	Nil	Nil
Rock Outcrop:		Nil	Nil	Nil	Nil
Groundwater Depth:		Nil	Nil	Nil	Nil
Soil Classification		Red Earth	Red Earth	Red Earth	Red Earth
Horizon	Depth (cm)	A 0-25 B_1 25-90 B_2 90-130+	A_1 0-5 A_2 5-30 B 30 – 70 70+ Parent Material	A_2 0-10 B 10-50 50+ Refusal	A_2 0-25 B 25-85 85+ Parent Material
	Boundary	A to B_1 Gradual B_1 to B_2 Gradual	A_1 to A_2 Gradual A_2 to B Gradual	A_2 to B Gradual	A_2 to B Gradual
	Colour	A Dark reddish brown B_1 Red B_2 Red	A_1 Dark reddish brown A_2 Dark reddish browned B Dark reddish brown	A_2 Dark reddish brown B Reddish brown	A_2 Dark reddish brown B Reddish brown
	Mottles	A Nil B_1 Nil B_2 Nil	A_1 Nil A_2 Nil B Nil	A_2 Nil B Nil	A_2 Nil B Nil
	Texture	A Loam B_1 Clay loam B_2 Sandy clay loam	A_1 Clay loam A_2 Clay loam B Light clay	A_2 Clay loam B Light clay	A_2 Clay loam B Light medium clay
	Coarse Fragments	A 5% angular B_1 30% angular B_2 50% angular	A_1 Nil A_2 10% angular B 30% angular	A_2 Nil B Nil	A_2 Nil B Nil
	Structure	A Pedal weak polyhedral 2-5mm B_1 Pedal weak polyhedral 2-5mm B_2 Pedal weak polyhedral 2-5mm	A_1 Pedal weak polyhedral 2-5mm A_2 Pedal moderate polyhedral 2-5mm B Pedal moderate polyhedral 2-5mm	A_2 Pedal weak polyhedral 2-5mm B Pedal strong polyhedral 5-10mm	A_2 Pedal weak polyhedral 2-5mm B Pedal strong polyhedral 5-10mm
	Consistency	A Very weak B_1 Weak B_2 Weak	A_1 Weak A_2 Firm B Firm	A_2 Weak B Firm	A_2 Weak B Firm
	Field pH	A 5.5 B_1 8.5 B_2 7	A_1 6.5 A_2 7 B 8	A_2 5 B 6	A_2 5 B 6.5
	Segregations	A Nil B_1 Nil B_2 Nil	A_1 Nil A_2 Nil B Nil	A_2 Nil B Nil	A_2 Nil B Nil

Site No:		**S5**	**S6**	**S7**	**S8**

Runoff:		Slow	Fast	Fast	Fast
Permeability:		Very slow	Fast	Moderate	Moderate
Drainage:		Imperfect	Well drained	Well drained	Well drained
Landform:		Flat	Midslope	Midslope	Flat
Site Disturbance:		Previously cleared for grazing	Previously cleared for grazing.	Cleared for grazing	Previously cleared for logging
Land Use:		Grazing (sheep)	Grazing (sheep)	Grazing (sheep)	State Forest
Slope:		0^0	3^0	3^0	0^0
Vegetation:	Dom. spp./stratum	Improved pasture	Improved pasture	Improved pasture	Callitris sp / Eucalyptus spp.
	Height	-	-	-	10-15m
	FPC	80%	70%	70%	60%
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type	Nil	Sheet	Sheet	Sheet
	Degree	Nil	Major	Major	Major
Surface Coarse Fragments:		Nil	80%	80%	50%
Rock Outcrop:		Nil	Nil	Nil	Nil
Groundwater Depth:		Nil	Nil	Nil	Nil
Soil Classification		Red Earth	Lithosol	Red Earth	Red Earth
Horizon	Depth (cm)	A_2 0-30 30+ Refusal	A 0-40 40+ Parent Material	A_2 0-40 B 40-50 50+ Refusal	A_2 0-30 B 30-40 40+ Refusal
	Boundary	NA	NA	A_2 to B Gradual	A_2 to B Gradual
	Colour	A_2 Dark reddish brown	A Very dusky red	A_2 Dusky red B Dusky red	A_2 Very dusky red B Dark red
	Mottles	A_2 Nil	A Nil	A_2 Nil B Nil	A_2 Nil B Nil
	Texture	A_2 Loam	A Loam	A_2 Loam B Clay loam	A_2 Loam B Clay loam
	Coarse Fragments	A_2 Nil	A 90% sub rounded	A_2 Nil B Nil	A_2 40% subrounded B 60% subrounded
	Structure	A_2 Pedal weak polyhedral 2-5mm	A Pedal weak polyhedral 2-5mm	A_2 Pedal weak polyhedral 2-5mm B Pedal weak polyhedral 2-5mm	A_2 Pedal weak polyhedral 2-5mm B Pedal weak polyhedral 2-5mm
	Consistency	A_2 Weak	A Very Weak	A_2 Weak B Weak	A_2 Very weak B Weak
	Field pH	A_2 6	A 5	A_2 6 B 6.5	A_2 5 B 4.5
	Segregations	A_2 Nil	A Nil	A_2 Nil B Nil	A_2 Nil B Nil

Site No:		S9	S10	S11	S12
Runoff:		Slow	Slow	Fast	Slow
Permeability:		Moderate	Fast	Moderate	Moderate
Drainage:		Imperfect	Well drained	Well drained	Well drained
Landform:		Flat	Midslope	Midslope	Waning lower slope
Site Disturbance:		Previously cleared for logging	Cleared for cropping	Cleared for grazing	Previously cleared for grazing
Land Use:		State Forest	Cropping (wheat)	Grazing (sheep)	Grazing (sheep)
Slope:		0^0	1^0	2^0	0^0
Vegetation:	Dom. spp./stratum	Callitris sp / Eucalyptus spp.	Wheat (stubble)	Callitris sp / Eucalyptus spp.	Improved pasture/Callitris sp / Brachychiton sp.
	Height	15m	-	15-20m	15 – 20m
	FPC	90%	90%	60%	80%
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type	Sheet	Sheet	Sheet	Sheet
	Degree	Minor	Minor	Major	Minor
Surface Coarse Fragments:		Nil	10%	10%	50%
Rock Outcrop:		Nil	Nil	Nil	Nil
Groundwater Depth:		Nil	Nil	Nil	Nil
Soil Classification		Red Earth	Red Earth	Red Earth	Red Earth
Horizon	Depth (cm)	A_2 0-40 B 40-80 80+ Parent material	A_2 0-20 B 20-40 40+ Refusal	A_2 0-30 B 30-50 50+ Refusal	A 0-30 B_1 30-50 B_2 50-110 110+ Parent Material
	Boundary	A_2 to B Gradual	A_2 to B Gradual	A_2 to B Gradual	A to B_1 Gradual B_1 to B_2 Diffuse
	Colour	A_2 Dusky red B Dark reddish brown	A_2 Dark reddish brown B Dark reddish brown	A_2 Dark reddish brown B Dark reddish brown	A Dark reddish brown B_1 Dark reddish brown B_2 Dark red
	Mottles	A_2 Nil B Nil	A_2 Nil B Nil	A_2 Nil B Nil	A Nil B_1 Nil B_2 Nil
	Texture	A_2 Loam B Loam	A_2 Loam B Clay loam	A_2 Loam B Clay loam	A Loam B_1 Loam B_2 Clay loam
	Coarse Fragments	A_2 Nil B 5% angular	A_2 40% subrounded B 60% subrounded	A_2 10% angular B 40% angular	A Nil B_1 Nil B_2 Nil
	Structure	A_2 Pedal weak polyhedral 2-5mm B Pedal weak polyhedral 2-5mm	A_2 Pedal weak polyhedral 2-5mm B Pedal weak polyhedral 2-5mm	A_2 Pedal weak polyhedral 2-5mm B Pedal weak polyhedral 2-5mm	A Pedal weak polyhedral 2-5mm B_1 Pedal moderate polyhedral 2-5mm B_2 Pedal moderate polyhedral 2-5mm
	Consistency	A_2 Weak B Very weak	A_2 Weak B Weak	A_2 Weak B Weak	A Weak B_1 Firm B_2 Firm
	Field pH	A_2 5 B 6	A_2 5.5 B 6	A_2 6 B 6.5	A 5 B_1 5.5 B_2 7.5
	Segregations	A_2 Nil B Nil	A_2 Nil B Nil	A_2 Nil B Nil	A Nil B_1 Nil B_2 Nil

Site No:		Q1	Q2	Q3	Q4

Runoff:		Very slow	Very slow	Moderate	Slow
Permeability:		Slow	Moderate	Fast	Moderate
Drainage:		Poorly drained	Imperfect	Well drained	Well drained
Landform:		Open depression	Flat	Waning lower slope	Crest
Site Disturbance:		Previously cleared for grazing	Cleared for cropping	Cleared for grazing and cropping	Previously cleared for grazing
Land Use:		Grazing (sheep)	Cropping (wheat)	Grazing (sheep) / cropping (wheat)	Grazing (sheep)
Slope:		0^0	0^0	7^0	0^0
Vegetation:	Dom. spp./stratum	Juncus sp. / Improved pasture	Wheat	Wheat (stubble)	Improved pasture/Eucalyptus sp.
	Height	-	-	-	10m
	FPC	100%	90%	100%	100%
Microrelief:		Nil	Nil	Nil	Nil
Erosion:	Type	Nil	Sheet	Nil	Nil
	Degree	-	Minor	-	-
Surface Coarse Fragments:		Nil	Nil	30%	30%
Rock Outcrop:		Nil	Nil	Nil	Nil
Groundwater Depth:		Nil	Nil	Nil	Nil
Soil Classification		Red Earth	Brown clay	Brown Clay	Brown Clay
Horizon	Depth (cm)	A_1 0-20 A_2 20-40 B 40–80 80+ Parent Material	A 0-30 B_1 30-50 B_2 50-85 85+ Parent Material	A_1 0-10 A_2 10-40 B 40–80 80+ Parent Material	A_1 0-25 B 25-60
	Boundary	A_1 to A_2 Gradual A_2 to B Gradual	A to B_1 Gradual B_1 to B_2 Gradual	A_1 to A_2 Gradual A_2 to B Gradual	A_1 to B Gradual
	Colour	A_1 Dark reddish brown A_2 Yellowish red B Reddish brown	A Reddish black B_1 Reddish brown B_2 Red	A_1 Dark reddish brown A_2 Black B Reddish brown	A_1 Very dark brown B Brown
	Mottles	A_1 Nil A_2 Nil B Nil	A Nil B_1 Nil B_2 Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil B Nil
	Texture	A_1 Loam A_2 Clay loam B Light medium clay	A Clay loam B_1 Light medium clay B_{21} Medium clay	A_1 Clay loam A_2 Light clay B Clay loam	A_1 Loam B_1 Clay loam
	Coarse Fragments	A_1 Nil A_2 Nil B Nil	A Nil B_1 Nil B_2 -Nil	A_1 Nil A_2 Nil B 30% angular	A_1 30% angular B 70% angular
	Structure	A_1 Pedal weak polyhedral 2-5mm A_2 Pedal moderate polyhedral 2-5mm B Pedal strong polyhedral 5-10mm	A Pedal moderate polyhedral 2-5mm B_1 Pedal moderate polyhedral 2-5mm B_2 Pedal moderate polyhedral 2-5mm	A_1 Pedal weak polyhedral 2-5mm A_2 Pedal weak polyhedral 2-5mm B Pedal weak polyhedral 2-5mm	A_1 Pedal weak polyhedral 2-5mm B_1 Pedal weak polyhedral 2-5mm
	Consistency	A_1 Weak A_2 Weak B Firm	A Firm B_1 Firm B_2 Firm	A_1 Weak A_2 Weak B Weak	A_1 Weak B Weak
	Field pH	A_1 5 A_2 5.5 B 6	A 5.5 B_1 6 B_2 6.5	A_1 6 A_2 7.5 B 7.5	A_1 6 B 7.5
	Segregations	A_1 Nil A_2 Nil B Nil	A Nil B_1 Nil B_2 Nil	A_1 Nil A_2 Nil B Nil	A_1 Nil B Nil

ATTACHMENT OB

SOIL PROFILE OBSERVATIONS

Observation Site Number	Site Description	Observation Site Number	Site Description
Mine Site OS1	Red Earth Slope 0^0 Flat Grazed improved pasture 100% FPC Weakly structured red A_2 0-15cm Strong structure higher red clay B 15-70cm	Mine Site OS6	Red Earth Major sheet erosion Red surface soil Weak structure A_2 60% surface coarse fragments Midslope Slope 4^0 Cleared for grazing Native pasture 70% FPC
Mine Site OS2	Lithosol Weakly structured A 0-15cm Refusal at 15cm 90% coarse fragments 60% surface coarse fragments Maximal upper slope Slope 4^0 Callitris sp./ Eucalyptus sp. 10-15m 60% FPC	Mine Site OS7	Red Earth Major sheet erosion Red weak structure A_2 0-30cm Dam cutting Flat Slope 0^0 Sheep grazing Cyperus 10m high FPC 70%
Mine Site OS3	Red Earth Major sheet erosion Weak structure red A_2 0-40cm Strong structure red B 40cm+ Erosion gully Flat Slope 0^0 Grazed paddock 80% FPC	Mine Site OS8	Red Earth Major sheet erosion Red weak structure A_2 0-30cm Callitris sp. / Eucalyptus spp 20m Flat Slope 0^0 Grazing (sheep)
Mine Site OS4	Red Earth Major sheet erosion Red weak structure A_2 0-50cm 80% surface coarse fragments Red strong structure B 50+cm Erosion gully Midslope Slope 1^0 Grazing / Improved pasture 70% FPC	Mine Site OS9	Red Earth Major sheet erosion Red weak structure A_2 0-20cm Callitris sp. / Eucalyptus spp 20m Open depression Slope 1^0 Cropping (wheat) / grazing (sheep)
Mine Site OS5	Red Earth Major sheet erosion Red weak structure A_2 0-20cm Midslope Slope 2^0 Cleared for grazing 90% FPC	Mine Site OS10	Red Earth Minor sheet erosion Red weak structure A2 60% coarse fragments (subrounded) Callitris sp. / Eucalyptus spp 20m Midslope Slope 2^0 Cropping (wheat) / grazing (sheep) 80% FPC
Observation Site Number	**Site Description**	**Observation Site Number**	**Site Description**

Mine Site OS11	Red Earth Minor sheet erosion Red weak structure A_2 0-10cm Callitris sp. / Brachychiton sp. 20m 80% FPC Cropping (wheat) / grazing (sheep) Flat Slope 1^0	Mine Site WDO1	Lithosol Rehabilitated mine landform 80% surface coarse fragments 0-10cm pH 8.5 30-40cm pH 7.5 Native pasture / weed species 40% FPC
Mine Site OS12	Red Earth Red weak structure A_2 0-20cm Minor sheet erosion Eucalyptus spp / Callitris sp./ native pasture 25-30m 90% FPC Slow runoff Well drained Midslope 1^0 Cleared for grazing (sheep)	Mine Site WDO2	Lithosol Rehabilitated mine landform 95% surface coarse fragments 0-10cm pH 8.5 40-50cm pH 7.5 Native pasture / weed species 25% FPC
Mine Site OS13	Red Earth Major sheet erosion Red weak structure A_2 0-40cm 90% surface coarse fragments Callitris sp. / Eucalyptus spp. Grazing (sheep) / native bush 70% FPC	Quarry QOS1	Red Earth Dark red moderate structure A_1 0-10cm Dark red moderate structure A_2 10-30cm Midslope Slope 2^0 Cleared for cropping (wheat) / grazing (sheep) 100% FPC Wheat stubble
Mine Site OS14	Red Earth Minor sheet erosion Red weak structure A_2 0-20cm Callitris sp. / Acacia sp. / native pasture 15m FPC 95% Grazing (sheep) Midslope Slope 1^0		

ATTACHMENT OC

SOIL ANALYSES

Soil Laboratory Tests

Test	Symbol	Units
Cation exchange capacity	CEC	meq/100g
Exchangeable sodium percentage	ESP	%
Electrical conductivity (1:5 soil:water)	EC	dS/m
Electrical conductivity (saturation extract)	ECse	dS/m
pH (1:5 soil:water)	pH_w	

Syerston Project – Analytical Results of Representative Soil Samples

Parameter	Units	Sample Site and Horizon (Refer Figures 2 and 3 for sites)												
		S1-A	**S1-B1**	**S1-B2**	**S2-A1**	**S3-A2**	**S3-B**	**WD1-A**	**WD1-B**	**WD2-A**	**WD2-B**	**Q3-A1**	**Q3-A2**	**Q3-B**
Soil colour	Munsell	Red	Red	Yellow Red	Brown	Red Brown	Red Brown	Brown Yellow	Brown Yellow	Red	Weak Red	Brown	Brown	Brown
Soil Texture		Fine sandy loam	Clay Loam	Fine Sandy Clay Loam	Loam	Clay Loam	Clay	Silty Loam	Silty Loam	Clay Loam	Clay Loam	Loam	Clay Loam	Clay Loam
pH		6.8	8.2	8.6	6.2	6.2	7.4	8.7	8.8	9.1	8.7	8.2	8.3	8.5
C	%	1.7	0.6	0.2	>5.0	1.3	0.6	0.7	0.2	0.1	0.1	3.7	1.9	1.9
N	mg/kg	0.7	1	0.4	6.5	10	1.8	1.1	0.8	1.3	2.9	28.1	10.4	10.8
S	mg/kg	2	6	3	4	14	18	2	1	2	66	9	2	6
P (BSES)	mg/kg	17	15	7	58	26	24	17	16	18	13	103	59	8
P (Cowell)	mg/kg	4	3	2	18	13	3	8	8	5	4	13	5	5
K	meq/100g	0.52	1.07	0.43	1.19	1.49	0.69	0.62	0.2	0.59	0.55	1.8	1.26	0.21
Ca	meq/100g	9.52	20.28	9.9	14.94	8.56	13.92	19.48	3.43	3.67	2.13	34.71	34.43	25.79
Mg	meq/100g	3.56	3.83	3.39	17.01	5.82	10.6	11.71	8.35	11.58	11.94	1.23	0.97	0.51
Na	meq/100g	0.06	0.08	0.09	0.03	0.09	0.32	0.03	0.25	1.38	3.58	0.04	0.1	0.05
Cl	mg/kg	5	10	20	10	25	60	10	10	5	150	5	5	10
Cu	mg/kg	1.6	2	0.6	1.2	3.9	3.7	1.2	0.3	0.4	0.6	0.3	0.5	0.2
Zn	mg/kg	0.4	0.2	0.2	3.1	0.6	0.1	0.2	0.1	0.2	0.1	0.8	0.3	0.2
Mn	mg/kg	16	<1	<1	26	10	5	2	1	<1	<1	6	3	1
Fe	mg/kg	15	6	5	21	44	6	6	7	4	6	18	5	4
B	mg/kg	0.8	3.2	1.6	3.3	1.5	1.9	0.6	0.9	3.1	3	1.5	0.8	0.8
Calculations														
CEC	meq/100g	13.66	25.26	13.81	33.16	15.96	25.53	31.84	12.24	17.23	18.2	37.78	36.76	26.57
Ca/Mg Ratio		2.68	5.3	2.92	0.88	1.47	1.31	1.66	0.41	0.32	0.18	28.21	35.33	50.34
ESP	%	0.46	0.31	0.65	0.09	0.55	1.26	0.1	2.04	8	19.67	0.11	0.27	0.2
EC(se)		0.2	0.8	0.8	1.1	0.5	0.4	0.9	0.7	0.6	3	1.5	1	1