Section 4

Assessment and Management of Key Environmental Issues

PREAMBLE

This section of the Environmental Assessment provides relevant background information relating to the environmental aspects identified in Section 3. The following sub-sections provide information related to the existing environment and the proposed mitigation measures and management procedures that would be implemented throughout the life of the Project with respect to the following environmental issues.

- *Noise and blasting.*
- *Groundwater.*
- *Aboriginal heritage.*
- *Bushfire.*
- *Air quality and energy.*
- *Soils and land capability.*
- *Ecology.*
- *Surface water.*
- *Non-Aboriginal heritage.*
- *Traffic and transportation.*
- *Visual amenity.*
- *Socio-economic setting.*

A detailed assessment of the likely residual impacts and, where relevant, programs to monitor the potential environmental impacts, are also outlined.

Information is presented in sufficient detail to enable readers to fully understand the potential impacts of the Project, should it be approved. The extent of detail provided reflects the potential likelihood and severity of impacts and the priority for each environmental issue determined in Section 3.3.

This page has intentionally been left blank

4.1 BACKGROUND

4.1.1 Introduction

The descriptions of various environmental aspects of the Project throughout this section are reliant upon a range of background information common to many of the key environmental issues. In this sub-section, background information is provided on the topography, climate, geology, land ownership and residences, land uses and the community surrounding the Project Site.

4.1.2 Topography and Drainage

4.1.2.1 Regional Topography and Drainage

The Project Site is located in an area of undulating hills located between two north - south trending ridgelines (**Figure 4.1**). The western ridgeline, located between approximately 15km and 20km to the west of the Project Site is a section of the Great Dividing Range with maximum elevations of approximately 1 346m AHD and 1 359m AHD at Mount Lowden (approximately 15km to the west-northwest of the Project Site) and Mount Cowangerong (approximately 23km to the southwest of the Project Site) respectively. To the west of the Great Dividing Range is a series of rolling to deeply incised hills.

The eastern ridgeline, located approximately 12km to the east of the Project Site, is unnamed with a maximum elevation of 965m AHD at Monga Mountain. This ridgeline peters out to the north of the Project Site. To the east of this ridgeline is a second, lower ridgeline and an east-sloping escarpment with average slopes of approximately 1:1 (V:H) down to coastal plain.

Approximately 1km to the south of the Project Site is deeply incised, south to southeast orientated, narrow valley with side slopes of up to 1:1 (V:H). The floor of the valley occurs at elevations approximately 500m lower than the head of the valley.

The area to the north of the Project Site is dominated by gently undulating hills with elevations between approximately 600m AHD and 800m AHD, with occasional steep sided hills. The highest point to the north of the Project Site is Mount Gillamatong, with a maximum elevation of 907m AHD. Slopes within the area to the north of the Project Site are typically less than 1:10 (V:H), with some more steeply sloped areas having slopes of up to approximately 1:5 (V:H).

The Project Site lies on the boundary of Shoalhaven and Moruya Catchments (**Figure 4.1**). The upper Shoalhaven Catchment covers an area of approximately 9 460km^2. Surface waters within the catchment flow to the Shoalhaven River which flows in northerly direction before turning east and flowing to the Pacific Ocean to the east of Nowra.

The Moruya Catchment covers an area of approximately 1 490km^2. Surface waters in the vicinity of the Project Site flow initially to Majors Creek, before flowing to Araluen Creek and the Deua River. The Deua River merges with the Moruya River and flows to the Pacific Ocean at Moruya.

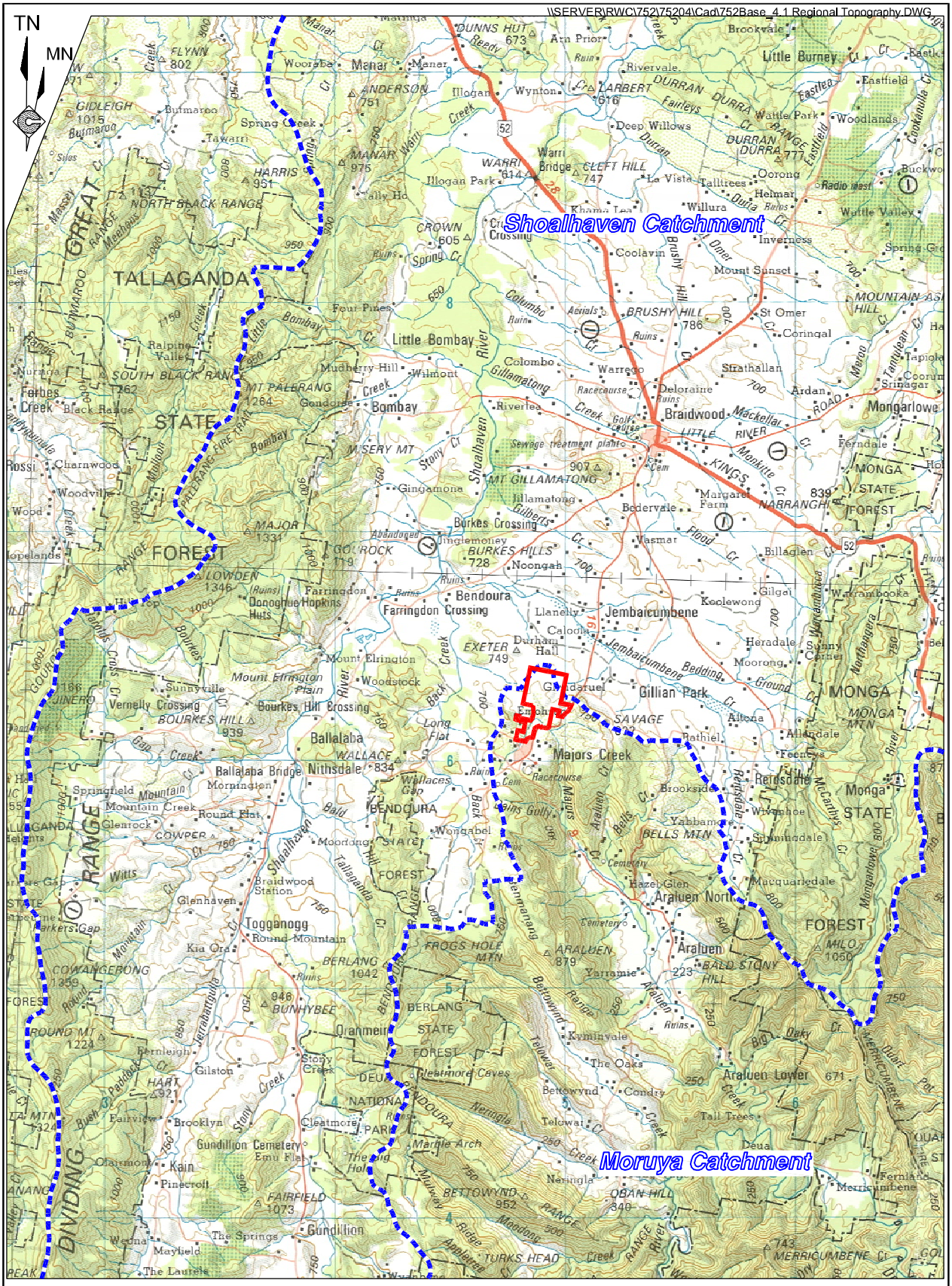


Figure 4.1
REGIONAL TOPOGRAPHY AND DRAINAGE

4.1.2.2 Local Topography and Drainage

The topography surrounding the Project Site is presented on **Figure 4.2**. The area immediately to the north, west and east of the Project Site is typically gently undulating, with elevations ranging from 749m AHD at an unnamed hill to the northwest of the Project Site to approximately 650m AHD at the confluence of the Jembaicumbene Creek and the Shoalhaven River.

The topography immediately to the south of the Project Site is more steeply sloped, particularly to the south of the escarpment at the head of the Araluen Valley. Elevations to the south of the Project Site vary from 700m AHD to 300m AHD.

The northern section of the Project Site is within the Shoalhaven Catchment, with a number of unnamed drainages to the northeast of the Project Site draining to Jembaicumbene Creek and to the northwest draining to Back Creek. Both Back and Jembaicumbene Creeks merge with the Shoalhaven River approximately 7km to the northwest of the Project Site.

Jembaicumbene Creek, to the northeast of the Project Site, has been significantly disturbed by mining-related activities and now forms a series of pools and swampy areas.

The area to the southwest and southeast of the Project Site is dominated by Majors Creek which also flows through the southern section of the Project Site. The creek, which has its headwaters approximately 1km to the west of the Project Site, flows to the east before turning to the northeast within the Project Site and then to the south downstream of the Project Site. The creek flows over the escarpment into the Araluen Valley approximately 1.5km to the southeast of the Project Site.

4.1.2.3 Project Site Topography and Drainage

The topography within and immediately surrounding the Project Site is presented on **Figure 4.3**.

The northern section of the Project Site is typically gently undulating with elevations ranging from approximately 740m AHD on the northern boundary of the Project Site to 700m AHD at the head of a number of deeply incised creeks.

The undulating northern section of the Project Site is cut by a number of deeply incised creeks associated with Spring Creek and its tributaries. The slopes of these incised valleys are typically convex, with more gentle slopes on the upper sections and steeper slopes closer to the base of the valley. The surface water assessment (SEEC, 2010 – see Section 4.5) indicates that this reflects active natural erosion that has been exacerbated by past land use history, including alluvial gold mining and construction of water races and dams within the creek lines. SEEC (2010), however, note that the recent gully stabilisation works have successfully stabilised a number of formerly active gullies.

The southern section of the Project Site is dominated by Majors Creek an is typically moderately to gently undulating. Elevations within that section of the Project Site typically range from approximately 650m AHD to 620m AHD.

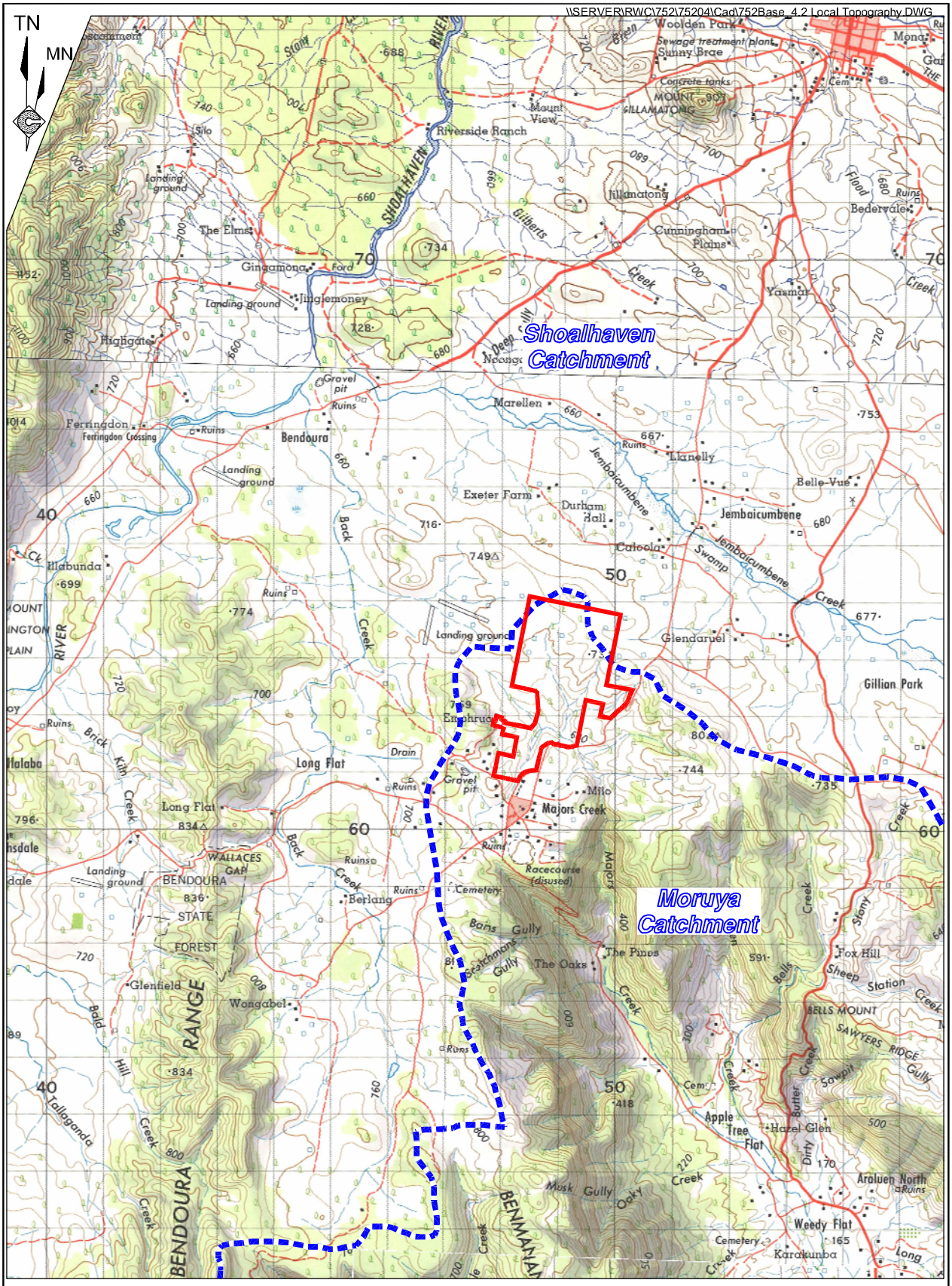


Figure 4.2
LOCAL TOPOGRAPHY AND DRAINAGE

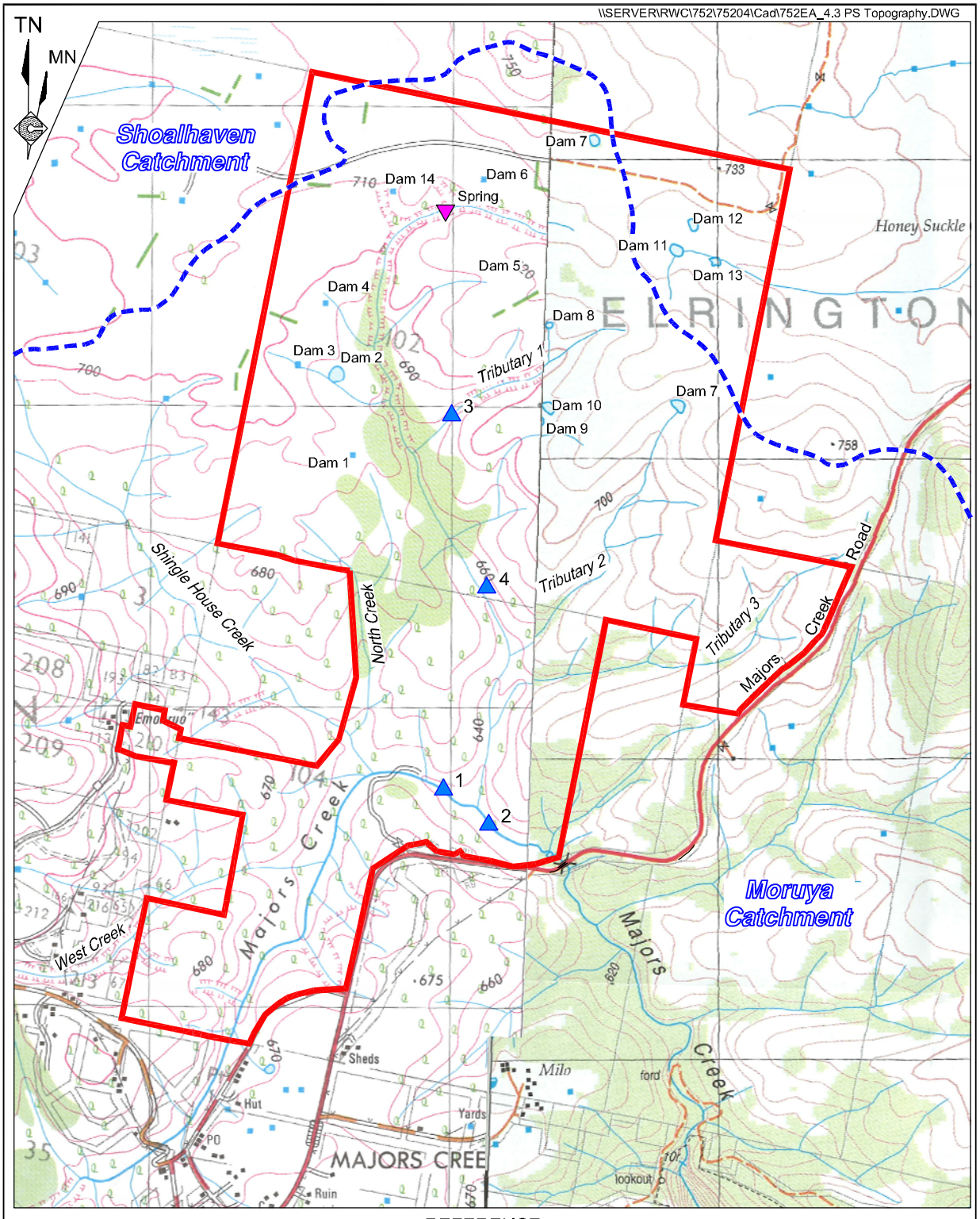


Figure 4.3
PROJECT SITE TOPOGRAPHY AND DRAINAGE

Drainage within the northern section of the Project Site is dominated by Spring Creek and a number of unnamed tributaries (referred to as Tributaries 1, 2 and 3). This creek is fed by a small spring in the headwaters of the creek (**Figure 4.3**). Spring Creek merges with Majors Creek in the southern section of the Project Site. The creek and its tributaries have been extensively disturbed by previous mining-related activities.

Drainage immediately to the west of the Project Site is dominated by Shingle House Creek and its tributary, North Creek.

Drainage within the southern section of the Project Site is dominated by Majors Creek which, within the Project Site, flows from west to east. This creek has also been extensively disturbed by previous mining-related activities, with the alluvial sediments subjected to sluicing and dredging. In addition, the non-Aboriginal Heritage Assessment (ASR, 2010b – see Section 4.7) noted that at least two stamp batteries and a chlorination plant were established within the creek.

Within the small section of the Project Site within the Shoalhaven Catchment, drainage lines are typically poorly defined and ephemeral.

Within the Project Site a number of farm dams have been constructed. These are identified on **Figure 4.3** and are discussed further in Section 4.5.

4.1.3 Climate

4.1.3.1 Introduction

Climatic conditions have the potential to influence a range of potential Project-related impacts on surrounding residents and the environment. This sub-section provides a brief overview of the climatic conditions surrounding the Project Site, focusing particularly on those aspects of the climate that are likely to influence the potential Project-related environmental impacts.

4.1.3.2 Data Sources

Meteorological data from the following Bureau of Meteorology-operated stations is presented in **Table 4.1.** These stations are located approximately 13km to the north-northeast of the Project Site.

- Braidwood – Wallace Street Station - (temperature - 1907 to 1975, rainfall -1887 to 2010, evaporation – 1996 to 2010).
- Braidwood Racecourse Station – (temperature - 1985 to 2010).

Temperature data from these stations has been combined for the period 1907 to 2010.

4.1.3.3 Temperature and Humidity

January is the hottest month, with a maximum average temperature of 26.0°C. July is the coldest month with an average maximum temperature of 11.4°C and an average minimum temperature of -0.2°C.

Table 4.1
Climate Data

	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Temperature (C°)													
Mean maximum temperature	26.0	25.4	23.0	19.1	15.2	12.0	11.4	13.2	16.4	19.4	22.0	25.0	
Mean minimum temperature	10.9	11.1	9.3	5.9	2.6	0.7	-0.2	0.8	2.7	5.4	7.6	9.6	
Rainfall (mm)													
Mean rainfall	70.3	65.6	69	56.4	58	66.5	47.2	47.4	48.8	62.7	62.9	64	718.8
Highest rainfall	262	324	340	249	664	517	345	251	146	358	216	278	1342
Lowest rainfall	0.8	0.0	0.3	0.0	1.2	0.5	0.0	0.6	4.1	2.0	1.3	0.0	340.0
Mean number of rain days	8.6	8.0	8.3	7.4	7.7	8.5	7.6	8.1	8.8	8.9	8.6	8.2	98.7
Highest daily rainfall	104.6	175.0	160.4	118.0	199.9	113.3	101.9	89.6	154.9	106.7	86.9	106.7	
Open Pan Evaporation (mm)													
Mean daily evaporation	4.7	3.9	3.1	2.2	1.3	0.9	1	1.7	2.6	3.5	4	4.6	2.8

Note Temperature data from 1907 to 1975 sourced at Braidwood – Wallace Street. Temperature data from 1985 to 2010 has been sourced from the Braidwood Racecourse Station. Combined data has been used to calculate mean, maximum and minimum temperatures for the period 1907 to 2010.

Source: Bureau of Meteorology – Braidwood – Wallace Street (Station Number: 069010) and Braidwood Racecourse (Station Number: 069132).

4.1.3.4 Rainfall and Evaporation

Annual average rainfall is 718.8mm, with rainfall distributed reasonably evenly through the year, with between 47mm and 70mm falling on average each month. The driest year on record is 1982 when 340mm of rain was recorded. By contrast, the wettest year on record is 1974 when 1 341mm of rain was recorded. The maximum daily rainfall recorded is 200mm which was recorded on 27 April 1925.

Annual evaporation is approximately 1 022mm and varies from approximately 4.7mm per day in January to 0.9mm per day in June. Monthly evaporation exceeds rainfall in all months except May, June and July.

4.1.3.5 Wind and Atmospheric Stability

Wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction) data have been collected from a meteorological station operated within the Project Site since March 2009. **Figure 4.4** presents the annual and seasonal wind roses compiled by PAEH (2010) from the data collected from the Project Site meteorological station for the period March 2009 to March 2010.

On an annual basis, the data show a high frequency of winds from the south-southeast and from the northwest directions. In summer and autumn, winds are predominantly from the south-southeast and to a lesser extent from the northwest direction. In winter and spring, the dominant winds are from the northwest, with predominant winds also from the south-southeast in spring. On an annual basis, the mean wind speed for the Project Site is 3.7m/s and the percentage of calms (wind speeds less than 0.5m/s) is 3.6%. Seasonal wind roses by time of day as required by the *NSW Industrial Noise Policy* are presented in Appendix D of Spectrum (2010b).

\\SERVER\RWC\752\75204\Cad\752EA_4.4 wind.DWG

Figure 4.4
ANNUAL AND SEASONAL WINDROSES

Source: PAE Holmes - Figure 4

The data from March 2009 to March 2010 was used by PAEH (2010) to generate proportional occurrences of Pasquill Gifford Stability Classes (a description of the vertical mixing potential or atmospheric turbulence). Six atmospheric turbulence stability classes are classified (A to F) with class A being the most unstable (or most turbulent) class, and class F the most stable (or least turbulent) class. **Table 4.2** presents the frequency of occurrence of the six stability categories.

Table 4.2
Frequency of Atmospheric Stability Classes

Pasquill Gifford Stability Class	Frequency (%)
A	2.0
B	3.5
C	11.9
D	59.6
E	18.6
F	4.4
Source: Modified after PAEH (2010) – Table 4.2	

The most common stability class for the Project Site was determined to be class D at 59.7%. PAEH (2010) interprets this as indicating that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time. The frequency of E and F class conditions (slow dispersal conditions) are lower at 23% (combined).

4.1.4 Local and Regional Geology

The Project Site and surrounds are underlain by Devonian-aged Braidwood Granodiorite, an intrusive pluton consisting of multiple intrusions and occupying an area of about 1 000km^2 (**Figure 4.5).**

The Braidwood Granodiorite intruded the early Devonian-aged Long Flat Volcanics, a felsic extrusive, which outcrops the west of the Project Site. Ordovician-aged sediments occur to the east of the granodiorite approximately 10km to the east of the Project Site.

The Braidwood Granodiorite is cut by a number of north-west / south-east trending, steeply dipping faults. The granodiorite is also cut by a second suite of structures striking to the north-northeast (**Figure 4.5**). These structures are zones of weakness and appear to control drainage patterns within the Project Site and surrounds.

Gold mineralization at Dargues Reef is structurally controlled and is hosted within east-west trending lenses that maintain a steep southerly dip within strongly altered granodiorite near the contacts of a sub-vertical diorite to quartz diorite dyke. The lenses follow the east-west fracture system in the granodiorite which is particularly well developed adjacent to the diorite dykes. The mineralised lodes have a width of between 5m and 20m, a strike length of up to 140m and they extend down-dip for at least 450m.

The upper 10m to 15m of the granodiorite is weathered with a sharp contact with the underlying fresh rock.

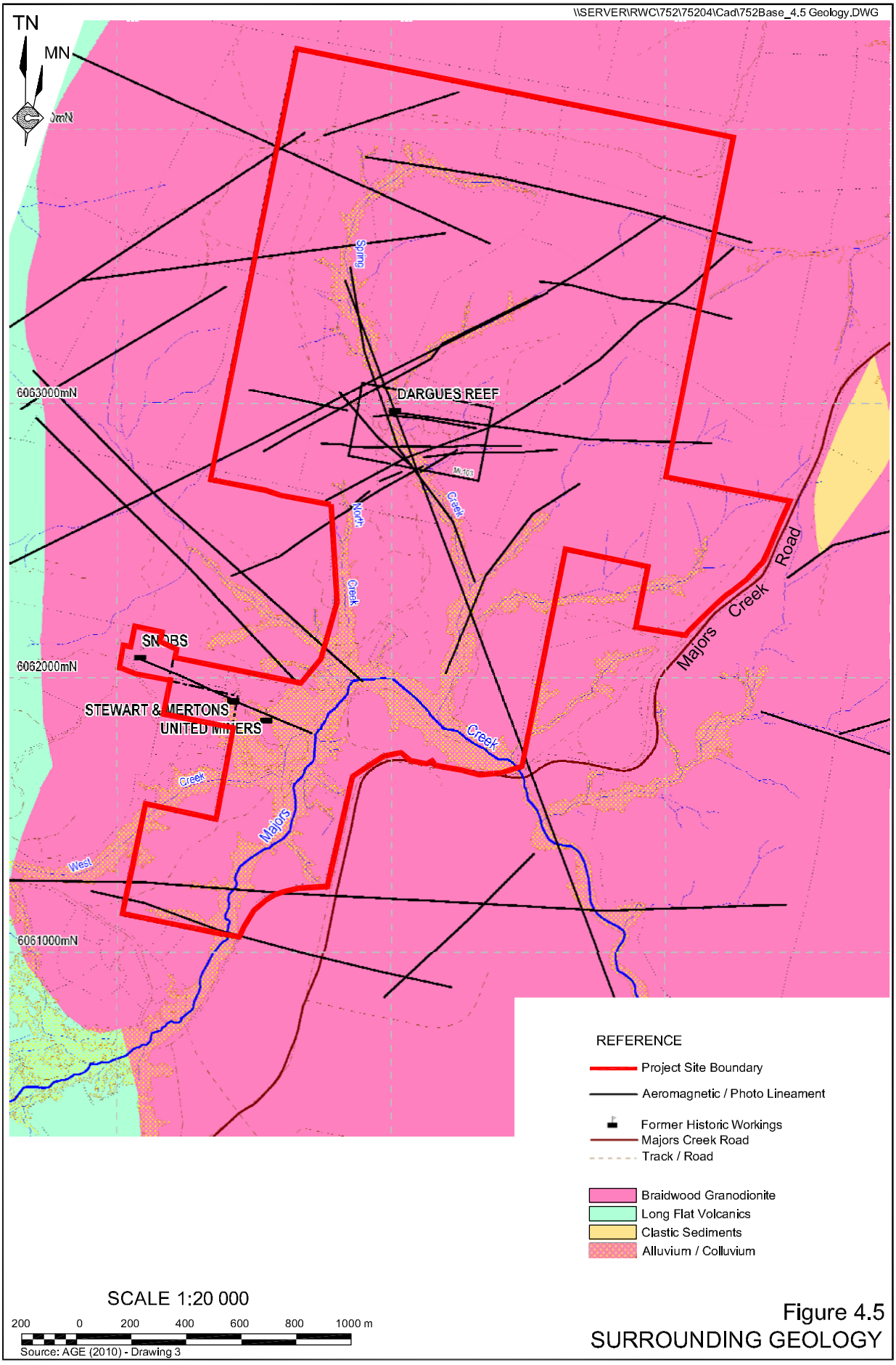


Figure 4.5
SURROUNDING GEOLOGY

Alluvium, consisting of coarse sand and clay and granodiorite boulders has been deposited along Majors Creek, whereas the deposits in the base and sides of the tributaries to Majors Creek are colluvial material that has washed from the slopes above the tributaries. The alluvium along Majors Creek varies between about 60m and 200m in width and has been extensively disturbed by goldmining activities in the late 1800's, early 1900's.

4.1.5 Surrounding Land Ownership, Residences and Land Use

4.1.5.1 Land Ownership and Residences

Table 4.3 and **Figure 4.6** presents the land ownership surrounding the Project Site while **Figure 4.7** presents the residences surrounding the Project Site. It is noted that landownership data was sourced from an extensive search of the register of land titles administered by the Land and Property Authority Management in March 2010. In addition, the residence plan was prepared based on site inspections from public roads by the Proponent and interpretation of aerial photographs. As a result, while all reasonable steps were taken during preparation of these plans and associated table to ensure their accuracy, it may be that some landownership details have changed since the date of the database search or that some structures identified as residences and visa versa.

Table 4.3
Surrounding Land Ownership

Page 1 of 4

Land Reference[1]	Residence Reference[2]	Section/Lot/DP	Landowner[3]
1	-	1021/1127185, 102/755934, 1/986483, 2/986483, 3/986483, 4/986483, 5/986483, 104/1100849.	Cortona Resources Limited
2	-	103/755934	Exeter Farm Pty Ltd
3	R34	98/755934	Ref not held
4	-	2/1099172, 1/61600	Glendaruel (Holdings) Pty Limited
5	-	1/996501, 2/996501, 1/5/758636, 2/5/758636, 3/5/758636, 4/5/758636, 5/5/758636, 6/5/758636, 7/5/758636, 9/5/758636, 10/5/758636, 13/5/758636, 14/5/758636, 9/835597,	P. Callan, C McGrath, L Haggan
6		Reference not used	
7	R31	1/136801, 2/136801, 3/755934, 82/755934, 83/755934, 95/755934, 113/755934, 114/755934, 141/755934, 143/755934	P. & L. Matthias
8	R24	1/199645, 2/199645	S.J. Redden
9	-	1/28/758636, 2/28/758636, 3/28/758636, 5/28/758636, 5A/28/758636, 6/28/758636, 7/28/758636, 10/28/758636, 11/28/758636, 13/28/758636, 14/28/758636	Valerie Carpenter
10	-	12/28/758636	Certificate has not been issued
11	-	18/27/758636	D.P. Drew
12	-	13/27/758636	B.S. & S.F. Drew
13	R58	14/27/758636	N.V. Harrington

Table 4.3 (Cont)
Surrounding Land Ownership

Land Reference[1]	Residence Reference[2]	Section/Lot/DP	Landowner[3]
14	-	15/27/758636	S. Lee
15	-	16/27/758636	Reference not held
16	R55	17/27/758636	Reference not held
17	R54	9/31/758636	A.D. & M.S. Phillips
18	R53	2/31/758636	Mangold Investments (NSW) Pty Ltd
19	-	2A/27/758636	Reference not held
20	-	701/1054207, 701/1054979, 1/123143, 1/123393, 1/48260, 161/755934, 162/755934, 188/755934, 193/755934, 209/755934, 213/755934, 5/4/758636, 6/4/758636, 7/4/758636, 8/4/758636, 9/4/758636, 1/21/758636, 2/21/758636, 3/21/758636, 4/21/758636, 7/21/758636, 8/21/758636, 9/21/758636, 10/21/758636, 1/24/758636, 2/24/758636, 4/24/758636, 5/24/758636, 6/24/758636, 7/24/758636, 8/24/758636, 9/24/758636, 10/24/758636, 11/24/758636, 12/24/758636, 4/25/758636, 5/25/758636, 6/25/758636, 7/25/758636, 8/25/758636, 9/25/758636, 10/25/758636, 11/25/758636, 12/25/758636, 13/25/758636, 1/53/758636, 3/53/758636, 4/53/758636, 5/53/758636, 6/53/758636, 701/93977	State of NSW
21	R59	20/27/758636	L.G. Delamont
22	-	19/27/758636	Y.M. Chin
23	-	7/27/758636	Reference not held
24	-	7A/27/758636	Reference not held
25	R21, R71, R72	8/27/758636	Reference not held
26	-	9/27/758636	Reference not held
27	-	10/27/758636	Reference not held
28	-	21/27/758636, 22/27/758636	1/1112412 – Timothy James Rankin
29	R60	1/42/758636, 2/42/758636, 3/42/758636, 4/42/758636, 5/42/758636,	R.A. & J.A. South McKenzie
30	-	7/15/758636	The Right Reverend Mesac Thomas
31	-	121/48413, 120/755934, 8/15/758636	K.M. Stuart
32			Reference not used
33	R61	5/15/758636, 6/15/758636	A. & C.W.Y.H. Brace & R. Mahncke
34	-	1/4/758636, 2/4/758636	W. Brickwood
35	-	2A/4/758636, 3/4/758636, 4/4/758636	Crown land
36	-	8/5/758636	A.J. & L.E.M.M. Astley
37	-	1/14/758636, 2/14/758636, 2A/14/758636, 3/14/758636, 3A/14/758636, 4/14/758636, 4A/14/758636, 6/14/758636, 6A/14/758636, 7/14/758636, 7A/14/758636, 8/14/758636, 9/14/758636, 5/836923	B.W. McCarron

Table 4.3 (Cont)
Surrounding Land Ownership

Land Reference[1]	Residence Reference[2]	Section/Lot/DP	Landowner[3]
38	-	5/6/758636	C.A. & M.T. Powell
39	R44	6/6/758636, 7/9/758636	B.D. & G.B.L. Hayes
40	R45	8/6/758636	A.A. Casey
41	R40	A/336039	N. Tetley & S.L. Buchanan
42	R39	1/665110	B. Sheridan & J. McIntyre
43		2/6/758636, 3/6/758636, 4/6/758636	W.M. Nelson
44	R43	1/39/758636, 2/39/758636	S.P. & K.A. Junor
45		240/775934	Reference Not Held
46	R84	6/877483	W.H. & J.F. Butcher
47	R85	5/877483	L.J. Stinson
48	R86	4/877483	R.M. Grant & M. Allatt
49	R87	3/877483	S.L. Bennett
50	R88	1/877483, 2/877483	B.R. Doherty & N.L. Watts
51	R91	23/1004205	M.J. Franz
52	R64	5/13/758636, 5A/13/758636, 6/13/758636, 7/13/758636, 7A/13/758636,	A.H. & C.E. Struzina
53	R65	4/13/758636, 4A/13/758636	K. Angel
54	R66	33/1012809	R. & E.P. Blakely-Kidd
55	R67	2/13/758636	N.L. Amey
56	R68	1/13/758636	J.L. & C.A. Corcoran
57	R63	2/17/758636	J.T. & C.M. Bowman
58	-	3/17/758636, 4/17/758636	R.E. McCarron
59	-	1/17/758636	J.W. Wiggins
60	-	9/18/758636	Reference Not Held
61	R94	1/18/758636, 2/18/758636, 3/18/758636, 7/18/758636	M.A. Ross
62	R93	4/18/758636, 5/18/758636, 5A/18/758636, 1/26/758636	Star Buttons Enterprises Pty Ltd
63	-	6/18/758636	Lachmere Pty Ltd
64	R70	1/40248, 11/15/758636, 1/16/758636, 2/16/758636,	S.M. McCarron
65	-	9/1068558	J.S. Weeks & J.B. McDonald
66	-	10/1068558	D.E. Jeffery & M.A. Stoyles
67	-	11/1068558	A. & M.J. McDonald
68	R19	8/1068558	A.P. Dann
69	-	7/1068558	P.A. & V.L. Grindrod
70	-	6/1068558	R.C. Stone
71	R20	5/1068558	A. & M.Z. Page
72	R6	1/797719	B. Carruthers
73	R7	253/755934	A.K. & N. Riley
74	R2	3/842928, 6/842928, 7/842928, 8/842928, 45/872802	D.B.R. & B.A. Messum
75	R16	11/709905, 9/735425, 10/735425, 1/986527	L.T. & P.S. Ruzicka
76	R17	1/831229, 2/831229	B. McDonald
77	R18	14/842928, 1/859129	G. Gibson
78	R23	4/1068558	M.L. Cathro
79	R22	3/1068558	P.J. & L.J. Cram
80	-	2/1068558	G. & J. Wheatley and K. & S. Jones
81	-	1/1068558	D.J. & L.M. Avery

Table 4.3 (Cont)
Surrounding Land Ownership

Land Reference[1]	Residence Reference[2]	Section/Lot/DP	Landowner[3]
82	-	4/755934	Reference Not Held
83	-	3/20/758636, 4/20/758636	H.A. Gillespie
84	-	11/574879, 12/574879, 13/574879	The Council of the Shire of Tallaganda
85	-	1/19/758636	R. Allen & S.M. McIlveen
86	R9	247/755934, 15/22/758636, 16/22/758636, 17/22/758636, 18/22/758636	William Edmund Waterhouse
87	R10	5/21/758636, 6/21/758636	Sarah Elizabedth Vella
88	R11	2/53/758636, 9/53/758636	G.E. & L.H. Ison
89	-	21/720161	L.A. & G.M. Baillie
90	R13	13/24/758636, 14/24/758636, 15/24/758636, 16/24/758636, 17/24/758636, 18/24/758636, 19/24/758636, 20/24/758636, 21/24/758636, 22/24/758636, 23/24/758636, 24/24/758636	B. Vugec
91	-	3/24/758636	W.A. & K.T. O'Leary
92		1/36/758636	R.J. & C.H. Smith-Roberts
93	R14	65/755934, 67/755934, 191/755934, 216/755934	D.K. & D.M. Wood
94	R12	163/755934, 164/755934	S, P, P, W & J. Cootes
95	R15	125/755934, 212/755934	M. Flakelar & J. Holmes
96	R32, R36	211/755934	B. Crittenden
97	-	202/755934	V. Laurie
98	R29	1/194317, 66/755934, 210/755934	B. & C. James
99	R1	93/755934, 166/755934	M. Toner & R. Manderson
100	-	5/1093136	J. & K. Spring
101	-	?/54/758636	Reference Not Held
102	-	?/1/758636	Reference Not Held
103	-	1/23/758636	Reference Not Held
104	-	165/755934	Reference Not Held
105	R30	94/755934	Reference Not Held
106	R26,R27, R28	104/755934	Reference Not Held
107	-	113/755934	Folio Cancelled
108	-	95/755934	Reference Not Held
109	-	101/755934	Reference Not Held
110	-	4/755934	Reference Not Held
111	-	9/18/758636	Reference Not Held
112	-		Reference Not Held
113	-	96/755934	Reference Not Held
114	-	104/1149075	J. Stachow & R. Stachow

Note 1: See **Figure 4.6**
Note 2: See **Figure 4.7**
Note 3: "reference not held" indicates that the owner of the land is not registered on the Land Titles Register, possibly as a result of the land being "Old Title."

Source: Land and Property Management Authority (March 2010)

\\SERVER\RWC\752\75204\Cad\752EA_4.6 Land Ownership.DWG

TN
MN

INSET A

SCALE 1:15 000
250 0 250 500

Note: See **Table 4.3** for the Land Ownership details of each property

SEE INSET A

SEE INSET B

INSET B

SCALE 1:25 000
250 0 250 500 750 1000 1250 m

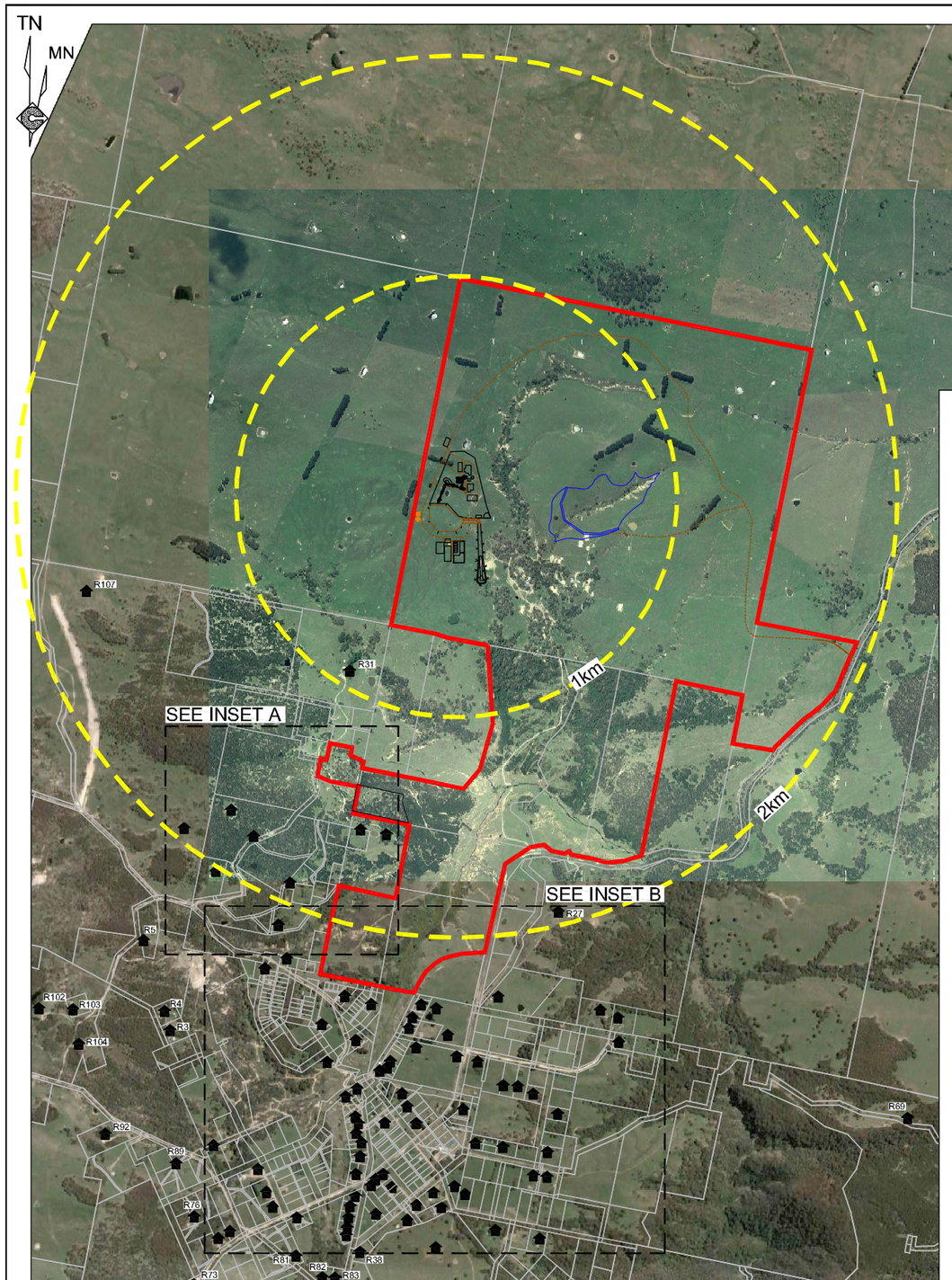
SCALE 1:10 000
100 0 100 200 300 400 500 m

REFERENCE
Project Site Boundary
Cadastral Boundary
(1) Landowner Reference
R1 Residence & Identifier

Land Ownership Source: Land and Property Management Authority - March 2010

Figure 4.6
SURROUNDING LAND OWNERSHIP

This page has intentionally been left blank

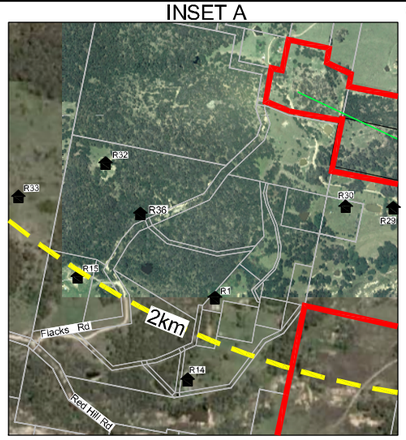


SCALE 1:25 000

250 0 250 500 750 1000 1250 m

INSET A

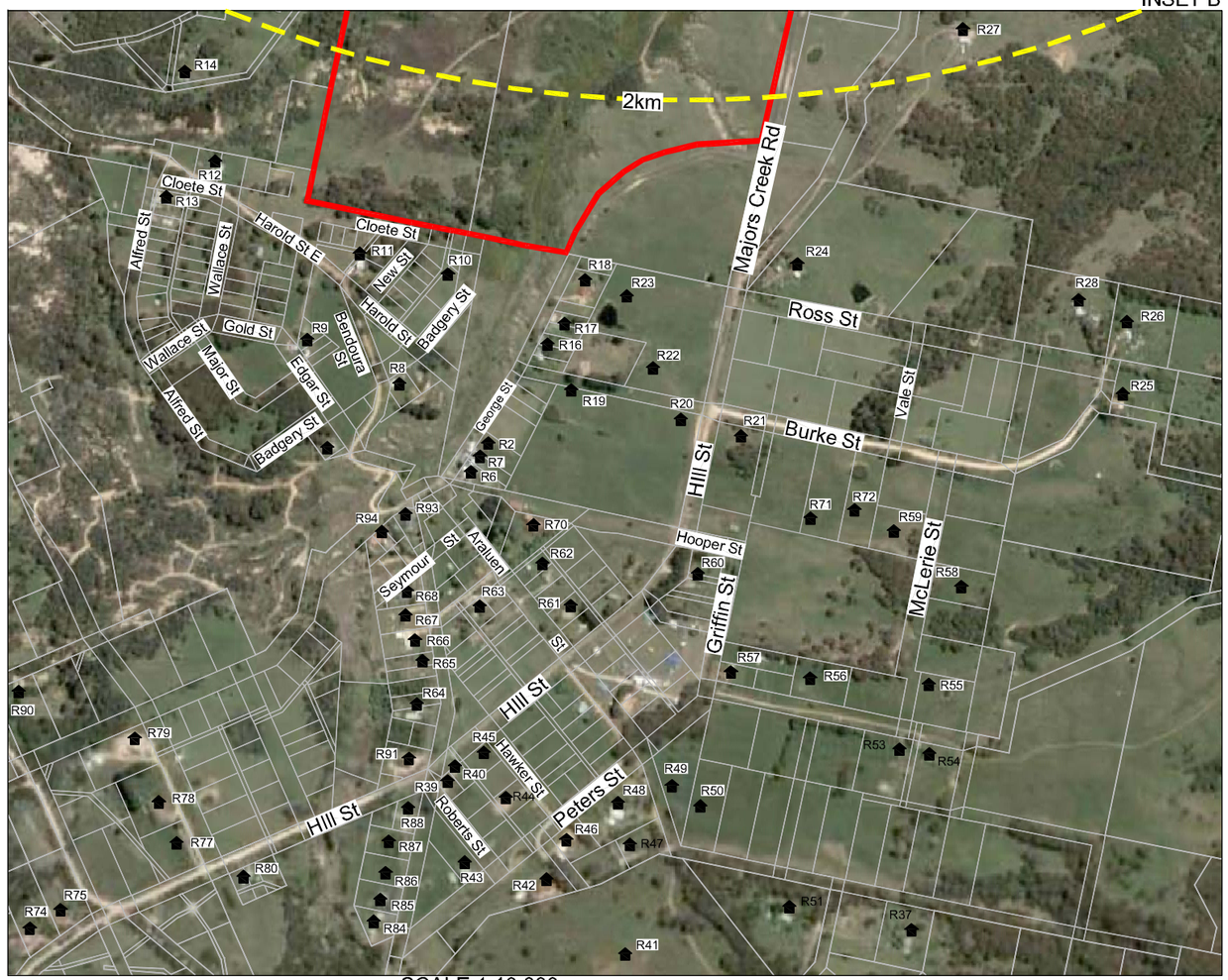
\\SERVER\RWC\752\75204\Cad\752EA_4Surround Residence.DWG



SCALE 1:15 000

250 0 250 500

INSET B



SCALE 1:10 000

100 0 100 200 300 400 500 m

REFERENCE

Project Site Boundary
Cadastral Boundary
R1 Residence & Identifier
Distance from Processing Plant

Source: Big Island Mining Pty Ltd

Figure 4.7
SURROUNDING RESIDENCES

This page has intentionally been left blank

4.1.5.2 Land Use

Land uses surrounding the Project include the following (**Figure 4.8**).

- Agriculture – principally grazing of sheep and cattle, with some areas of cropping. Agricultural activities are principally undertaken in cleared areas on undulating hills.
- Nature conservation and forestry – these land uses are principally restricted to areas of steep slopes and areas unsuitable for other land uses.
- Residential and rural residential – Majors Creek and surrounding areas include areas of rural residential and residential land use.
- Mineral exploration.

The Proponent contends that the Project would not be inconsistent with these surrounding land uses.

4.1.6 Surrounding Community

4.1.6.1 Introduction

Information presented in the following sub-sections has been obtained from census data produced by the Australian Bureau of Statistics from the 2006 Census. The Census data relate to the census statistical area of Braidwood State Suburb (**Figure 4.9**) and NSW as a whole.

4.1.6.2 Population and Population Growth

Table 4.4 presents a summary of the 2006 population statistics for the Braidwood State Suburb (referred to hereafter as 'Braidwood') and for NSW as a whole.

The Census data indicate that the proportion of persons aged 14 years and younger in Braidwood (19.0%) was similar to the proportion for NSW as a whole (19.8%). By contrast, people aged 15 to 24 years in Braidwood (7.7%) represented a smaller percentage of the population than NSW as a whole (13.3%). Similarly, the proportion of people in Braidwood between the ages of 25 and 54 years (38.5%) was less than the proportion for NSW a whole (42%). Finally, the proportion of people aged over 55 years in Braidwood (34.8%) is significantly higher than for NSW as a whole (24.8% respectively).

This data indicates that a greater proportion of people aged over the age of 55 live within Braidwood than in NSW as a whole. In addition, the lower proportion of adults aged between 25 and 54 in Braidwood compared with NSW as a whole, combined with similar proportions of those aged 14 or under suggest that, on average, families within Braidwood are larger than in NSW as a whole.

This may be the result of the lower cost of living or other factors attracting or retaining young families and retirees to Braidwood.

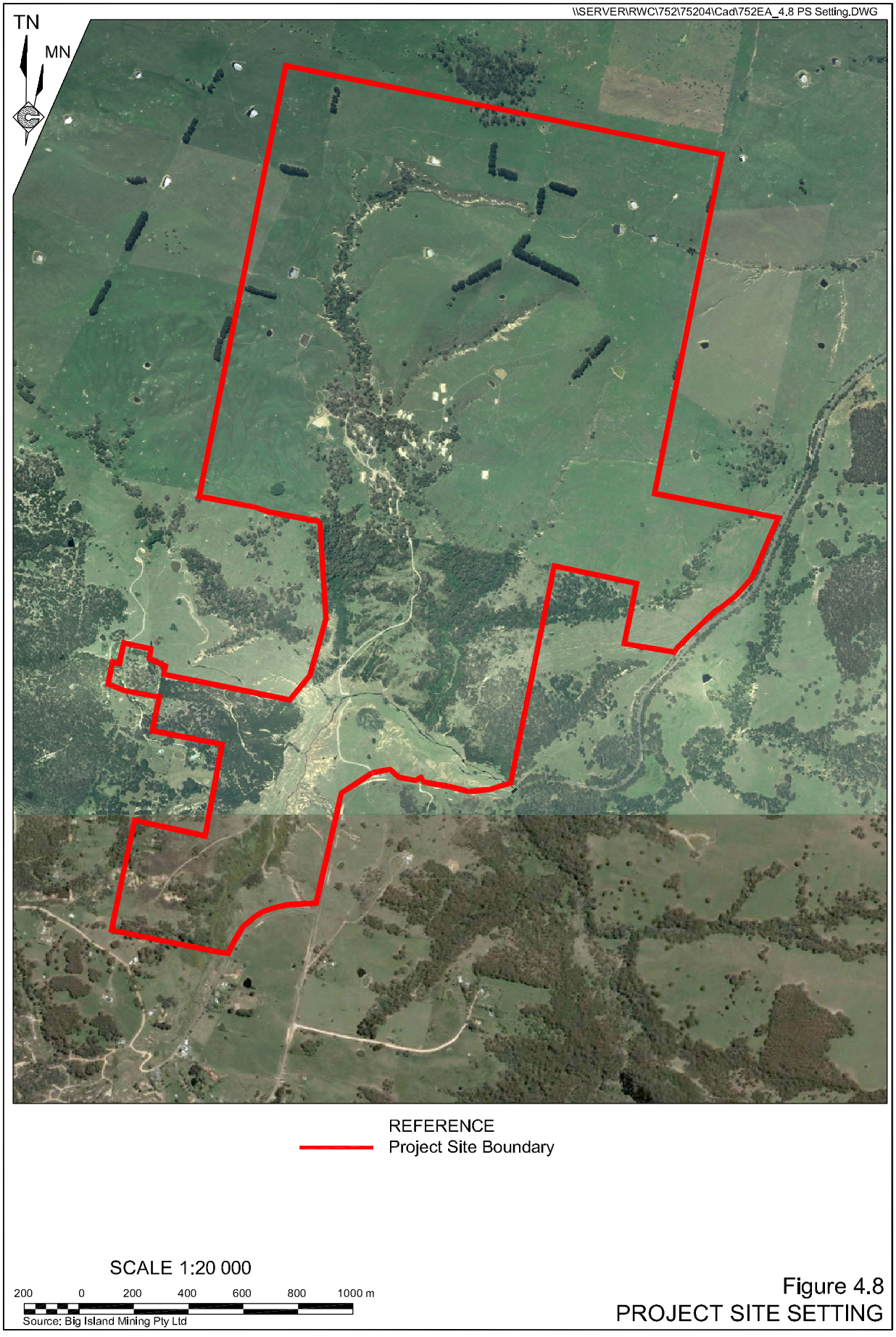


Figure 4.8
PROJECT SITE SETTING

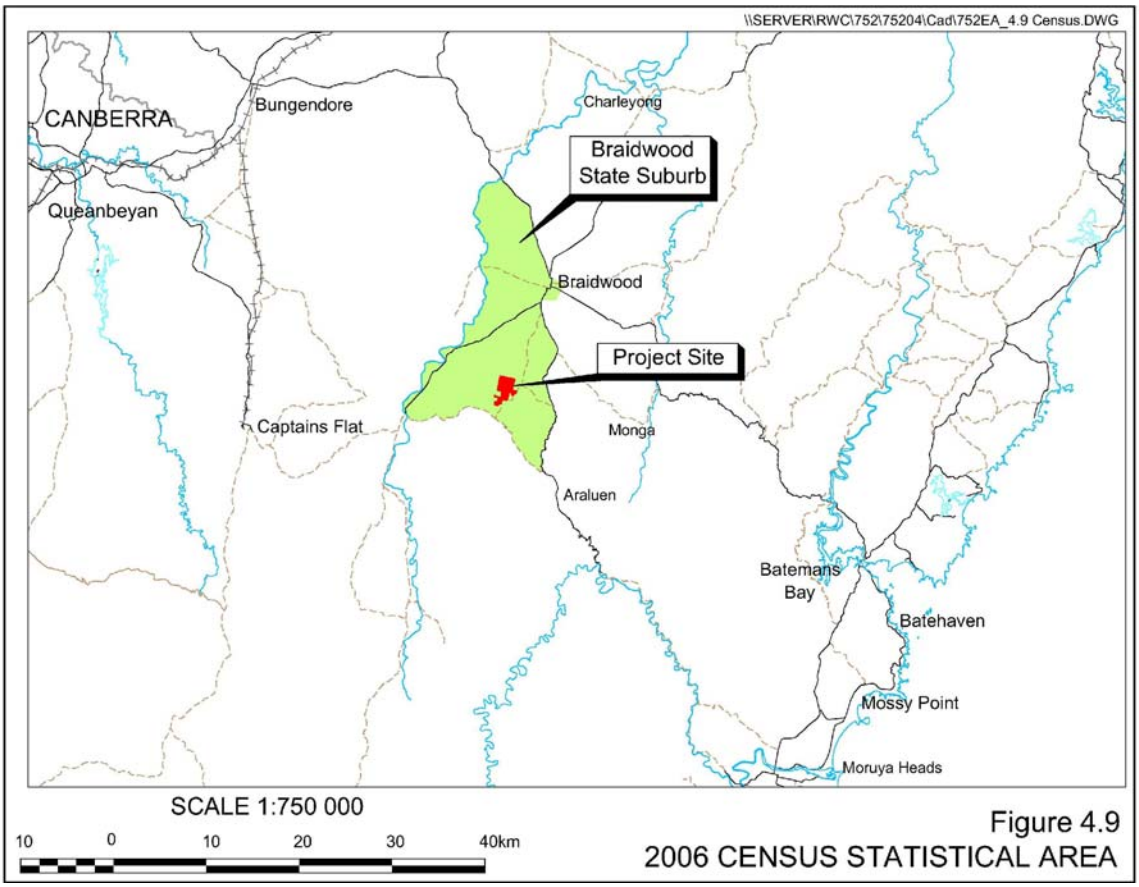


Table 4.4
2006 Census Population Statistics

		Braidwood		NSW	
	Age Groups	**Persons**	**Percentage**	**Persons**	**Percentage**
Children	0-4 years	108	7.4%	420 431	6.4%
	5-14 years	170	11.6%	878 483	13.4%
Studying or Working	15-24 years	113	7.7%	871 717	13.3%
	25-54 years	565	38.5%	2 753 219	42%
Approaching Retirement or Retired	55-64 years	224	15.3%	719 551	11%
	65 years and over	286	19.5%	90 5778	13.8%
	Total Persons	**1 466**		**6 549 178**	
Source: Australian Bureau of Statistics - 2006 Census					

Finally, in the 2001 census the Braidwood State Suburb (Census Collection Districts 1170702, 1170704 and 1170707) recorded a population of 1 302 people. When compared with the 2006 recorded population of 1 466 people, this suggests an annual net growth rate of approximately 33 people or 2.5%. This compares with an annual growth rate for NSW as a whole of 0.8%.

4.1.6.3 Employment, Occupation and Industries

Table 4.5 presents the employment statistics from the 2006 Census. This data indicates that the unemployment rate in Braidwood on the date of the census was 3.5%, considerably lower than for NSW as a whole (5.8%).

Table 4.5
2006 Census Employment Statistics

	Braidwood		NSW	
	Persons	**Percentage**	**Persons**	**Percentage**
Employed				
Full-time(a)	379	54.8%	1 879 628	59.2%
Part-time	241	34.8%	842 713	26.5%
Employed, away from work(b)	27	3.9%	187 103	5.9%
Hours worked not stated	21	3.0%	83,578	2.6%
Total	*668*	96.5%	2 993 022	94.2%
Unemployed, looking for				
Full-time work	18	2.6%	115 165	3.6%
Part-time work	6	0.9%	67 994	2.1%
Total	*24*	3.5%	183 159	5.8%
Labour Force Participation				
Total labour force		692		3 176 181
Total Persons		1 466		6 549 177
Labour force participation		47.2%		48.5%
Source: Australian Bureau of Statistics - 2006 Census				

Table 4.6 presents a summary of the 2006 Census statistics relating to industry of employment. This data indicates "Retail", "Agriculture, forestry and fishing" and "Public administration and safety" employs 11%, 10.9% and 10.0% of the workforce respectively. State-wide, these industries employed 8.9%, 3.5% and 6.6% of the workforce. For NSW as a whole, the principal industries of employment were "Manufacturing" and "Construction" employing 12.9% and 11.7% of the workforce respectively. This data reflects the importance of Braidwood as a regional services centre with an important agricultural industry and limited manufacturing and construction. No respondents within Braidwood indicated employment within the mining industry.

4.1.6.4 Income

Table 4.7 presents income statistics provided in the 2006 Census. That data indicates that median individual, family and household incomes in Braidwood were between 17% and 31% lower than NSW as a whole. This may be attributable to the fact that, typically, wages and salaries available for workers in rural areas are lower than other areas within the State.

4.1.6.5 Majors Creek Community Profile

It is acknowledged that Census statistics present a limited view of the community. In addition, the statistics presented are dominated by residents who live in areas such as Braidwood and surrounding communities that may not be directly impacted by the Project. As a result, the following presents a profile of the Majors Creek community based on anecdotal information provided to or obtained by Marcom Communication who were engaged by the Proponent to consult with the Majors Creek community.

Table 4.6
Industry Employment Statistics

	Braidwood		NSW	
	Persons	**Percentage**	**Persons**	**Percentage**
Agriculture, forestry & fishing	73	10.9%	55 532	3.5%
Mining	0	0.0%	18 322	1.2%
Manufacturing	43	6.4%	202 434	12.9%
Electricity, gas, water & waste services	8	1.2%	23 079	1.5%
Construction	49	7.3%	183 998	11.7%
Wholesale trade	12	1.8%	87 166	5.6%
Retail trade	78	11.7%	140 058	8.9%
Accommodation & food services	61	9.1%	86 433	5.5%
Transport, postal & warehousing	37	5.5%	111 898	7.1%
Information media & telecommunications	8	1.2%	40 119	2.6%
Financial & insurance services	9	1.3%	68 253	4.3%
Rental, hiring & real estate services	8	1.2%	25 360	1.6%
Professional, scientific & technical services	28	4.2%	115 503	7.4%
Administrative & support services	11	1.6%	43 167	2.7%
Public administration & safety	67	10.0%	103 620	6.6%
Education & training	60	9.0%	67 250	4.3%
Health care & social assistance	58	8.7%	67 856	4.3%
Arts & recreation services	11	1.6%	21 311	1.4%
Other services	30	4.5%	63 176	4.0%
Inadequately described/Not stated	18	2.7%	45 913	2.9%
Total	**669**		**1 570 448**	
Source: Australian Bureau of Statistics - 2006 Census				

Table 4.7
Income Statistics 2006

	Braidwood	NSW
Median individual income ($/weekly)	382	461
Median family income ($/weekly)	971	1 181
Median household income ($/weekly)	711	1 036
Source: Australian Bureau of Statistics - 2006 Census		

Majors Creek is a small village with approximately 200 residents and approximately 80 others who own land in the village but live elsewhere. The community has been described as a close knit community. Many residents have lived in the village for a significant period of time and it has been suggested that all local residents know one another. There is a strong sense of community, with residents participating in several events as a community. Annual community events include: New Year's Day Picnic – which will celebrate its 150th anniversary in 2012, Community Christmas Party and the Music at the Creek Folk Festival held in November most years. Other social events are advertised on a community noticeboard on the Majors Creek Road at the entrance of the village.

Communal facilities present in Majors Creek include:

- St Stephen's Church;
- the community hall; and

- a community recreation ground which includes basketball courts, tennis courts, a playground and an oval.

While sporting facilities are available in Majors Creek, the majority of formal sporting activities are conducted through sporting associations in Braidwood.

Several community committees and organisations exist in order to advance and develop the community, these include:

- Majors Creek Progress Association;
- Majors Creek Volunteer Bushfire Brigade;
- Majors Creek Recreation Reserve Trust;
- Majors Creek Country Women's Association; and the
- Majors Creek Community Liaison Committee.

Residents also participate in other community institutions in neighbouring areas.

The main commercial venture within the village is the Majors Creek Hotel. However, there are several other home businesses operating including:

- a bed and breakfast;
- electrical service;
- IT service; and
- animal protection service.

The village relies on Braidwood and other larger centres for shopping and access to services such as banks, child care, medical centre, libraries, schools and government services.

Despite a limited number of employment opportunities within the village, it is contended that almost all adult residents are employed, retired, stay-at-home parents or students. A number of residents of Majors Creek are professionals who commute outside the village to work. Professionals in the village range from tradespeople and farmers, to artists, educators, journalists, doctors and scientists.

4.2 NOISE AND BLASTING

4.2.1 Introduction

The Director-General's Requirements (DGRs) issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Noise and Blasting**". The DGRs specify that the assessment include "*construction, operational and road traffic noise*".

Based on the risk assessment undertaken for the Project (see Section 3.3), specific noise and blasting related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Increased noise levels associated with Project activities causing annoyance, distractions, ie. amenity impacts.
- Sleep disturbance as a result of maximum noise levels.
- Structural damage to buildings and structures.
- Nuisance/amenity impacts on surrounding landowners / residents.
- Reduced yield / availability of water from affected groundwater bores.

The DGRs require that the noise and blasting assessment refer to the

- *NSW Industrial Noise Policy (EPA, 2000);*
- *Environmental Criteria for Road Traffic Noise (EPA, 1999);*
- *Interim Construction Noise Guideline (DECC, 2008);*
- *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration (ANZECC, 1990); and*
- *Assessing Vibration: A Technical Guideline (DEC, 2006).*

A Noise and Blasting Assessment was undertaken by Spectrum Acoustics (Spectrum) to address the DGRs and assess the impact of the Project on the local environment. The assessment was completed by Dr Neil Pennington (PhD, B.Sc (Physics), B.Math (Hons)) of Spectrum. This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 1 (Volume 1) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "Spectrum (2010b)[1]". The following sub-sections describe and assess the existing noise environment, identify the relevant noise and blasting assessment criteria and describe the noise attenuation and other controls, safeguards and mitigation measures proposed by the Proponent. Additionally, the assessment of the residual noise and blasting related impacts following the implementation of these safeguards and mitigation measures are presented.

4.2.2 Existing Environment

Background noise levels surrounding the Project Site are typical of a rural environment with minor contributions from transport noise and domestic activities. The principal sources of noise that contribute to background noise levels include:

- traffic on Majors Creek Road and the streets of Majors Creek;
- farm equipment such as tractors and cultivators;
- domestic activities such as lawn mowers and chainsaws;
- insect noise such as cicadas, especially during spring and summer months;
- livestock and other farm and native animals; and
- wind through vegetation.

[1] A report prepared by Spectrum Acoustics in March 2010 is also referred to in this report and is referenced as Spectrum (2010a).

Attended monitoring was undertaken by Spectrum at Residences 81 and 31 in March 2010 (**Figure 4.7**). This monitoring, undertaken during a drilling campaign within the Project Site, recorded an L_{Aeq} noise level of 26db(A) during the late afternoon (5:30pm – 6:00pm) and 25dB(A) during the late evening (9:30pm to 10:00pm) at Residence 81 (Spectrum, 2010a). Notably, on-site drilling operations were not audible at the time of monitoring and as such the measured noise levels provides a fair representation of background noise levels. Noise levels of 25dB(A) to 26dB(A) are typical of a quiet rural environment with some insect activity.

On the basis of the attended monitoring results obtained in March 2010 (Spectrum, 2010a) and the rural / village locality, none of the residences surrounding the Project Site and are likely to be currently subjected to significant noise-related impacts. It is therefore assumed that background noise levels (L_{A90}[2]) are currently at or below 30dB(A) at all residences during day, evening and night time periods.

Under the NSW *Industrial Noise Policy* (INP) (EPA, 2000), it is a standard requirement that noise levels below 30dB(A) can be taken as 30dB(A) for the purposes of assessing industrial noise, such as noise that would be produced by the Project. As such, a 30dB(A) L_{90} background level has been adopted for all residences surrounding the Project Site during the day, evening and night time.

4.2.3 Assessment Criteria

4.2.3.1 Introduction

The assessment of impacts of the Project on the local noise climate has been undertaken by calculating likely noise levels during both the site establishment (construction) and operational stages of the Project and comparing those noise levels against the noise criteria established through reference to:

- the *Industrial Noise Policy* (INP) (EPA, 2000): for site operational noise and sleep disturbance;
- relevant sections of the *Interim Construction Noise Guideline* (DECC, 2009): for site establishment / construction noise criteria;
- *NSW Environmental Criteria for Road Traffic Noise* (ECRTN) (EPA, 1999): for road traffic noise; and
- Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990 (ANZECC, 1990): for air overpressure and ground vibration generated by blasting.

4.2.3.2 Site Establishment Noise Criteria

Table 2 of the *Interim Construction Noise Guideline* (DECC, 2009) provides management levels for noise at residences and how they are to be applied. These noise management levels identify standard hours of operation (7:00am to 6:00pm) and non-standard hours of operation (6:00pm to 7:00am) and provide for differing noise criteria in each case.

[2] The noise level which is exceeded for 90% of the time at a given location.

The recommended construction noise criteria for standard and non-standard hours of operation are as follows.

- Standard hours of operation (7:00am to 6:00pm): background + 10dB(A) (40dB(A)).
- Non-standard hours of operation (6:00pm to 7:00am): background + 5dB(A) (35dB(A)).

It is noted that the DGRs refer explicitly to DECC (2009). However, advice provided by DECCW following the issuing of the DGRs indicates that construction noise criteria do not apply to mining projects. Based on this advice, all noise has been considered against the operational noise criterion (which is equivalent to the construction noise criterion for non-standard hours of operation).

4.2.3.3 Operational Noise Criteria

The INP specifies two noise criteria:

- an *intrusiveness criterion* which limits L_{Aeq} noise levels from the industrial source to a value of 'background plus 5dB(A)'; and
- an *amenity criterion* which aims to protect against excessive noise levels where an area is becoming increasingly developed.

Since there is no existing major industry dominating noise levels at residences surrounding the Project Site, and road traffic noise is not continuous, only the intrusiveness criteria were considered in setting the existing project-specific operational noise limit.

In addition, as the Project Site is situated in a rural environment with limited other noise sources, the INP default background noise level of 30dB(A) has been assumed for day, evening and night-time at all non-Project related residences.

As a result, the relevant $L_{eq(15\text{-minute})}$ operational noise assessment criteria for the Project for all periods of the day is 35dB(A). It is noted that this is the lowest intrusiveness criterion that can be established under the INP.

4.2.3.4 Sleep Disturbance Criteria

The DECCW recommends a $L_{1(1\text{-minute})}$ sleep disturbance criterion at building facade of background plus 15dB(A). As a result, the $L_{1(1\text{-minute})}$ sleep disturbance criterion that would apply to the Project would be 45dB(A). The sleep disturbance criterion only applies during the night time period.

4.2.3.5 Road Traffic Noise Criteria

Vehicle noise associated with vehicles operating within the Project Site is considered to be operational noise. However, vehicle noise associated with vehicle movements on public roads is considered to be road traffic noise. Road traffic noise emissions are managed under the *NSW Environmental Criteria for Road Traffic Noise* (ECRTN).

It is noted that the Project would result in additional traffic travelling on Majors Creek Road, Araluen Road and Captains Flat Road (between the Project Site and Braidwood) and Coghill and Wallace Streets (within Braidwood before joining the Kings Highway). These are all classified as local roads in accordance with the ECRTN and accordingly, the following $L_{Aeq(1hr)}$ road traffic noise criteria would apply to the Project.

- Day (7:00am to 10:00pm) – 55dB(A).
- Evening (10:00pm to 7:00am) – 50dB(A).

4.2.3.6 Blasting Criteria

The Department of Climate Change and Water (DECCW) commonly adopts blasting assessment criteria based on the human comfort criteria identified in the document *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990* published by the Australian and New Zealand Environment and Conservation Council (ANZECC). These criteria have been adopted for any Project-related blasting.

- The recommended maximum overpressure level for blasting is 115dB(L).
- The level of 115dB(L) may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120dB(L) at any time.
- The recommended maximum vibration velocity for blasting is 5mm/s Peak Vector Sum (PVS).
- The PVS level of 5mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10mm/s at any time.

4.2.4 Assessment Methodology

4.2.4.1 Operational and Sleep Disturbance Noise Assessment

The anticipated Project-related construction, operational and sleep disturbance noise impacts have been established by Spectrum (2010b) using RTA Software's *Environmental Noise Model* to predict noise levels at residences surrounding the Project Site. The acoustical algorithms utilised by this software have been endorsed by all State environmental authorities. The model was constructed by placing the various noise generating equipment in either the most exposed location that mobile equipment would be likely to operate in, or in the proposed location for fixed equipment such as the crusher or rotary breaker. This information was then used to determine estimated noise levels at each of the surrounding residences for the following scenarios.

Scenario 1a: 24-hour Site Establishment - Excluding Bulk Earthworks

This scenario considers the noise likely to be generated by all site establishment activities, with the exception of bulk earthworks. These activities would be undertaken 24-hours per day. **Figure 4.10** illustrates the indicative locations of the following noise generating equipment that would be associated with Scenario 1a.

- Operation of a crane to erect of processing plant framework and buildings.

- Operation of front-end loaders for miscellaneous movement of material around the Project Site.
- Operation of lighting plant and silenced generators.
- Operation of limited trucks and light vehicles for the movement of materials and personnel.
- Operations of other low noise level equipment such as fork-lifts, fuel trucks, welding equipment, etc.

These activities would be undertaken during the day, evening or night period, and therefore could be undertaken during inversion conditions.

Scenario 1b: Site Establishment and Initial Mine Development - Bulk Earthworks

This scenario considers the noise likely to be generated by the establishment of surface infrastructure and initial development of the box cut.

Figure 4.10 illustrates the indicative locations of the following noise generating equipment associated with Scenario 1b.

- Construction of surface infrastructure required for the underground mine, including a box cut, portal and decline, magazines, communication tower, fuel store, ventilation rise and power and water supply.
- Construction of a processing plant and office area which would include:
  - a Run-of-Mine (ROM) pad and temporary waste rock emplacement;
  - crushing and grinding, gravity separation and floatation circuits; and
  - Proponent and mining contractor site offices, workshops, laydown areas, ablutions facilities, stores, car parking, and associated infrastructure.
- Construction of a tailings storage facility.
- Construction of a water management system, including construction of eight dams and associated water reticulation system.
- Construction of a site access road and new intersection with Majors Creek Road.
- Construction of ancillary infrastructure, including soil stockpiles, core yards, internal roads and tracks and surface water management structures.

It is noted that the activities identified as part of this scenario would be undertaken during the period 7:00am to 6:00pm only and would be concurrent with the activities identified in Scenario 1a above. As a result, the noise assessment for Scenario 1b included noise sources identified in both Scenarios 1a and 1b.

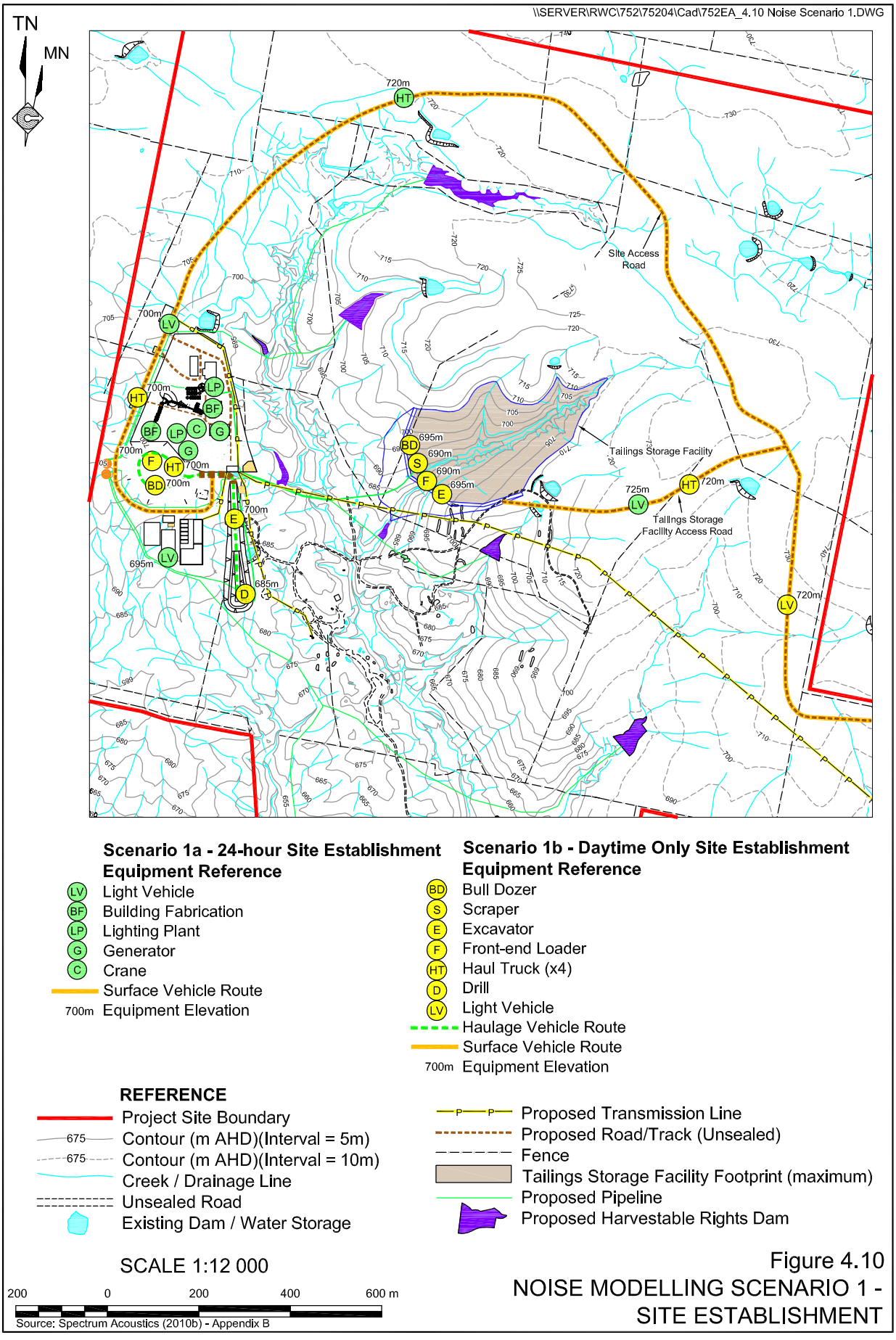


Figure 4.10
NOISE MODELLING SCENARIO 1 - SITE ESTABLISHMENT

Scenario 2: Project Operation

This scenario considers the noise likely to be generated by the mining, processing and internal transport operations associated with the operational phase of the Project. **Figure 4.11** illustrates the indicative locations of the noise generating equipment associated with Scenario 2. This scenario would involve the following activities.

- Continuous operation of a front-end loader (to manage stockpiles, blend the ore material and deliver it to the ROM bin), and campaign operations of a rock breaker, on the ROM pad and temporary waste rock emplacement.
- Movement of haul trucks between the box cut and the ROM pad / temporary waste rock emplacement.
- Processing operations including:
  - a crushing and screening circuit;
  - a primary ball mill for grinding; and
  - a gravity circuit and flotation circuit.
- Operation of equipment at the tailings storage facility including water pumps.
- Operation of heavy vehicles (road registered semi-trailer).
- Miscellaneous operations on the Project Site, including:
  - equipment maintenance within laydown areas and workshops; and
  - light vehicles movements to / from, and around the site.

The noise assessment initially assumes that all noise generating equipment would be operated simultaneously in the locations shown on **Figures 4.10** and **4.11** and that the sound power levels of all earthmoving equipment would correspond with the sound power levels presented in *Appendix A* of Spectrum (2010b). It is noted that the sound power levels identified in Appendix A of Spectrum, (2010b), and therefore incorporated into the noise assessment, take into account the proposed noise controls identified in Section 4.2.5.

Modelled Climatic Conditions

The INP requires assessment of winds when winds of less than 3m/s are recorded for more than 30% of a particular time period (day, evening or night) in a particular season (summer, autumn, winter or spring) from a particular direction. As noted in Section 4.1.3.5, and on **Figure 4.4**, the majority of all winds are at speeds in excess of 4.5m/s. However, Spectrum (2010b) note that winds from the north-northwest of less than 3m/s occur for more than 30% of the time during the night during autumn, winter and spring. As a result, north-northwest winds are a feature of the local environment.

Inversion conditions are a feature of the local environment. As a result, both winds from the north-northwest and temperature inversions have been modelled by Spectrum (2010b) for the mining operations scenario (Scenario 2)[3]. Three atmospheric conditions were modelled by Spectrum (2010b).

- *Calm (neutral) conditions:* 20^{o}C, 70% relative humidity (RH), no wind and -1^{o}C/100m vertical temperature gradient. Modelled for all scenarios.

[3] Inversion conditions have not been considered for Scenario 1b as these activities would only be undertaken between 7:00am to 6:00pm when inversion conditions are not likely to occur.

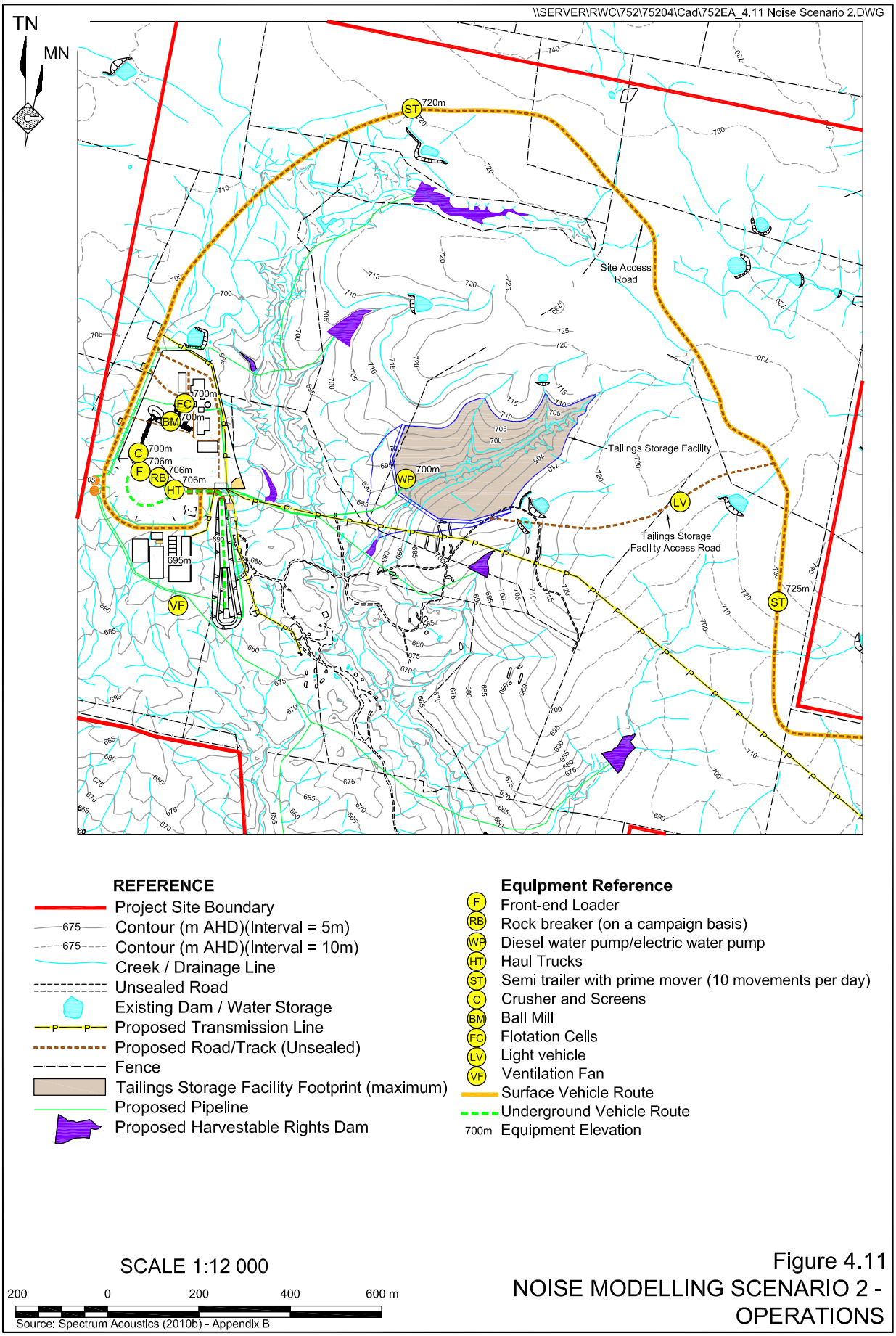


Figure 4.11
NOISE MODELLING SCENARIO 2 - OPERATIONS

- *Inversion conditions:* 5°C, 85% RH, inversion strengths of +4°C/100m. Modelled for Scenarios 1a and 2 only.
- *North-northwest winds:* 5°C, 80% RH, wind speed 3m/s from the north-northwest.

As the Proponent intends to operate the Project 24-hours per day, the potential for the Project to disturb sleep exists. As a result, Spectrum (2010b) modelled impact noise under the noise-enhancing atmospheric conditions discussed above using the sound power levels presented in *Appendix A* of Spectrum (2010b).

4.2.4.2 Road Traffic Assessment

Traffic generated by the Project on public roads would be of an intermittent rather than constant nature. As a result, the methodology described in the document *Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974* published by the US Environmental Protection Agency was used to determine the road traffic noise. The equation used in that assessment assumes a triangular noise signal and as presented as Equation 1 of Spectrum (2010b).

4.2.4.3 Blasting Assessment

Blast overpressure and ground vibration levels have been predicted by Spectrum (2010b) using the following standard equations sourced from the United States Bureau of Mines.

Blast Overpressure

$OP = 165 - 24(\log_{10}(D) - 0.3 \log_{10}(Q))$ [dB(L)]

Where:

- D is distance from the blast to the assessment point (m); and
- Q is the weight of explosive per delay (kg).

Spectrum (2010b) reports that analysis of 12 months of blast data for a coal mine in the Hunter Valley has shown this equation underestimates overpressure levels by up to 3dB(L) for small blasts (Maximum Instantaneous Change (MIC) 100kg to 400kg) and over-estimate by 1dB(L) for larger blasts (MIC >400kg). Given the small MIC values likely to be necessary for the Project, a plus 3dB(L) correction has been applied for the Longwall Project.

Blast Vibration

$$PPV = 500\left(\frac{D}{Q^{0.5}}\right)^{-1.6} \quad \text{, mm/s} \quad \text{(for hard rock)}$$

Where:

- PVP is peak particle vibration;
- D is distance from the blast to the assessment point (m); and
- Q is the weight of explosive per delay (kg).

4.2.5 Management and Mitigation Measures

A preliminary acoustic assessment (Spectrum, 2010a) identified that under some meteorological conditions, the proposed operation of the Project would be likely to generate noise levels above the nominated intrusiveness noise criteria (35dB(A)). In order to reduce (and maintain) the predicted noise levels experienced at surrounding residences to levels complying with the noise criteria, the following management and mitigation measures would be adopted.

Construction Noise Controls

- Ensure all bulk earthworks strictly adhere to standard construction hours of operation, namely 7:00am to 6:00pm.
- Maintain the on-site road network to limit body noise from empty trucks travelling on internal roads.
- Maintain an open dialogue with the surrounding community and neighbours to ensure any concerns over noise or vibration are addressed.

Operational Noise Controls

- Place and operate the crusher within an enclosure engineered to achieve a noise reduction of at least 12dB.
- Ensure that the grinding circuit is rubber lined.
- Place and operate the final ventilation fan at least 10m below ground level rather than at the surface. The interim ventilation fan would be placed within the deepest section of the box cut until the final fan is commissioned. The interim fan may be retained as a backup ventilation system in the event of failure of the final fan.
- Construct a noise bund of at least 5m high along the southern and western edges of the ROM pad.
- Undertake noise monitoring at the residences most likely to be affected by noise generated by the Project.
- Prepare a *Noise Management Plan* prior to the commencement of mining activities which would incorporate the specific details of all noise controls and provide measures to address noise criteria exceedances and/or complaints should they occur.

Transport Noise Controls and Operational Procedures

- Ensure strict adherence to hours of operation, identified in **Table 2.6**.
- Ensure, where practicable, that all project employees and contractors enter and exit the Project Site in a courteous manner and without causing undue traffic noise.
- Prepare and implement a Drivers Code of Conduct and ensure that all drivers of heavy vehicles that regularly access the Project Site sign and comply with the code.

Blasting Controls

- Ensure that all blasts are designed by a suitably qualified and experienced blasting engineer or shotfirer and that each blast has an MIC of no greater than 105kg (until such time that a site law is developed which will allow for more precise predictions of blast emissions).

Other Noise and Vibration Controls

In addition to the design and operational features of the Project, the Proponent would apply the following noise controls.

- Ensure that equipment with lower sound power levels is used in preference to more noisy equipment.
- Maintain an open dialogue with the surrounding community and neighbours to ensure any concerns over noise or vibration are addressed.

4.2.6 Assessment of Impacts

4.2.6.1 Site Establishment Noise (Scenarios 1a and 1b)

Table 4.8 presents the predicted noise levels during site establishment at selected residential receivers surrounding the Project Site for Scenarios 1a and 1b. It is noted that only residences expected to receive construction noise levels greater than or equal to 30dB(A) are presented in **Table 4.8**. Spectrum, (2010b) presents assessment results for all residences surrounding the Project Site. The construction noise criteria and differential between the predicted noise level and the construction noise criteria for standard hours of operations is also presented in **Table 4.8**.

With the implementation of the nominated noise controls, compliance with the construction noise criteria is predicted by Spectrum (2010b).

4.2.6.2 Operational Noise (Scenario 2)

Table 4.9 presents the predicted operational noise levels at selected residential receivers surrounding the Project Site under calm and inversion conditions. It is noted that only residences expected to receive operational noise levels greater than or equal to 30dB(A) are presented in **Table 4.9**. Spectrum, (2010b) presents assessment results for all residences surrounding the Project Site. The operational noise criterion and differential between the predicted noise level and the operational noise criterion are also presented in **Table 4.9**.

Finally **Figures 4.12** and **4.13** present operational noise contours generated by the noise modelling of Spectrum (2010b) for calm and inversion conditions. It is noted that these contours are presented to provide the reader with a general appreciation of the likely noise environment during the operations stage of the Project, with the values presented in **Table 4.9** considered the definitive predictions for assessment purposes.

Table 4.8
Predicted Site Establishment Noise Levels

Residence[1]	Criterion dB(A),$L_{eq(15min)}$	Predicted level dB(A),$L_{eq(15min)}$			Differential dB
		Neutral	Inversion	NNW Wind	
Scenario 1a - 24-hour Site Establishment - Excluding Bulk Earthworks					
R1	35	<20	30	28	-5
R27	35	21	30	28	-5
R31	35	23	35	35	0
R32	35	21	31	29	-4
R33	35	20	30	28	-5
R107	35	26	33	28	-2
Scenario 1b - Site Establishment and Initial Mine Development - Bulk Earthworks					
R1	35	31	-	-	-4
R2	35	30	-	-	-5
R5	35	30	-	-	-5
R6	35	30	-	-	-5
R7	35	30	-	-	-5
R10	35	30	-	-	-5
R11	35	31	-	-	-4
R12	35	32	-	-	-3
R13	35	30	-	-	-5
R14	35	30	-	-	-5
R15	35	32	-	-	-3
R16	35	30	-	-	-5
R17	35	31	-	-	-4
R18	35	31	-	-	-4
R19	35	30	-	-	-5
R20	35	30	-	-	-5
R21	35	30	-	-	-5
R22	35	30	-	-	-5
R23	35	31	-	-	-4
R24	35	31	-	-	-4
R25	35	31	-	-	-4
R26	35	32	-	-	-3
R27	35	34	-	-	-1
R28	35	32	-	-	-3
R30	35	30	-	-	-5
R31	35	35	-	-	0
R32	35	33	-	-	-2
R33	35	32	-	-	-3
R34	35	30	-	-	-5
R58	35	30	-	-	-5
R59	35	30	-	-	-5
R60	35	30	-	-	-5
R107	35	32	-	-	-3

Note 1: For Scenario 1b, only those residences predicted to experience noise levels greater than or equal to 30 dB(A) are shown.
Source: Modified after Spectrum (2010b) – Tables 4 and 5

Table 4.9
Predicted Operational Noise Levels at Non-Project-Related Residences

Residence	Criterion dB(A),$L_{10(15min)}$	Predicted level dB(A),$L_{eq(15min)}$			Minimum Differential dB
		Calm	Inversion	NNW Wind	
R2	35	20	30	30	-5
R5	35	20	31	29	-4
R6	35	20	30	30	-5
R7	35	20	30	30	-5
R11	35	21	32	32	-3
R12	35	22	32	32	-3
R13	35	20	32	31	-3
R14	35	20	31	30	-4
R15	35	22	33	31	-2
R16	35	20	31	31	-4
R17	35	21	31	31	-4
R18	35	21	32	32	-3
R19	35	20	31	31	-4
R20	35	20	31	31	-4
R21	35	20	30	31	-5
R22	35	20	31	31	-4
R23	35	21	31	31	-4
R24	35	21	32	32	-3
R25	35	21	31	31	-4
R26	35	22	31	32	-3
R27	35	24	33	34	-1
R28	35	22	31	32	-3
R31	35	25	31	31	-4
R32	35	23	31	32	-3
R33	35	22	30	30	-5
R34	35	<20	31	<20	-4
R59	35	20	30	30	-5
R60	35	20	30	30	-5
R62	35	<20	30	30	-5
R63	35	<20	30	29	-5
R70	35	<20	30	30	-5
R71	35	20	30	30	-5
R72	35	20	30	30	-5
R93	35	<20	30	30	-5
R94	35	<20	30	30	-5
R107	35	27	33	27	-2

Note 1: For Scenario 1b, only those residences predicted to experience noise levels greater than or equal to 30 dB(A) under inversion conditions are shown.
Source: Modified after Spectrum (2010b) – Table 6

4.2.6.3 Sleep Disturbance Assessment

Predicted sleep disturbance (maximum) noise levels at all non-project related residences under worst case night time conditions (temperature inversion) are shown in **Table 4.10** which also includes the "differentials" between the predicted levels and the noise criterion. It is noted that only residences expected to receive sleep disturbance noise levels greater than or equal to 40dB(A) are presented in **Table 4.10**. Spectrum, (2010b) presents assessment results for all residences surrounding the Project Site. With the implementation of the nominated noise controls, compliance with the operational noise criteria is predicted by Spectrum, (2010b). The maximum predicted $L_{10(15min)}$ noise level under temperature inversion conditions is expected to be 33dB(A) at Residences 107 and 27.

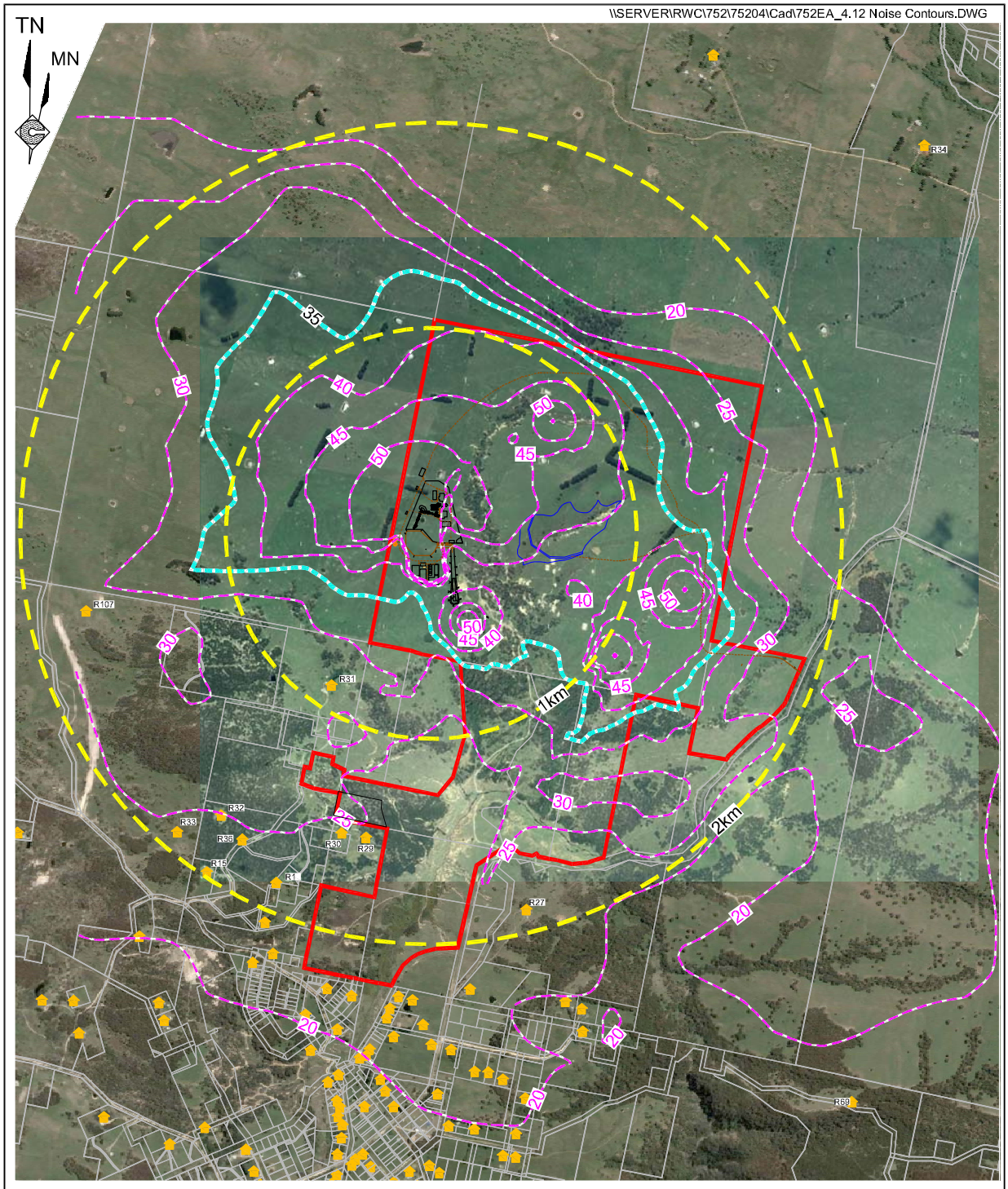


Figure 4.12
PREDICTED OPERATIONAL NOISE LEVELS - CALM

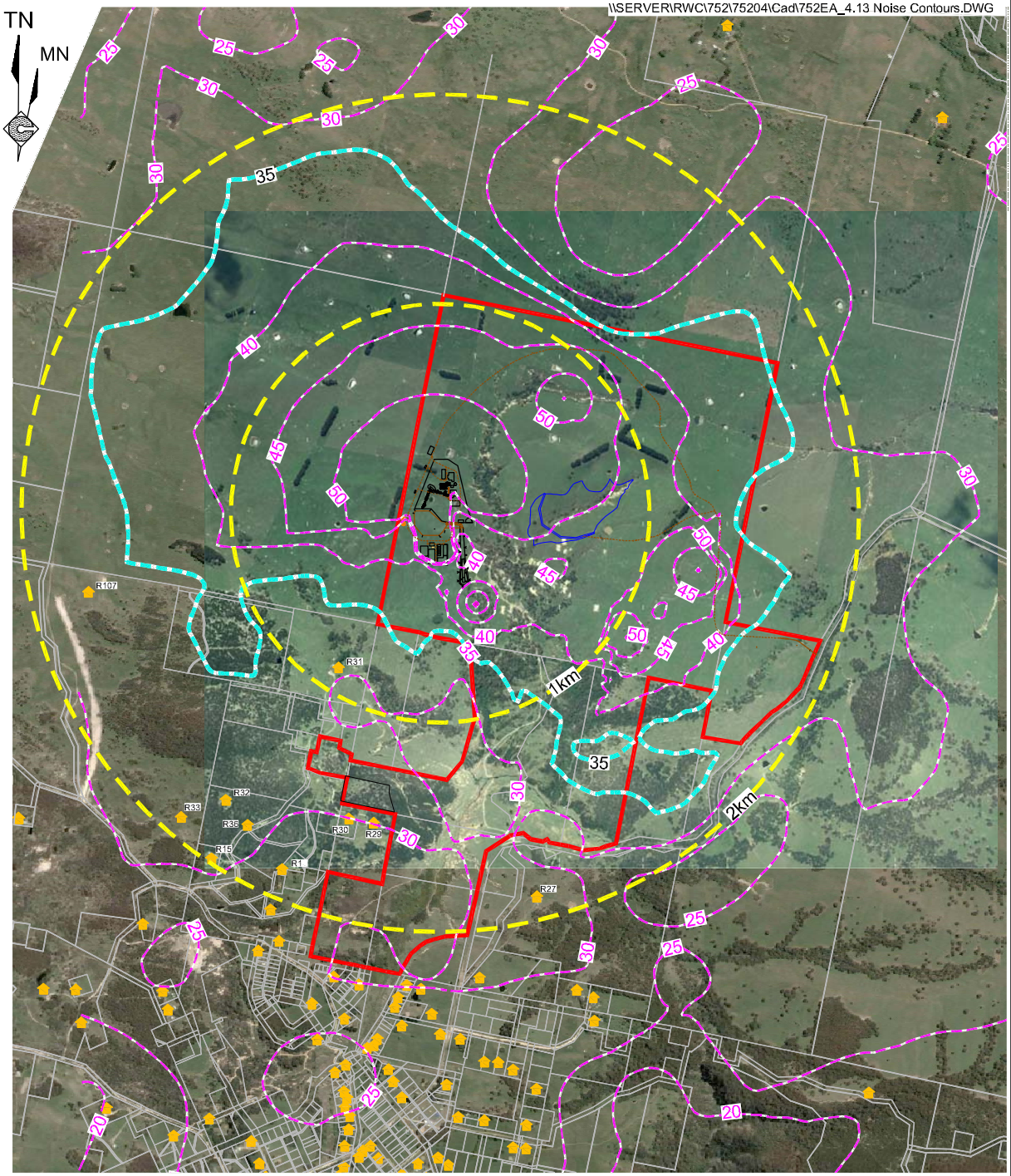


Figure 4.13
PREDICTED OPERATIONAL NOISE LEVELS - TEMPERATURE INVERSION

With the implementation of the nominated noise controls compliance with the sleep-disturbance (maximum) noise criteria is predicted by Spectrum, (2010b). The maximum predicted $L_{A1(1minute)}$ noise level is expected to be 42dB(A) at a number of residences.

Table 4.10
Predicted Maximum $L_{A1(1\text{-}minute)}$ Operational Noise Levels

Residence	Criterion dB(A),L_{max}	Predicted level dB(A),L_{max}	Differential dB
R2	45	40	-5
R5	45	40	-5
R6	45	40	-5
R7	45	40	-5
R10	45	40	-5
R11	45	41	-4
R12	45	41	-4
R13	45	40	-4
R14	45	40	-5
R15	45	42	-3
R16	45	41	-4
R17	45	41	-4
R18	45	42	-3
R19	45	40	-5
R20	45	41	-4
R21	45	40	-5
R22	45	41	-4
R23	45	42	-3
R24	45	42	-3
R25	45	41	-4
R26	45	42	-3
R27	45	42	-3
R28	45	42	-3
R31	45	42	-3
R32	45	41	-4
R33	45	40	-5
R34	45	41	-4
R49	45	40	-5
R53	45	40	-5
R54	45	40	-5
R55	45	41	-4
R56	45	40	-5
R57	45	40	-5
R59	45	41	-4
R60	45	40	-5
R62	45	40	-5
R63	45	41	-4
R64	45	40	-5
R68	45	40	-5
R70	45	40	-5
R71	45	40	-5
R72	45	41	-4
R93	45	40	-5
R107	45	42	-3

Source: Modified after Spectrum (2010b) – Table 7

4.2.6.4 Road Traffic Noise

All roads to be used by Project-related traffic currently carry very low volumes of traffic (less than 1 500 vehicles per day and a maximum hourly traffic volume of up to 115), with proportion of heavy vehicles around 10% (TUP, 2010). Spectrum (2010b) note that these levels of traffic indicate existing traffic noise levels are well below the traffic noise criteria identified in Section 4.2.3.5 at any residence more than 15m from the road edge.

Spectrum (2010b) have calculated, using the methodology in Section 4.2.4.2, that the contribution of 10 heavy vehicle movements (the maximum hourly increase in traffic likely to be generated by the Project (TUP, 2010), travelling at 80km/hr, would provide for a traffic noise contribution of 50dB(A),$L_{eq(1\ hour)}$[4]. This is 5dB below the night time traffic noise criterion and 10dB below the daytime criterion. As a result, the Project would not result in the traffic noise levels received at residences along the transport route exceeding the nominated criteria.

4.2.6.5 Blasting Assessment

Based on the formulae presented in Section 4.2.4.3 and a minimum distance from the box cut to the closest non-Project-related residence (Residence R31) of 750m, an instantaneous charge of 105kg would result air blast overpressure emissions of approximately 115dB(L) or equal to the blasting criterion (Spectrum, 2010b). The calculated peak ground vibration level for an instantaneous charge of 105kg at Residence R31 is 0.5mm/s. The Proponent notes that this is one-tenth of the 5mm/s exceedance criterion for ground vibration.

Once construction of the box cut is complete, blasting would be required within the decline and Dargues Reef mine. As this blasting would be underground, airblast overpressure impacts would not be generated. As a result, ground vibration-related impacts would be the only blasting-related impact. As the instantaneous charge that would be used during underground mining operations would be less than 105kg and the above assessment concluded that an instantaneous charge of 105kg would result in ground vibration levels that would be one-tenth of the relevant criteria, the Proponent contends that underground blasting impacts would be significantly less than the relevant criteria.

Finally, as blast monitoring information is collected, a blasting "site law" for the Project would be developed allowing for more precise predictions of blasting impacts. This may allow for blasts with maximum instantaneous charges of more than 105kg.

4.2.7 Monitoring

The Proponent would implement a *Noise and Vibration Monitoring Program* prior to commencement of site establishment operations. Results of the monitoring program would be presented in the *Annual Environmental Management Report* that would be prepared for the Project to ensure that noise and vibration impacts associated with the Project are managed appropriately. The monitoring program, which would be developed in consultation with the Department of Planning, Department of Environment, Climate Change and Water and the local community, would include the following elements.

- Noise compliance monitoring would be undertaken during both the daytime and night time periods during the site establishment phase.

[4] At a nominal distance of 20m from the road edge.

- Routine noise compliance monitoring would be conducted on a quarterly basis during the first two years of the operational stage of the Project. The frequency of ongoing monitoring would be determined based.
- Suitable monitoring locations may include R107, R31, R30, R27 and R34 which are the closest locations surrounding the Project Site and compliance at these locations would imply compliance at more distance receivers.

4.3 ECOLOGY

4.3.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Ecology** – *including:*

- *accurate estimates of any vegetation disturbance associated with the project;*
- *impacts on threatened species, populations or ecological communities; critical habitats; and native vegetation generally;*
- *a detailed description of the measures that would be implemented to maintain or improve the regional biodiversity values in the medium to long term."*

Based on the risk assessment undertaken for the Project (see Section 3.3), specific ecology-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Loss of, or alteration to, existing habitats.
- Direct adverse impact on threatened species, populations or endangered ecological communities.
- Local or regional reduction in distribution of threatened species, populations or endangered ecological communities.
- Possible local extinction of threatened species, populations or endangered ecological communities.
- Local or regional reduction in distribution of threatened species, populations or endangered ecological communities.
- Possible local extinction of threatened species, populations or endangered ecological communities.

The Ecology Assessment was undertaken by Gaia Research Pty Ltd (Gaia). This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 2 (Volume 1) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "Gaia (2010)".

The Ecology Assessment was managed by Mr Garry Daly (BSc, GradDipEd) of Gaia. Mr Daly holds the following licences.

- Scientific Investigation Licence No. S10470. Animal Research Authority Issued by the Director General of NSW Agriculture No. 05/2371 to conduct fauna surveys utilising a variety of techniques.

Mr Daly was assisted by the following individuals.

- Mr Greg Stone (BAppSc, AdvDipLandMgt, AssDipLandMgt) – flora specialist.
- Ms Alison Rowell (BSc) – grassland specialist.
- Mr Barry Virtue (BA) – bird specialist.
- Mr Brian James (BEd) – bird specialist.

Curriculum vitae for each of the above individuals are presented in Appendix 5 of Gaia (2010).

4.3.2 Regional Flora and Fauna

Gaia (2010) undertook a search of an area within 5km of the Project Site using the following databases to identify listed species and ecological communities that may occur within the vicinity of the Project Site.

- NPWS Wildlife Atlas, accessed 30 April 2010.
- NPWS Flora Atlas, accessed 30 April 2010.
- DEWHA Protected Matters Search Tool, accessed 21 June 2010.
- PlantNet/Flora Online, accessed 14 June 2010.

In addition, DECCW provided a list of species required to be assessed during the Ecology Assessment and Mr Daly included further species based on his experience. As a result, **Table 4.11** presents those listed species and ecological communities identified as having the potential to occur within and surrounding the Project Site.

Table 4.11
Listed Species and Ecological Communities

Threatened Species / Ecological Community	Scientific Name	TSC Act Schedule[1]	EPBC Act[1,2]	DECCW DGRs	Gaia Research
Fauna Species					
Koala	*Phascolarctos cinereus*	2		x	
Squirrel Glider	*Petaurus norfolcensis*	2		x	
Yellow-bellied Glider	*Petaurus australis*	2		x	
Spotted-tailed Quoll	*Dasyurus maculatus*	2		x	
White-footed Dunnart	*Sminthopsis leucopus*	2		x	
Eastern Pygmy Possum	*Cercartetus nanus*	2		x	
Grey-headed Flying Fox	*Pteropus poliocephalus*	2	V		
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	2		x	
Eastern Bentwing Bat	*Miniopterus schreibersii oceanensis*	2		x	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	2		x	
Golden-tipped Bat	*Kerivoula papuensis*	2		x	
Large-footed Myotis	*Myotis macropus*	2		x	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	2		x	
Smoky Mouse	*Pseudomys fumeus*	1	E		
Australian Painted Snipe	*Rostratula australis*	1	V		
Little Eagle	*Hieraaetus morphnoides*	2		x	
Square-tailed Kite	*Lophoictina isura*	2		x	
Brown Treecreeper	*Climacteris picumnus victoriae*	2		x	
Regent Honeyeater	*Xanthomyza phrygia*	1	E		

Table 4.11 (Cont)
Listed Species and Ecological Communities

Threatened Species / Ecological Community	Scientific Name	TSC Act Schedule[1]	EPBC Act[1,2]	DECCW DGRs	Gaia Research
Fauna Species					
Diamond Firetail	*Stagonopleura guttata*	2		x	
Hooded Robin	*Melanodryas cucullata cucullata*	2		x	
Scarlet Robin	*Petroica boodang*	2		x	
Flame Robin	*Petroica phoenicea*	2		x	
Pink Robin	*Petroica rodinogaster*	2		x	
Barking Owl	*Ninox connivens*	2		x	
Powerful Owl	*Ninox strenua*	2		x	
Gang-gang Cockatoo	*Callocephalon fimbriatum*	2		x	x
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	2		x	x
Swift Parrot	*Lathanus discolour*	1	E		
Striped Legless Lizard	*Delma impar*	2	V	x	
Broad-headed Snake	*Hoplocephalus bungaroides*	1	V		
Giant Burrowing Frog	*Heleioporus australiacus*	2	V	x	
Littlejohn's Tree Frog	*Litoria littlejohni*	2	V	x	
Southern Bell Frog	*Litoria raniformis*	1	V	x	
Macquarie Perch	*Macquaria australasica*		E		
Australian Graying	*Prototroctes maraena*		V		
Flora Species					
Small-leaved Gum	*Eucalyptus parvula*	1		x	
Araluen Gum	*Eucalyptus kartzoffiana*	1	V	x	
Mauve Burr Daisy	*Calotis glandulosa*	2			
Michelago Parrot-Pea	*Dillwynnia glaucula*	1		x	
Monaro Golden Daisy	*Rutidosis leiolepis*	2		x	
Austral Toadflax	*Thesium australe*		V	x	
Araluen Zieria	*Zieria adenophora*	1A		x	
Dense Cord-rush	*Baloskion longipes*	2		x	
Hoary Sunray	*Leucochrysum albicans var. tricolor*		E		
Tangled Bedstraw	*Gallium australe*	1		x	
Thick-lipped Spider-orchid	*Caladenia tessellata*		V		
Endangered Ecological Communities					
Majors Creek Leek Orchid	*Prasophyllum sp. Majors Creek*	1A		x	
Pale Golden Moths	*Diuris ochroma*	1			
Small Snake Orchid	*Diuris pedunculata*	1			
Natural Temperate Grasslands of the Southern Tablelands (NSW and ACT) (EPBC community)			E		
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland			CE		

Note 1: TSC Act = Threatened Species Conservation Act 1995,
EPBC Act = Environment Protection & Biodiversity Conservation Act 1999
Note 2: V = Vulnerable, E = Endangered, CE = Critically Endangered.
Source: Gaia (2010) – Table 2

4.3.3 Survey Methodology

4.3.3.1 Introduction and Survey Area

The survey methodology used during the Ecology Assessment complies with the requirements of:

- *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (Working draft)*, prepared by the Department of Environment and Conservation (2004); and
- *Draft Guidelines for Threatened Species Assessment* prepared by the (then) Department of Environment and Conservation and Department of Primary Industries (2005).

The survey area for the Ecology Assessment included the entire Project Site. As a result, the survey area and Project Site are coincident with the Project Site and are referred to hereafter as the Project Site.

4.3.3.2 Flora Survey Methodology

The flora surveys were undertaken on:

- 14 October 2009;
- 25 January 2010;
- 3 May 2010;
- 4 June 2010; and
- 9 June 2010.

A preliminary survey was initially undertaken to determine the major vegetation types present within the Project Site and the distribution of each. Sites representative of these vegetation types were selected for further surveying using 100m transects and 20 x 20m quadrats. **Figure 4.14** presents the location of the transects and quadrats. In addition, searches for plant species of conservation significance were then carried out in potential habitat using the random meander technique.

Finally, it is noted that it was agreed with the DECCW during an onsite meeting on 7 May 2010 that pastures/grasslands within the Project Site would be classified either as:

- Native Grassland;
- Native-dominated Pasture; or
- Exotic-dominated Pasture.

Section 3.2.3 of Gaia (2010) provides a detailed description of classification of each of those classes of vegetation.

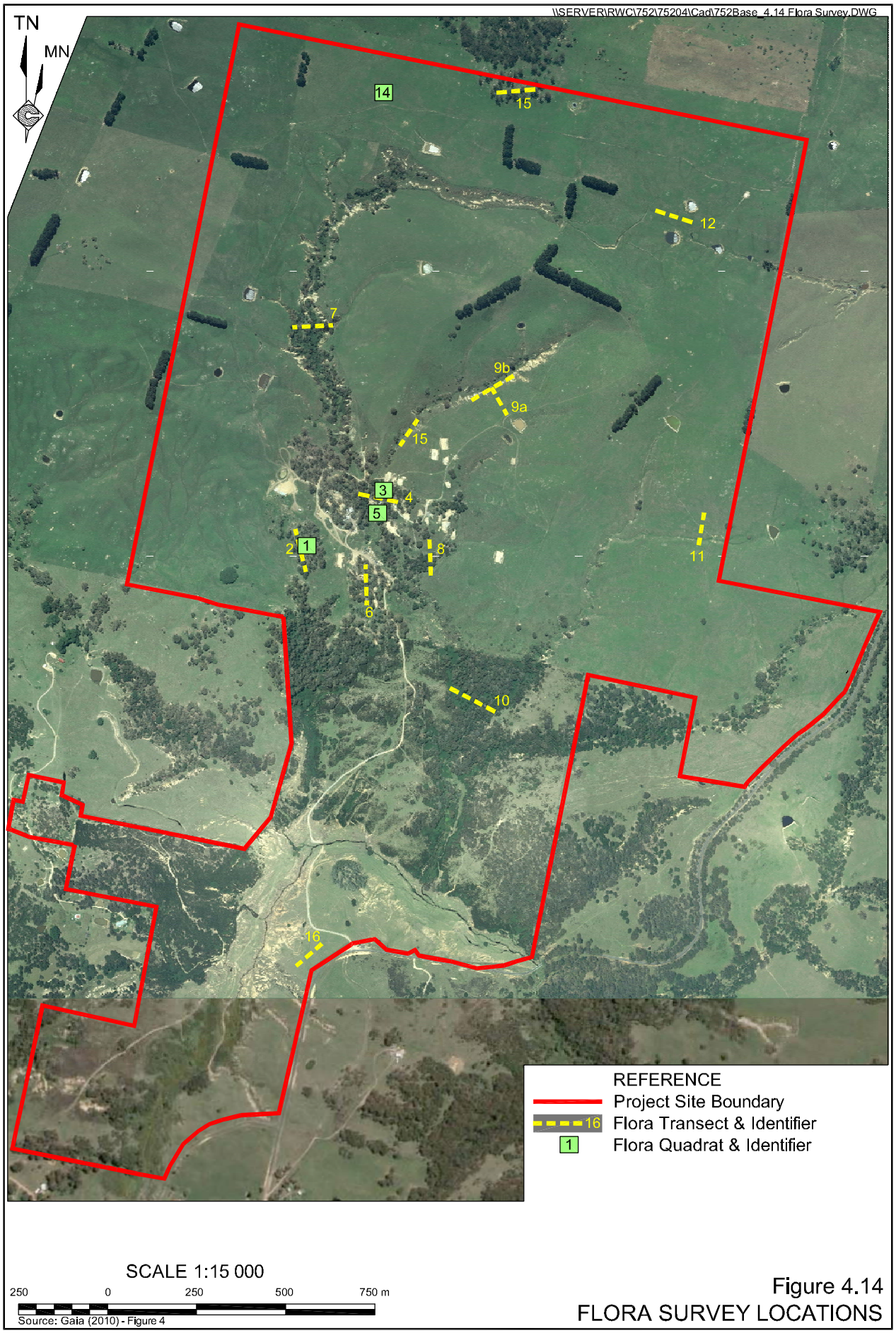


Figure 4.14
FLORA SURVEY LOCATIONS

4.3.3.3 Fauna Survey Methodology

The fauna surveys were undertaken:

- on 19 November 2007;
- from 12 to 15 October 2009; and
- from 1 to 4 February 2010.

An initial preliminary survey was undertaken to identify habitat types. Following this, the following surveys were undertaken. It is noted that a detailed description of the fauna survey methodology is presented in Section 3.3 of Gaia (2010). **Figure 4.15** presents each of the survey locations.

- Elliot and cage trapping - two 100m x 200m transects were established within an area of Ribbon Gum – Snow Gum Open Forest (Ribbon Gum Forest) (see Section 4.3.4.3) adjacent to Spring Creek. These sites were surveyed in October 2009 and in February 2010. Each transect consisted of 10 Elliot Traps (type A) and two 20cm x 20cm x 55cm cage traps.
- Harp trapping – six harp trapping locations were established in sections of the Project Site likely to be utilised by bats.
- Diurnal bird census – diurnal bird censuses were undertaken for 20 minutes along each Elliot and cage trapping transect. In addition, smaller surveys were undertaken at a further three locations within the Project Site. Birds were identified by their species-specific calls and by direct observation with the aid of binoculars. Birds detected outside the surveyed transects were also recorded.
- Foot-based spotlighting - Spotlighting was conducted for arboreal mammals for 40 minutes within the Ribbon Gum Forest. Spotlighting was conducted with the aid of 50 watt/12 volt lights and involved the identification of animals by direct observation and the recognition of species-specific calls.
- Nocturnal playback – The calls of a standard suite of species were broadcast from the start of one of the Elliott and cage trap transects through a car stereo system from 7:43pm to 8:00pm on 1 February 2010. This location was selected as it was on a ridge and within remnant mature forest. No spotlights were operated during the playback but the immediate area was spotlit after the cessation of the playback.
- Diurnal herpetofauna census - The herpetofauna census involved two 60 minute searches by two people along Elliot trapping lines on 14 October 2009 between 8:55am and 9:25am and repeated on 3 February 2010 between 12:27pm and 12:57pm.
- Nocturnal streamside search - Amphibian searches were conducted beside Majors Creek for 30 minutes duration with the aid of a 50 watt/12 volt spotlight from 8:55pm to 9:25pm on the 2 February 2010.

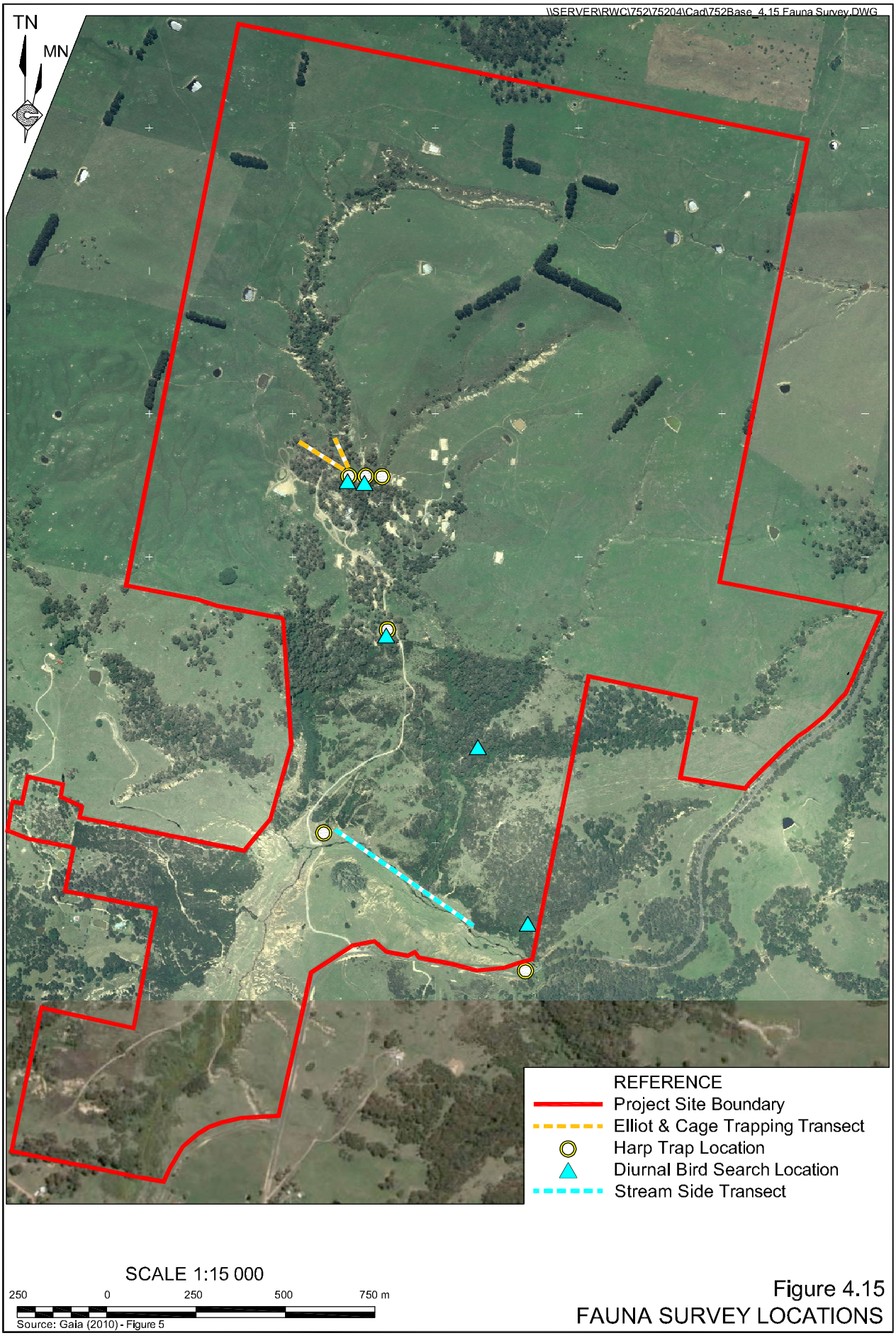


Figure 4.15
FAUNA SURVEY LOCATIONS

- Targeted surveys were conducted for the following species using the following methods.
  - Yellow-bellied Gliders *Petaurus australis* - searching for incised Ribbon Gum and Narrow-leaved Pepermint during rolling foot censuses.
  - Large forest owls - searches were made of the base of all hollow-bearing trees for 'white-wash'.
  - Koala - searches were made for Koala scats at the base of large gum trees. In addition, scratches on Ribbon Gum were examined as Koala make many small scratch marks on the trees that they climb as opposed to large scratch marks made by the Common Brushtail Possum and or Lace Monitor.
  - Striped Legless Lizard – diurnal searches involving lifting of rocks and fallen logs.
  - Spotted-tailed Quoll – searches were made for latrine sites along Majors Creek at sites that had exposed rock outcrops.
  - Gang-gang Cockatoo - searches were made of hollow-bearing trees for nesting individuals.
- Incidental observations - further incidental observations of animals were made based on visual identification of animal, remains, other features or call recognition.

Gaia (2010) state that the fauna survey methodology and effort are considered adequate to detect threatened species of fauna. It is noted that the survey methodology did not, in all cases, comply with the recommended methodology provided in the Environmental Assessment Requirements provided by DECCW on 1 April 2010. Section 3.4 of Gaia (2010) provides a detailed description of where the actual survey methodology differed from that recommended by the DECCW and justifies that divergence.

4.3.4 Project Site Flora and Fauna

4.3.4.1 Introduction

This sub-section presents an overview of the species and vegetation communities identified within the Project Site. It is noted that this sub-section focuses principally on listed species and communities and a complete list of all species identified is presented in Sections 4.4 and 4.5 and Appendices 2, 3 and 4 of Gaia (2010).

4.3.4.2 Flora Species Identified

A total of 100 species of native and 38 species exotic of plant were identified within the Project Site. No species listed under the *Threatened Species Conservation Act 1995* (TSC Act) or *Environment Protection and Biodiversity Conservation Act, 1999* (EPBC Act) were identified.

It is noted, however, that potential habitat for the Major's Creek Leek Orchid was identified within the Project Site (**Figure 4.16**). The habitat is dominated by Swamp Gum with a grassy understorey of native and exotic species. This site was first identified in May 2010 and opportunity to inspect the area during the orchid's October to December flowering season has not been possible. Gaia (2010) state that this species would be unlikely to be found elsewhere within the Project Site.

4.3.4.3 Vegetation Communities Identified

The Ecology Assessment identified 10 vegetation communities within the Project Site. The following provides a brief description of each community and **Figure 4.16** presents the distribution of each. Further details are presented in Section 4.4.4 of Gaia (2010). The classification of each community is in accordance with Tozer *et al.* (2006). It is noted that there are significant similarities between some communities and that the location of boundaries between those communities are subjective.

Community 1 - Ribbon Gum - Snow Gum Grassy Open Forest

The remnant vegetation within the Project Site may be classified as Ribbon Gum - Snow Gum Grassy Open Forest on flats and undulating hills of the eastern tableland (Ribbon Gum Forest).

The overstorey is dominated by Ribbon Gum and Narrow-leaved Peppermint with occasional Snow Gum. Many trees are mature and support hollows. The understorey is typically sparse.

Community 2 - Fragmented Ribbon Gum - Snow Gum Grassy Open Forest

This community represents a degraded and disjunct form of Ribbon Gum - Snow Gum Grassy Open Forest described above.

Community 3 - Woody Weeds Shrubland

This community consists largely of Broom and Blackberry and is common in the southern sections of the Project Site on land newly acquired by the Proponent. This community consists of a dense shrub layer to 2m and commonly occurs in highly disturbed areas but can also occur in untreated areas as the shrub layer in Ribbon Gum Forest and or Black wattle regrowth. It is noted that weed management programs undertaken by the Proponent in the northern section of the Project Site have removed most of this community from that section of the Project Site.

Community 4 - Regenerating Wattles

Patches of Black Wattle and Blackwood occur along the gullies and on the edges of the Ribbon Gum Forest and in areas of regeneration. Vegetation within the Regenerating Wattles Community is up to 5m high and often supports Broom and/or Blackberry in the shrublayer. The groundcover often consists of exotic grasses, such as Rye Grass.

Community 5 - Exotic Vegetation

This community consists of stands of poplars and pines planted as wind breaks. The groundcover consists of exotic grasses, such as Rye Grass.

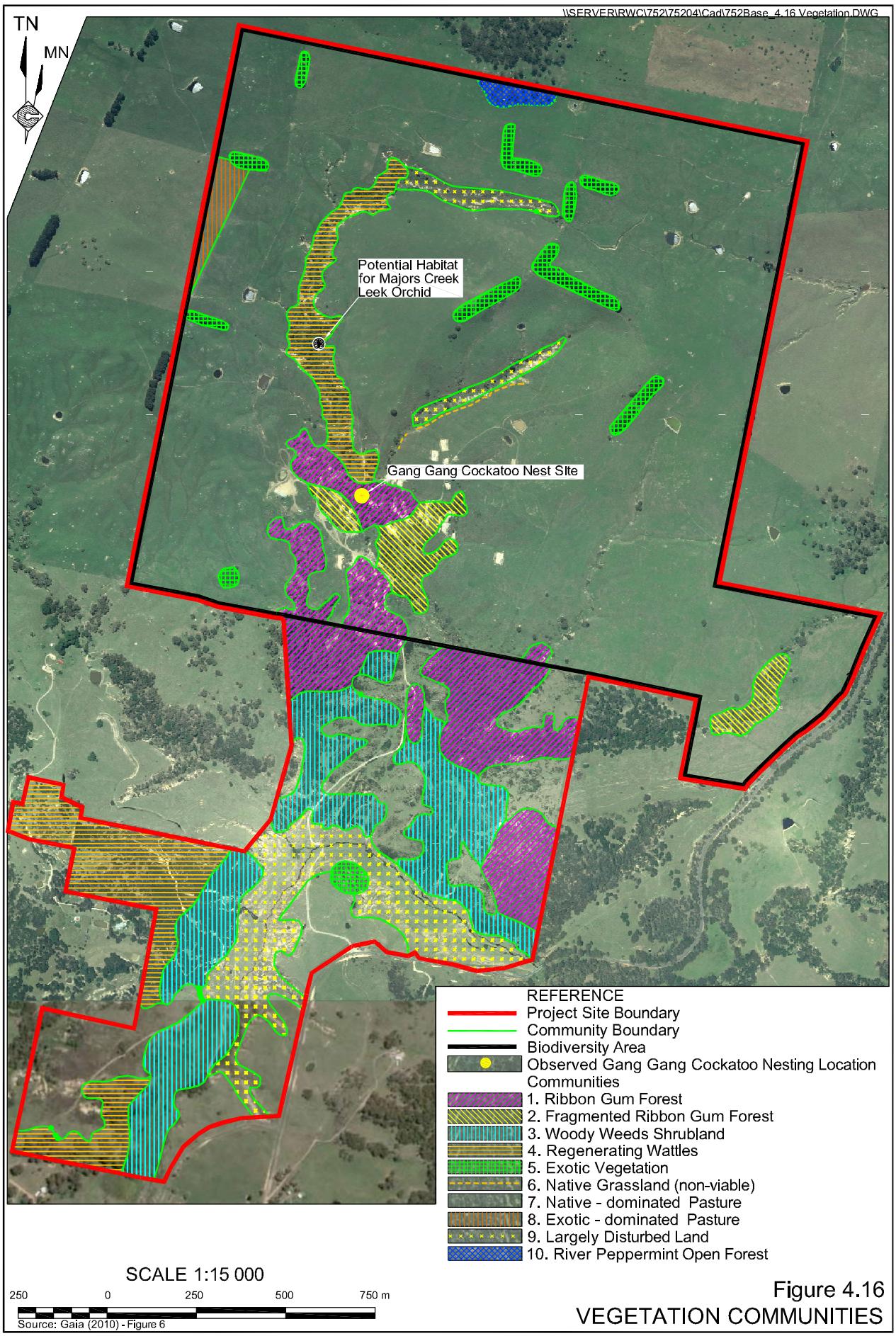


Figure 4.16
VEGETATION COMMUNITIES

Community 6 – Native Grassland

Native Grassland or Natural Temperate Grassland is present at one location within the Project Site as an interrupted strip of less than 5m width present above an eroding gully (**Figure 4.16**). The community is diverse and includes mostly grassland species such as Kangaroo Grass and Spear Grass suggesting that the community may have been within a woodland / grassland mosaic.

The total area of the Native Grassland is small and Gaia (2010) consider that the community is not viable due to the fact that it is an interrupted, elongate strip at the top of an eroding slope.

Community 7 – Native-dominated Pasture

The majority of the Project Site supports Native-dominated Pasture of low-diversity with species such as Weeping Grass and Snow Grass in association with exotic pasture species. It is noted that this community forms a continuum with the Native Grassland Community and the Exotic-dominated Pasture and that sections with higher and lower species diversity were observed.

Community 8 Exotic-dominated Pasture

Areas of Exotic-dominated Pasture include common pasture species such as Phalaris, Clovers and Ryegrass with a very low incidence of native species.

Community 9 – Largely Disturbed Land

Past mining activities and subsequent erosion have resulted in areas of disturbed land, generally associated with creeks and gullies. These areas are either devoid of vegetation or support a sparse vegetative cover.

Community 10 – River Peppermint Open Forest

A small remnant of open forest dominated by River Peppermint occurs adjacent to the northern boundary of the Project Site. The understorey is dominated by Weeping Grass with weeds and exotic pasture species.

Endangered Ecological Communities

Gaia (2010) state that none of the identified vegetation communities conform with the classification of any vegetation community classified as an Endangered Ecological Community (EEC) under the TSC Act.

It is noted, however, that a the NSW Scientific Committee has made a Preliminary Determination to support a proposal to list the Tablelands Frost Hollow Grassy Woodlands in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South western Slopes Bioregions as an EEC. Gaia (2010) state that the Ribbon Gum - Snow Gum grassy open forest has an affinity with that community. However, it is also noted that the preliminary determination waon public exhibition during the final stages of preparation of this document and that no date has been set for the making of a Final Determination.

Finally, Gaia (2010) note that the Native Grassland community has an affinity with the Natural Temperate Grasslands of the Southern Tablelands listed and an EEC under the Commonwealth EPBC Act.

4.3.4.4 Fauna Species Identified

The Ecology Assessment identified 151 species of vertebrate including two fish, seven frog, seven reptile, 117 bird and 18 mammal species within the Project Site. **Table 4.12** presents a summary of the species identified. A complete list of all species identified is included in Appendix 2 of Gaia (2010).

Table 4.12
Summary of Fauna Detected During the Survey

Vertebrate group	Species detected during survey
Fish	2
Frog	7
Reptile	7
Bird	117 (six exotic)
Mammal - non flying	11 (3 exotic)
Mammal - bats	7
Total	**151**
Source: Gaia (2010) – Table 7	

Table 4.13 presents the TSC Act or EPBC Act listed species observed within the Project Site. It is noted that the Gang-gang Cockatoo was observed to nest within the Project Site during a survey on 19 November 2007 and has been observed by employees of the Proponent in remanent vegetation at regular intervals since that date. The approximate location of the nest site is provided in **Figure 4.16.**

Table 4.13
Listed Species Observed within the Project Site

Common Name	Scientific Name	Source
Little Eagle	*Hieraaetus morphnoides*	B. James
Gang-gang Cockatoo	*Callocephalon fimbriatum*	B. James, G. Daly
Scarlet Robin	*Petroica boodang*	B. James
Flame Robin	*Petroica phoenicea*	B. James, G. Daly
Source: Gaia (2010) – Table 10		

4.3.5 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to minimise the potential for adverse Project-related impacts on flora, fauna or ecological communities within or surrounding the Project Site.

- Ensure that, with the exception of minor disturbance associated with, installation of water pipelines and management of existing tracks, no surface disturbing activities are being undertaken within areas of Ribbon Gum Forest and Fragmented Ribbon Gum Forest. No vegetation over 3m high would be removed.
- Avoid the use of phosphate-based fertiliser in pasture areas to encourage the regeneration of native grasses.
- Manage grazing operations, including stocking rates and fencing, in a manner to sustain and facilitate the spread of native grass species.
- Fence all areas of Ribbon Gum Forest and Fragmented Ribbon Gum Forest and exclude stock from those areas.

- Ensure that areas of habitat suitable for the Majors Creek Leek Orchid are appropriately identified and fenced and access restricted. Ensure no disturbance occurs within the fenced areas.
- Prepare a management plan to ensure that Common Wombat are not harmed during establishment of the tailings storage facility. This plan may include the following.
  - Mark all wombat burrows prior to the commencement of ground disturbing activities.
  - Commence ground disturbing activities on the upper slopes of creek banks a few days before disturbing the identified hollows to allow individual wombats time to vacate their burrows at night when equipment is not operating.
  - Inspect all burrows to ensure that common wombats have vacated the proposed area of disturbance. Any remaining wombats would be relocated in consultation with local wombat experts.
- Continue the existing weed and pest control program, with particular focus on managing Broom and Blackberry within the southern section of the Project Site.
- Ensure that dead fallen and standing timber are not removed or disturbed to preserve fauna habitat.
- Implement fully the Biodiversity Strategy described in Section 2.15, including ensuring that the strategy would be implemented in perpetuity.
- Prepare a *Biodiversity Management Plan* in consultation with the relevant government agencies and surrounding community within 12 months of receipt of the project approval. That plan would:
  - specify biodiversity-related actions to be undertaken during the life of the Project and for several years after the site has been decommissioned;
  - incorporate the above commitments;
  - describe management of the proposed biodiversity area;
  - describe the proposed revegetation and amelioration program, including identification of areas to be revegetated/ameliorated and the species to be used; and
  - involve, where practicable, local community groups in management of biodiversity with in the Project Site.

4.3.6 Impact Assessment

4.3.6.1 Introduction

This sub-section presents an assessment of the anticipated Project-related impacts on listed fauna, flora and ecological communities within and surrounding the Project Site. In order to ensure that the assessment has considered all appropriate species, a preliminary impact assessment is provided. That assessment focuses on those listed species that may potentially use the available habitat within the Project Site. For those species that are likely to use habitat within the Project Site, separate detailed assessments are provided the TSC Act and EPBC Act. Finally, this sub-section concludes with an assessment of the likely impacts associated with the Project upon Koala habitat.

4.3.6.2 Impacts on Vegetation Communities

Figure 4.17 presents the vegetation communities identified within the Project Site, overlain on the proposed site layout. The figure also presents the areas of each community within the Project Site that would be disturbed.

In summary, the following vegetation communities would not be disturbed or would be disturbed in a manner that would have a negligible impact.

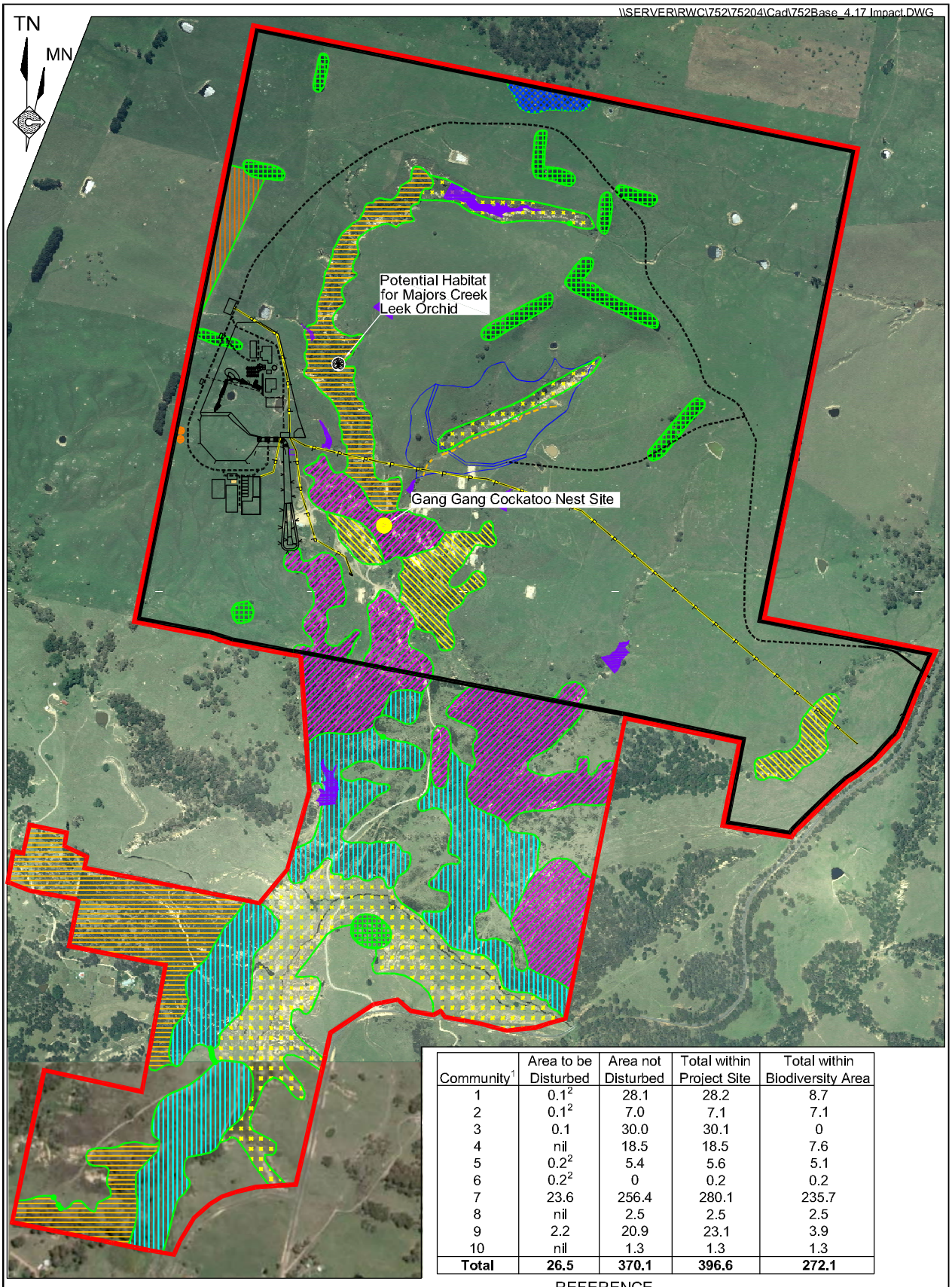
- Ribbon Gum forest.
- Fragmented Ribbon Gum forest.
- Woody weeds Shrubland.
- Regenerating wattles.
- Exotic vegetation.
- Exotic-dominated pasture.
- River Peppermint open forest.

The following vegetation communities would be disturbed. The area of disturbance is presented in parenthesis.

- Native Grassland (0.2ha). It is noted that Gaia (2010) state that this community is less than 5m wide and is considered to be non-viable.
- Native-dominated Pasture (23.7ha).
- Largely Disturbed Land (2.2ha).

4.3.6.3 TSC Act Preliminary Impact Assessment

Table 4.14 provides a preliminary assessment of the likelihood of species or communities listed under the TSC Act occurring within the Project Site. A detailed assessment of those species identified as requiring further assessment is provided in Section 4.3.6.4.



Community[1]	Area to be Disturbed	Area not Disturbed	Total within Project Site	Total within Biodiversity Area
1	0.1[2]	28.1	28.2	8.7
2	0.1[2]	7.0	7.1	7.1
3	0.1	30.0	30.1	0
4	nil	18.5	18.5	7.6
5	0.2[2]	5.4	5.6	5.1
6	0.2[2]	0	0.2	0.2
7	23.6	256.4	280.1	235.7
8	nil	2.5	2.5	2.5
9	2.2	20.9	23.1	3.9
10	nil	1.3	1.3	1.3
Total	**26.5**	**370.1**	**396.6**	**272.1**

Figure 4.17
VEGETATION COMMUNITY
AREAS OF DISTURBANCE

Table 4.14
Preliminary Assessment – TSC Act Species

Threatened Species / Ecological Community	Habitat Preference in region	Habitat Assessment Survey results	Further Assessment Required? (Section 4.3.6.4)
Fauna			
Koala	Ribbon Gum Forest.	Habitat present within Project Site but species not detected.	No
Squirrel Glider	Woodlands, especially those with Black wattle	Habitat present within Project Site. Species not detected.	No
Yellow-bellied Glider	Associated with Brown Barrel tall open forests and Ribbon Gum Forest	Site isolated and of insufficient size to support a troupe.	No
Spotted-tailed Quoll	Variety of habitat types which range from closed forest to heathland	Habitat not present within Project Site.	No
White-footed Dunnart	Variety of habitat types including open forests, woodlands and heathlands with dense shrublayer	Habitat not present within Project Site.	No
Eastern Pygmy Possum	Woodland/Heathlands with dense shrublayer plus tall open forest	Habitat not present within Project Site.	No
Grey-headed Flying Fox	Variety of habitat types including open forests, woodlands, tall open forest and closed forest, usually below 200 m AHD in temperate Australia.	Not expected to occur at this altitude.	No
Eastern False Pipistrelle	Associated with mature tall open forest at altitude above 100m. Roosts in tree hollows.	Habitat present within Project Site but no forest to be removed.	Yes
Eastern Bentwing Bat	In winter roosts in select caves but during spring/summer forages over a range of forest types.	Habitat present within Project Site but no forest to be removed.	Yes
Greater Broad-nosed Bat	Found in a variety of forests. Often coastal at higher latitudes and forages beside creeks. Roosts in tree hollows.	Habitat present within Project Site but no forest to be removed.	Yes
Golden-tipped Bat	Closed riparian forests usually with Yellow-throated Scrubwren as they roost in unused nests.	Habitat not present within Project Site.	No
Large-footed Myotis	Riparian habitats with hollow trees, bridges or caves.	Habitat present within Project Site but no forest to be removed.	Yes
Yellow-bellied Sheathtail-bat	Seasonal migrant found in a wide range of forest types	Habitat present within Project Site.	Yes
Smoky Mouse	Heath on ridge tops and slopes in sclerophyll forest, heathland and open-forest	Habitat not present within Project Site.	No
Australian Painted Snipe	Inhabits inland and coastal temporary or infrequently filled freshwater wetlands.	Habitat not present within Project Site.	No
Swift Parrot	Iox-ironbark forests and woodlands inland of the Great Dividing Range	Habitat not present within Project Site.	No

Table 4.14 (Cont)
Preliminary Assessment – TSC Act Species

Threatened Species / Ecological Community	Habitat Preference in region	Habitat Assessment Survey results	Further Assessment Required? (Section 4.3.6.4)
Fauna			
Little Eagle	Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland.	Habitat present within Project Site.	Yes
Square-tailed Kite	Seasonal summer breeding migrant that inhabits coastal and subcoastal forests.	Habitat present within Project Site but no forest to be removed.	Yes
Brown Treecreeper	Occupies eucalypt woodlands, particularly open woodland lacking a dense understorey.	Habitat present within Project Site but no forest to be removed.	Yes
Regent Honeyeater	Occurs in temperate *Eucalyptus* woodlands and open forest.	Habitat present within Project Site but no forest to be removed.	Yes
Diamond Firetail	Occupies eucalypt woodlands, forests and mallee where there is a grassy understorey.	Habitat present within Project Site but no forest to be removed.	Yes
Hooded Robin	Prefers woodlands with a variety of shrub species.	Habitat present within Project Site but no forest to be removed.	Yes
Scarlet Robin	Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within an open understorey of shrubs and grasses and sometimes in open areas.	Habitat present within Project Site. Previously detected.	Yes
Flame Robin	Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. It migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains	Habitat present within Project Site. Previously detected.	Yes
Pink Robin	Occurs in tall open eucalypt forests and closed forests	Habitat present within Project Site but no forest to be removed.	Yes
Barking Owl	Occurs in eucalypt woodland, open forest, swamp woodlands and riverine timber. In region detected in tall open forest	Habitat present within Project Site but no forest to be removed.	Yes
Powerful Owl	In region detected in tall open forests (Brown Barrel) with an abundance of arboreal mammals.	Habitat present within Project Site but no forest to be removed.	Yes
Gang-gang Cockatoo	Prefers various mature eucalypt forests.	Habitat present within Project Site. Species detected.	Yes
Glossy Black-Cockatoo	Prefers woodland and open forest with an abundance of Black Oak.	Habitat not present within Project Site.	No

Table 4.14 (Cont)
Preliminary Assessment – TSC Act Species

Threatened Species / Ecological Community	Habitat Preference in region	Habitat Assessment Survey results	Further Assessment Required? (Section 4.3.6.4)
Fauna			
Striped Legless Lizard	Occurs in temperate grasslands.	Habitat very marginal within Project Site and outside known range.	No
Broad-headed Snake	Sandstone outcrops in woodland within 200km of Sydney	Habitat not present within Project Site.	No
Giant Burrowing Frog	Occurs in heathland and woodland particularly beside non-perennial creeks	Habitat not present within Project Site.	No
Littlejohn's Tree Frog	Occurs in woodland and heathland and occasionally in open forest	Habitat not present within Project Site.	No
Southern Bell Frog	Occurs beside creeks with secondary billabongs that have Cumbungi and little canopy species	Habitat not present within Project Site.	No
Flora			
Araluen Gum	Grows near rivers, in grassy or shrubby woodland or in wet sclerophyll forest on moderately fertile sandy soil on granite.	Not located on site.	No
Small-leaved Gum	Grows mainly in grassy woodlands around the edges of broad, flat headwater valleys at altitudes of 800 – 1200 m AHD.	Not located on site.	No
Araluen Zieria	Araluen Zieria grows in shrubland on a rocky granite hillside at a single site near Araluen south of Braidwood.	Not located on site.	No
Austral Toadflax	Found in damp sites in association with Kangaroo Grass in grassland or grassy woodland.	Not located on site.	No
Dense Cord-rush	Commonly found in swamps or depressions in sandy alluvium, sometimes growing with sphagnum moss.	Not located on site.	No
Mauve Burr Daisy	Found in montane or natural temperate grassland and Snow Gum Woodlands on the Monaro and Shoalhaven area.	Not located on site.	No
Michelago Parrot-Pea	Occurs on exposed patches of clay or on rocky outcrops in eucalypt woodland.	Not located on site.	No
Monaro Golden Daisy	Grows on basalt, granite and sedimentary substrates usually in natural Temperate Grassland.	Not located on site.	No
Horay Sunray	Cabbage Gum woodland.	Not located on site.	No
Tangled Bedstraw	Moist gullies of tall forest, coastal Banksia shrubland, and *Allocasuarina nana* heathland.	Not located on site.	No

Table 4.14 (Cont)
Preliminary Assessment – TSC Act Species

Threatened Species / Ecological Community	Habitat Preference in region	Habitat Assessment Survey results	Further Assessment Required? (Section 4.3.6.4)
Flora			
Thick-lipped Spider-orchid	Generally found in grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil.	Not located on site. No further assessment required.	No
Majors Creek Leek Orchid	Currently only known from one site (cemetery) at Majors Creek	Not located on site.	Yes
Pale Golden Moths	Grown in open grassy woodland	Not located on site.	No
Small Snake Orchid	Often on peaty soils in moist areas	Not located on site.	No
Endangered Ecological Communities			
Tablelands Frost Hollow Grassy Woodlands in the South Eastern Highlands, Sydney Basin, South East Corner and NSW South western Slopes Bioregions[1]	Ribbon Gum - Snow Gum Grassy Open Forest has affinity with this community. However, only a negligible area (0.2ha) would be disturbed and no vegetation over 3m high would be removed.		No
Natural Temperate Grasslands of the Southern Tablelands (NSW and ACT) (EPBC community)	Grassy vegetation dominated by moderately tall (25–50 cm) to tall (50–100 cm), dense to open tussock grasses.	Narrow, restricted area located but considered to be non-viable.	No
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (EPBC community)		Not located on site.	No
Note 1: Preliminary listing only			
Source: Gaia (2010) – After Table 12.			

4.3.6.4 TSC Act Detailed Impact Assessment

This sub-section provides a detailed assessment of the anticipated Project-related impacts on species and ecological communities listed under the TSC Act and identified in Section 4.3.6.3 as requiring further assessment. This assessment takes into account the commitments made in Section 4.3.5. In determining whether anticipated Project-related impacts would be significant this assessment refers to the matters identified in Section 5A of the *Environmental Planning and Assessment Act 1979*. To avoid repetition, each of the matters identified in that Section are presented in full in *italics* and an overview of the assessment prepared by Gaia (2010) for each species is presented. Where appropriate, those species with similar habitat requirements are assessed together. Full descriptions of the habitat requirements for each species are presented in Section 6.3 of Gaia (2010).

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Eastern Bentwing Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, and Yellow-bellied Sheathtail Bat

There would be no direct impacts on these species as no hollow-bearing trees would be removed and foraging and potential roost sites do not occur within or in the immediate vicinity of the Project Site. The indirect impacts on these species would include an altered noise regime and areas of night-time lighting which may attract insects and provide additional feeding opportunities.

Large-footed Myotis

Targeted harp trapping totalling six trap nights did not identify this species, suggesting the species does not occur in the vicinity of the Project Site. There would be no direct impacts on this species as no hollow-bearing trees would be removed and foraging and potential roost sites do not occur within or in the immediate vicinity of the Project Site. The indirect impacts on this species would include an altered noise regime and areas of night-time lighting which may attract insects and provide additional feeding opportunities.

Gang-gang Cockatoo

The Ribbon Gum Forest within the Project Site provides foraging and nesting habitat for this species. No hollow-bearing trees would be removed and the loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The indirect impacts on this species would include an altered noise regime and areas of night-time lighting. It is noteworthy that nesting birds were observed approximately 50m from drilling operations in 2007 and did not appear to be perturbed. During the February 2010 survey, approximately 20 individuals were observed over three days, indicating that at that time the species was locally abundant. The birds were foraging within 50m of drilling operations and truck movements and the drilling areas were illuminated at night. These observations indicate that loud even noise and localised night-time illumination is tolerated by this species.

Little Eagle

The Ribbon Gum Forest within the Project Site provides foraging and nesting habitat for this species. No hollow-bearing trees are to be removed and the loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The indirect impacts on this species would include an altered noise regime and areas of night-time lighting. The impact of noise and illumination on nesting birds is unknown.

Square-tailed Kite

The loss of approximately 0.2ha of Ribbon Gum Forest would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Brown Treecreeper, and Regent Honeyeater

The Ribbon Gum Forest within the Project Site provides foraging and nesting habitat for these species. No hollow-bearing trees would be removed and the loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction. In addition, these species are not expected to occur within the Project Site as suitable habitat is small and fragmented.

Diamond Firetail

Diamond Firetail are expected to occur within the Project Site. The loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction. It is noted, however, that removal of broom and blackberry as part of the Proponent's weed management program may remove some potential nest sites.

Hooded Robin

This species is not expected to occur within the Project Site as the available habitat is small and fragmented. No hollow-bearing trees would be removed and the loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Scarlet Robin, and Flame Robin

Individuals of this species may, on occasion, pass through the Project Site as they migrate. In addition, the species is volar and forages over very large home ranges. As a result, the loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The indirect impacts on these species would include an altered noise regime and areas of night-time lighting. The impact of noise and illumination on nesting birds is unknown.

Pink Robin

The loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The indirect impacts on this species would include an altered noise regime and areas of night-time lighting. The impact of noise and illumination on nesting birds is unknown.

Barking Owl and Powerful Owl

The Ribbon Gum Forest within the Project Site provides foraging and nesting habitat for this species. No hollow-bearing trees would be removed and the loss of approximately 0.2ha of foraging habitat would not have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

The indirect impacts on these species would include an altered noise regime and areas of night-time lighting. The impact of noise and illumination on nesting birds is unknown.

Majors Creek Leek Orchid

Potential habitat for Majors Creek Leek Orchid within the Project Site is limited to a small, restricted remnant of Swamp Gum with a grassy understorey of native and exotic species (**Figure 4.17**). Given that the species is 'apparently highly susceptible to grazing', it is unlikely that Majors Creek Leek Orchid would be present within the Project Site. The Proponent has committed to fence and restrict access to the area of potential habitat and ensure that no further disturbance occurs. As a result, the Project would not result in impacts that would place a viable local population of the species at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

No endangered populations were identified within the Project Site.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

No TSC Act endangered ecological communities or critically endangered ecological communities were identified within the Project Site.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

The extent of habitat alteration associated with the Project is the loss of approximately 0.2ha of Ribbon Gum Forest/fragmented Ribbon Gum Forest. This is not considered to be significant.

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

The Project would not further fragment existing forest habitat

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Vegetation within the Project Site is not critically important to the long-term survival of threatened species.

For forest dependant birds such as the Gang-gang Cockatoo, Little Eagle, Scarlet Robin and Flame Robin, the loss of approximately 0.2ha of Ribbon Gum forest is not critically important as the loss will be within fragmented forest and would not involve the loss of hollow-bearing trees. These species have large home ranges and the loss of this area is small in comparison to those ranges.

For microbats such as the Eastern Bent-wing Bat, Eastern False Pipistrelle, Greater Broad-nosed Bat, Yellow-bellied Sheathtail Bat and Large-footed Myotis, the loss of approximately 0.2ha of Ribbon Gum forest is not critically important as the loss will be within fragmented forest and not involve the loss of hollow-bearing trees that may be used as roost sites. These species have large home ranges and the loss of this area of potential foraging habitat is small in comparison to those ranges.

Potential habitat for Majors Creek Leek Orchid within the Project Site would be fenced and protected from grazing and further disturbance. Potential habitat for the species would therefore not be removed, modified, fragmented or isolated.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

The Project would not have an adverse effect on critical habitat.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

A recovery plan has not been prepared for the Gang-gang Cockatoo, Little Eagle, Scarlet Robin, Flame Robin or any species of microbat. However, any action to remove potential, foraging or dispersal habitat would not be consistent with the objectives or actions within any recovery plan, should one be developed. Actions such as the proposed Biodiversity Strategy that promote the recovery of a species by the conservation of existing habitat and revegetation works to repair damaged landscapes is considered applicable to objectives or actions in recovery plans.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

The removal of native vegetation is a key threatening process. The vegetation communities to be removed are identified in Section 4.3.6.2.

Conclusion

Based on the above impact assessment, the Project would not have a significant impact on TSC Act-listed threatened species such that viable local populations of species or communities are likely to be placed at risk of extinction.

4.3.6.5 EPBC Act Preliminary Assessment

Part 9 of the EPBC Act identifies that any action that has, or is likely to have, a significant impact on a matter of National Environmental Significance must be referred to and may only progress with the approval of the Commonwealth Minister for the Environment. Relevant matters of national environmental significance include:

- listed threatened species and ecological communities; and
- listed migratory species.

Table 4.15 provides a preliminary assessment of the likelihood of species or communities listed under the EPBC Act occurring within the Project Site. A detailed assessment of those species identified as requiring further assessment is provided in Section 4.3.6.5.

Table 4.15
Preliminary Assessment – EPBC Act Species

Common Name	Status[1]	Habitat Preference	Further Assessment Required?
White-bellied Sea Eagle	M	Coastal fringes and large rivers	No
Rainbow Bee-eater	M	Large rivers with sandy banks	No
Clamorous Reed-Warbler	M	Dense reed beds beside rivers and wetlands	No
White-throated Needletail	M	Aerial – follows summer storm fronts but on occasion may land on trees	Yes
Wanderer Butterfly	M	Woodlands and disturbed areas	Yes
Great Egret	M	Dams, billabongs and rivers	Yes
Cattle Egret	M	Open paddocks with cattle	Yes
Latham's Snipe	M	Dams, wetlands and mud flats	No
Painted Snipe	M	Temporary or infrequently filled wetlands	No
Black-faced Monarch	M	Tall open forest and closed forest	Yes
Satin Flycatcher	M	Woodlands and open forest	Yes
Rufous Fantail	M	Tall open forest and closed forest	Yes
Regent Honeyeater	M, E	Box woodlands	Yes
Fork-tailed Swift	M	Arial, over a variety of habitats	Yes
Grey-headed Flying Fox	V	Range of native vegetation at low altitude	No
Smoky Mouse	E	Heath on ridge tops and slopes in sclerophyll forest, heathland and open-forest	No
Swift Parrot	E	Over-wintering habitat on the mainland is the box-ironbark forests and woodlands.	Yes
Striped Legless Lizard	V	Native temperate grasslands	Yes
Broad-headed Snake	V	Sandstone escarpments within 200km of Sydney	No
Giant Burrowing Frog	V	Heath and woodland on sandstone	No
Littlejohn's Tree Frog	V	Heath and woodland over 10m asl	No
Southern Bell Frog	V	Creeks with secondary billabongs that have Cumbungi	Yes
Macquarie Perch	E	Clear creeks at low altitude	No
Australian Grayling	V	Clear creeks running through native vegetation	No
Araluen Gum	V	Grows near rivers, in grassy or shrubby woodland or in wet sclerophyll forest on moderately fertile sandy soil on granite.	No
Austral Toadflax	V	Damp sites in association with Kangaroo Grass in grassland or grassy woodland.	No
Thick-lipped Spider-orchid	V	Grassy sclerophyll woodland on clay loam or sandy soils, though the population near Braidwood is in low woodland with stony soil.	No
Note 1: M = Migratory, V = Vulnerable, E = Endangered			
Source: Gaia (2010) – After Tables 13 and 14.			

4.3.6.6 EPBC Act Detailed Assessment

Table 4.16 presents a detailed assessment of the anticipated impacts on EPBC Act-listed species identified in **Table 4.15** as likely to occur with or in the vicinity of the Project Site.

Table 4.16
EPA Impact Assessment

Natural heritage element	Likely impact	Reasoning
Fauna	Negligible	The Gang-gang Cockatoo, Flame Robin and Monarch Flycatcher were observed during the ecology assessment. In addition, the Project Site supports habitat for the White-throated Needletail, Wanderer Butterfly, Great Egret, Cattle Egret, Fork-tailed Swift, Satin Flycatcher, Rufous Fantail, Regent Honeyeater, Swift Parrot, Black-faced Monarch, Striped Legless Lizard and Southern Bell Frog. An assessment of the impact of the threatened species using the EPBC guidelines indicates that the proposed development would not: • lead to a long-term decrease in the size of a population; • potentially disrupt the breeding cycle of a population; • reduce the area of occupancy of the species; • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline; or • interfere with the recovery of the species.
Flora		No species listed on the EPBC Act likely to occur within the Project Site.
EEC[1]	Negligible	Natural Temperate Grasslands of the Southern Tablelands exists as a small, non-viable fragmented strip beside an eroding creek edge.
Source: Gaia (2010) – Table 15. Note 1: EEC = Endangered Ecological Community		

In light of the anticipated impacts on EPBC-listed species being negligible, Gaia (2010) state that a referral to the Commonwealth Minister for the Environment is not required.

4.3.6.7 SEPP 44 – Koala Assessment

State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44) requires that a Plan of Management be developed for any development that will affect core Koala habitat within Local Government Areas identified within Schedule 1 of the Policy. "Core Koala Habitat" is defined as an area of land with a resident population of Koala. "Potential Koala Habitat" is defined as habitat where more than 15% of the trees are Koala feed tree species defined in Schedule 2 of the SEPP.

The proportion of Ribbon Gum within vegetated sections of Project Site constitute more than 15% of the total number of trees in the upper strata. As a result, vegetated sections of the Project Site may be classified as 'Potential Koala Habitat.' However, no Koala scats or scratches were identified.

Gaia (2010) state that as a result of previous clearing within the Project Site, Koala are unlikely to occur. As a result, SEPP 44 does apply to the Project.

4.3.6.8 Assessment of the Biodiversity Strategy

Section 2.15 presents a summary of the proposed Biodiversity Strategy. In summary, the strategy would result in:

- fencing of areas of existing native vegetation;
- ameliorative plantings;
- soil stabilisation;
- ongoing weed and feral animal control; and
- appropriate management of agricultural operations to ensure that the biodiversity value of the grassland / pasture within the Biodiversity Area is improved over time.

The strategy would be documented in a Property Vegetation Plan under the Native Vegetation Act 2003. That plan would be prepared in consultation with the Southern Rivers Catchment Management Authority and the DECCW. The strategy secured in perpetuity.

Gaia (2010) has undertaken an assessment of the proposed Biodiversity Strategy based on the thirteen principles presented in Appendix 2 of the document *Guidelines for Biodiversity Certification of Environmental Planning Instruments* published in April 2007 by the then Department of Environment and Climate Change. The following provides an overview of that assessment.

1. **Impacts must be avoided first by using prevention and mitigation measures.**

   The Project has been designed to ensure that the minimum area is disturbed. Measures that have been implements include the following.

   – Designing the proposed mining operations as an underground mine rather than an open cut to minimise the area.
   – Redesigning and relocating the box cut and other infrastructure in the vicinity of the Project Site to ensure that no hollow-bearing trees would be disturbed.
   – Locating the tailings storage facility at the top of an ephemeral drainage line to ensure that the facility occupies the minimum area possible.

2. **All regulatory requirements must be met.**

   The Proponent states that all regulatory requirements for the Project would be complied with.

3. **Offsets must never reward ongoing poor performance.**

   The Proponent contends that its existing environmental record is of a high standard. Examples of good environmental management include the following.

   – Management of weeds within the northern section of the Project Site. It is noted that the southern section of the Project Site was purchased by the Proponent in 2010 and ongoing weed management programs will be extended to those lands.
   – Management of exploration operations in a manner that ensure that the resident population of Gang-gang Cockatoo have remained within the Project Site.

4. Offsets will complement other government programs.

The Biodiversity Strategy would complement existing NSW Government conservation objectives as the Biodiversity Area would preserve an area of native-dominated pasture which would be managed in a manner that would ensure the re-establishment of native grasses. In addition, an area of native vegetation with a known population of threatened species would be fenced and managed for biodiversity purposes.

Majors Creek Landcare has conducted revegetation and fenced off one eroded gully in the recently acquired land. The proposed actions would also complement that program.

5. Offsets must be underpinned by sound ecological principles.

The proposed Biodiversity Strategy:

– reflects the requirement to re-establish areas of native grasslands within the area surrounding the Project Site;

– would permit the ongoing beneficial use of the Biodiversity Area, ensuring that resources remain available in perpetuity to manage the land in an appropriate manner; and

– would protect those sections of the Biodiversity Area that are currently forested and would, through the exclusion of stock, ensure that the understory and shrub layers within those section are permitted to regenerate.

6. Offsets should aim to result in a net improvement in biodiversity over time.

The Biodiversity Strategy would, through appropriate land management, encourage the re-emergence of native grassland within cleared sections of the Project Site while facilitating the re-establishment of groundcover and shrub layers within areas of Ribbon Gum Forest. This would result in net improvement in biodiversity over time. In addition, continued land stabilisation works would result in the stabilisation of areas of active erosion within the subject site.

7. Offsets must be enduring and they must offset the impact of the development for the period that the impact occurs.

The Proponent proposes to secure the Biodiversity Strategy in perpetuity.

8. Offsets should be agreed prior to the impact occurring.

The Proponent proposes to prepare a *Property Vegetation Plan* in consultation with DECCW and the Southern Rivers Catchment Management Authority within 12 months of the receipt of project approval, should it be granted.

9. Offsets must be quantifiable and the impacts and benefits must be reliably estimated.

Figure 4.17 presents the areas that would be disturbed by the Project and those that would be preserved within the Biodiversity Area.

10. Offsets must be targeted.

The Biodiversity Strategy would preserve and protect similar habitat to the habitat that would be disturbed.

11. Offsets must be located appropriately.

The Biodiversity Area is entirely within the Project Site and surrounds the areas of proposed disturbance.

12. Offsets must be supplementary.

The Biodiversity Area is not protected by existing covenants or other measures and not funded by other schemes. With the exception of limited funds provided to assist with creek bank stabilisation, there have been no incentive funds provided under previous management.

13. Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.

The Proponent anticipates that the project approval, should it be granted, would include a requirement to implement the proposed Biodiversity Strategy, including securing the biodiversity area to the satisfaction of the DECCW. In addition, the Proponent would undertake internal audits and monitoring of the biodiversity offset strategy and areas to determine that the proposed actions are leading to positive biodiversity outcomes.

In the event that the Proponent sells the land within the biodiversity area, subsequent purchasers would be bound by the *Property Vegetation Plan* that the Proponent would prepare.

4.3.7 Monitoring

The Proponent would ensure that the following ecology-related monitoring is undertaken during the life of the Project. The results of the monitoring program would be reported in each Annual Environmental Management Report prepared for the Project.

- Ensure that searches for Major's Creek Leek Orchid are undertaken during the flowering period for the orchid, both within suitable habitat areas within the Project Site and within the Majors Creek Cemetery.
- Ensure that all areas undergoing rehabilitation are be monitored on a 6 monthly basis to determine the success or otherwise of the management, mitigation and ameliorative measures and the rehabilitation programs.
- Establish a set of photographic reference points and ensure that photographs are taken at six monthly intervals to document activities within the Project Site, including weed control and revegetation actions.

4.4 GROUNDWATER

4.4.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**soil and water** – *including … a detailed groundwater model.*"

Based on the risk assessment undertaken for the Project (see Section 3.3), specific groundwater-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Reduced availability of water for beneficial use.
- Reduction in groundwater levels.
- Reduced yields of local groundwater bores.
- Reduced surface water flows.

The groundwater assessment was undertaken by Australasian Groundwater and Environmental Consultants Pty Ltd (AGE). This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 3 (Volume 1) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "AGE (2010)".

The assessment was managed by Mr Errol Briese (B.Sc (Hons), Grad Dip (Management)) of AGE.

4.4.2 Existing Environment

4.4.2.1 Introduction

A description of the topographic, drainage and geological setting of the Project Site is provided in Section 4.1. This sub-section provides a description of the regional and Project Site groundwater setting and the surrounding groundwater users that may potentially be impacted by the Project.

4.4.2.2 Regional Groundwater Setting

Three principal classes of aquifers exist within and surrounding the Project Site as follows.

- Fracture-controlled, granodiorite-hosted aquifer

  This aquifer occurs across the entire Project Site and surrounding catchments. As identified in Section 4.1.4, the Project Site is underlain by the Braidwood granodiorite which is cut by a number of fracture systems. As a result, the aquifer may be categorised a hydraulically "tight" massive granodiorite with little or no primary permeability and localised fracture or fault systems which may be open and transmit groundwater flow.

- A regolith aquifer, namely a shallow, weathered aquifer overlying the granodiorite.

  This aquifer occurs across the majority of the Project Site and surrounding catchments and is hosted by weathered granodiorite material. Weathering typically occurs to a depth of approximately 15m.

- A shallow alluvial aquifer associated with the Majors Creek alluvial deposits.

  This aquifer comprises sand and clay with boulders adjacent to and within Majors Creek. The alluvial material has been extensively disturbed during previous alluvial gold mining operations, resulting in piles of alluvial material in sections of the creek and exposed bedrock in other sections (**Plates 4.1** and **4.2**). AGE (2010) indicates that the thickness of in-situ alluvium prior to the commencement of alluvial mining operations was probably between 2m and 3m. **Figure 4.18** presents an overview of the distribution of this aquifer within and surrounding the Project Site. It is noted that AGE (2010) state that the "alluvium" mapped adjacent to the tributaries to Majors Creek is actually colluvium, or material sourced directly from the slopes of the valley through which the tributary flows, and does not form part of the alluvial aquifer.

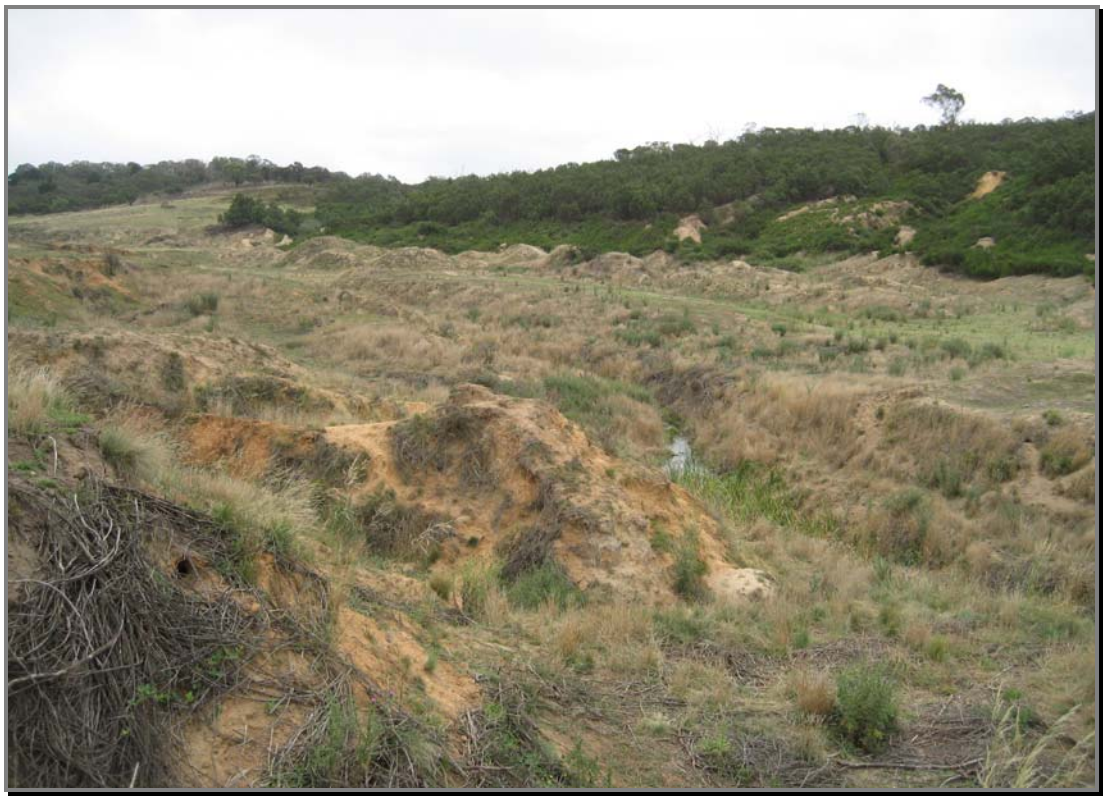


Plate 4.1 View of disturbed alluvium within Majors Creek

Plate 4.2 View of disturbed alluvium within Majors Creek

Source: AGE (2010) – Figure 3

4.4.2.3 Project Site Groundwater Setting

Survey Methodology

In order to establish the Project Site groundwater setting, AGE (2010) constructed 8 monitoring bores and six locations. **Figure 4.18** and **Table 4.17** presents the location and construction details respectively of each of the constructed bores. It is noted that at two locations adjacent to the upper sections of Spring Creek bores were twinned, namely two bores targeting different aquifers were constructed at each site. These twinned bores, namely DRWB01, DRWB02, DRWB03 and DRWB04, were constructed to test the level of interconnection between the regolith and granodiorite aquifers. As indicated in **Table 4.17,** slotted casing was installed in the deeper bore at a depth of more than 60m below surface. The upper section of the bore was then sealed to prevent shallow waters from entering the bore. Slotted casing was installed in the shallower bore at between approximately 10m and 17m below surface.

Section 7.3 of AGE (2010) presents a detailed description of the bore construction methodology. Applications for licences for all bores have been submitted to NSW Office of Water.

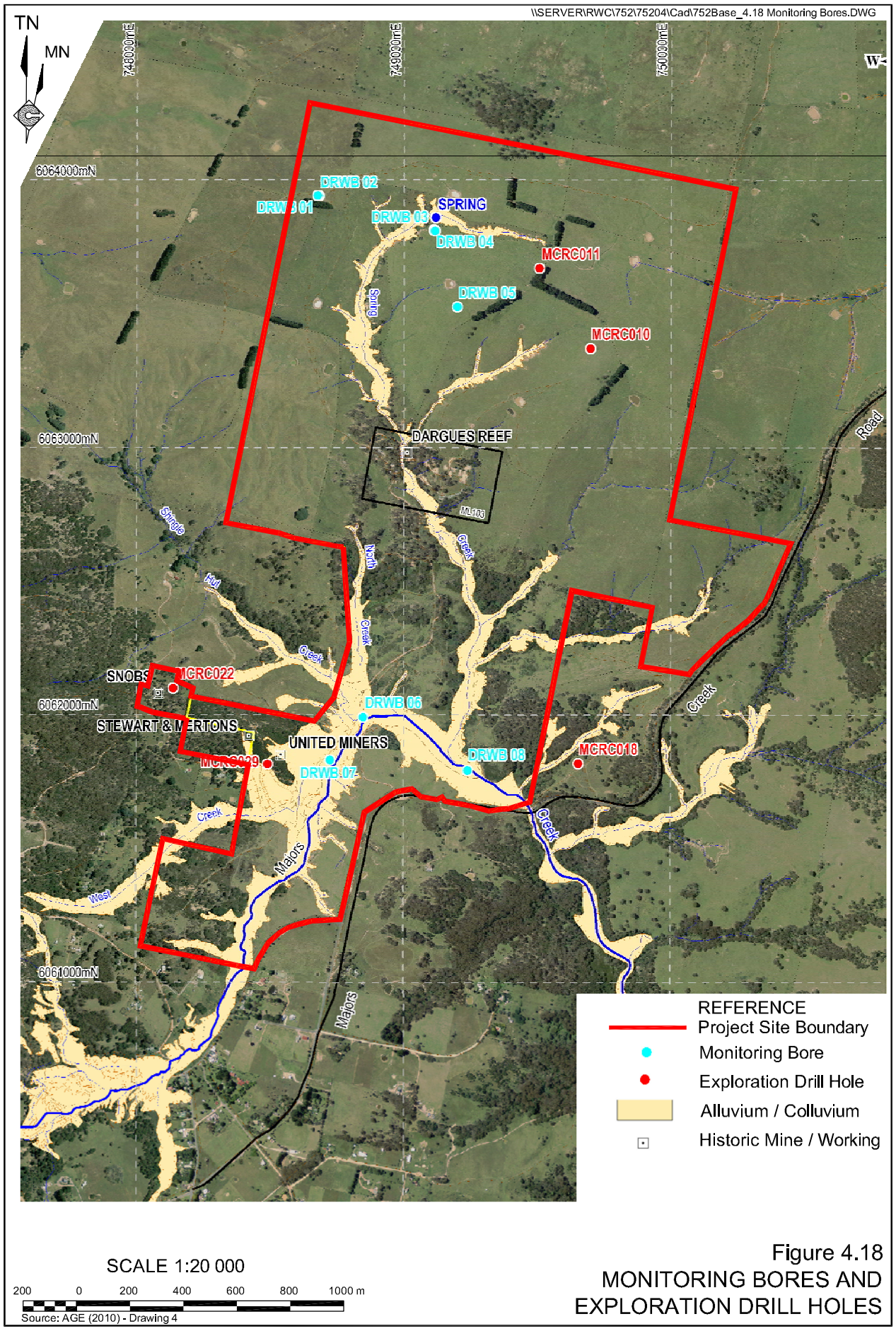


Figure 4.18
MONITORING BORES AND EXPLORATION DRILL HOLES

Table 4.17
Monitoring Bore Locations and Construction Details

Bore	Location		Elevation (RLm)		Depth	Screen	Static Water Level			Aquifer
	mE	mN	Ground	TOC[1]	(m)	(mbGL)[2]	Date	(mbGL)[2]	(mAHD)	
DRWB01	748681.1	6063944.8	714.65	715.20	67	61.0 – 7.0	25/04/10	9.41	705.8	granodiorite
DRWB02	748676.6	6063945.8	714.67	715.24	15.9	9.9 – 15.9	25/04/10	9.42	705.8	regolith
DRWB03	749111.8	6063817.2	712.35	712.91	66.1	60.1 – 66.1	25/04/10	8.64	704.3	granodiorite
DRWB04	749115.8	6063814.4	712.72	713.29	16.5	10.5 – 16.5	25/04/10	8.61	704.7	regolith
DRWB05	749200.3	6063530.7	721.89	721.87	15.58	9.6 – 15.6	25/04/10	dry		regolith
DRWB06	748848.7	6061994.6	632.34	632.98	6.45	3.45 – 6.45	20/04/10	1.24	631.7	alluvium
DRWB07	748724.7	6061835.4	636.72	637.17	11.25	5.25 – 11.25	20/04/10	4.23	632.9	alluvium
DRWB08	749240.0	6061796.4	627.38	628.01	11.22	5.12 – 11.12	20/04/10	1.93	626.1	Alluvium

Note 1: TOC = top of casing
Note 2: mbGL = metres below ground level
Note 3: co-ordinate projection MGA 94, Zone 56

Source: AGE (2010) – Table 2.

In addition to the monitoring bores constructed during the groundwater assessment, groundwater levels within a further 52 existing exploration drill holes were measured. **Figure 4.19** presents the location of the measured exploration drill holes and Appendix 5 of AGE (2010) presents additional information in relation to each drill hole.

Standing Groundwater Levels

Standing groundwater levels were measured in all monitoring bores constructed for the groundwater assessment, as well as 54 existing exploration drill holes. **Figure 4.19** presents an overview of the measured standing water levels and the interpreted groundwater level contours within and surrounding the Project Site. In summary, standing water levels have an elevation of approximately 715m AHD in the northern section of the Project Site. In the southern section of the Project Site, standing water levels have an elevation of approximately 627m AHD or approximately 88m lower than in the northern section of the Project Site.

Hydraulic Testing

Falling / rising head tests were conducted on the monitoring bores. These tests involved adding or removing a quantity of water to the bore and measuring the water level response using a vibrating wire piezometer at 2 second intervals to determine the hydraulic conductivity of the material surrounding the bore. **Table 4.18** presents a summary of the hydraulic conductivity determined as a result of these tests.

Table 4.18
Falling / Rising Head Test Results

Bore ID	Aquifer	Hydraulic Conductivity	
		m/sec	m/day
DRWB01	Granodiorite	5.52×10^{-9}	4.68×10^{-4}
DRWB03		1.01×10^{-9}	8.69×10^{-5}
DRWB02	Regolith (weathered zone)	2.34×10^{-7}	2.02×10^{-2}
DRWB04		1.52×10^{-6}	1.31×10^{-1}
DRWB07	Alluvium/Regolith	6.09×10^{-7}	5.26×10^{-2}
DRWB08		5.60×10^{-7}	4.84×10^{-2}

Source: AGE (2010) – Table 3.

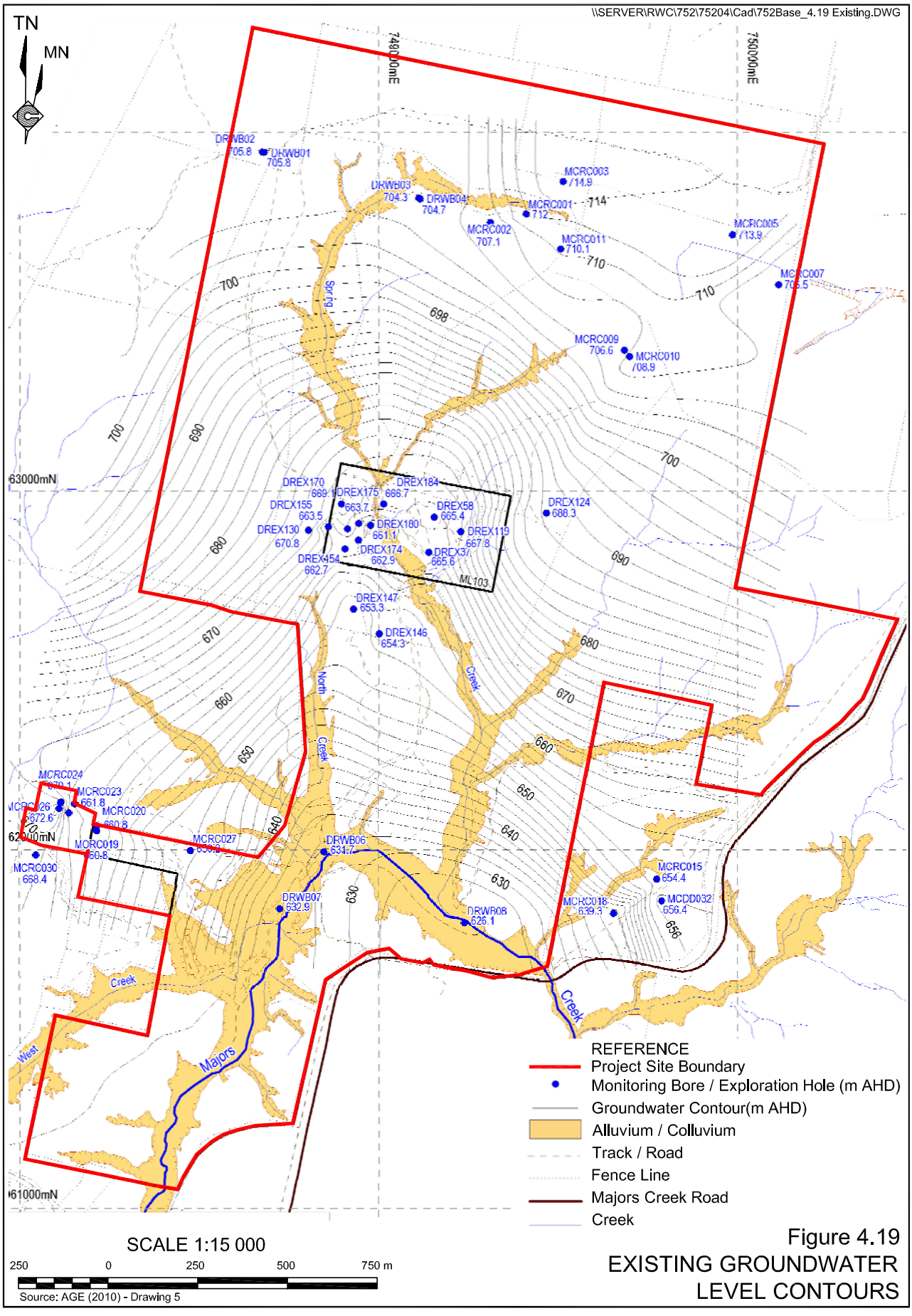


Figure 4.19
EXISTING GROUNDWATER LEVEL CONTOURS

Groundwater Quality

Groundwater samples were collected from each of the monitoring bores. In addition, samples were also collected from the spring in Spring Creek (see following sub-section) and from the existing Dargues Reef Shaft (**Figure 4.18**).

During sampling operations, a disposable bailer was used and at least three times the volume of the bore was removed prior to the sample being collected. In addition, with the exception of samples from DRWB03, no samples were collected until the pH and electrical conductivity (EC) of the water being removed had stabilised. In the case of DRWB03, the pH and EC failed to stabilise and a sample was collected anyway.

Table 4.19 presents the results of the groundwater monitoring program together with the Australian and New Zealand Environment and Conservation Council guidelines (ANZECC, 2000) for aquatic ecosystems associated with upland rivers in south-east Australia.

Table 4.19
Groundwater Quality Data

Sample ID		DRWB 01	DRWB 03	Dargues Shaft	DRWB 02	DRWB 04	Spring 1	DRWB 07	DRWB 08	ANZECC Guideline (2000)
Sample Date		22/04/10	21/04/10	21/12/09	22/04/10	22/04/10	22/04/10	22/04/10	22/04/10	
Aquifer	Unit	Granodiorite			Regolith			Alluvium		
pH value	pH	8.2	12.2	7.11	7.3	7.0	7.4	7.0	7.6	6.5 – 7.5
Electrical Conductivity	uS/cm	530	4300	1260	1300	360	270	630	410	30 - 350
Bicarbonate Alkalinity as $CaCO_3$	mg/L	199	<0.1		133	70.7	79.1	127	123	
Carbonate Alkalinity as $CaCO_3$	mg/L	<0.1	187		<0.1	<0.1	<0.1	<0.1	<0.1	
Hydroxide Alkalinity as $CaCO_3$	mg/L	<0.1	654		<0.1	<0.1	<0.1	<0.1	<0.1	
Total Alkalinity as $CaCO_3$	mg/L	199	841	516	133	71	79	127	123	
Chloride	mg/L	44	48		300	51	22	57	32	
Sulphate	mg/L	15	50		35	14	10	110	37	
Calcium	mg/L	54	150		110	26	17	56	42	
Magnesium	mg/L	14	<0.05		48	10	6.5	24	7.3	
Sodium	mg/L	34	310		58	22	23	31	24	
Potassium	mg/L	1.3	14		1.8	0.6	0.3	1.4	1.1	
Nitrate as N	mg/L	0.14	1.3		3.2	2.1	2.8	<0.01	<0.01	0.7
Nitrite as N	mg/L	0.02	0.03		<0.01	<0.01	<0.01	<0.01	<0.01	
Total Oxidized Nit. as N	mg/L	0.16	1.3		3.2	2.1	2.8	<0.01	<0.01	
Total Phosphorus as P	mg/L	0.16	0.21		0.71	0.06	0.14	0.27	0.41	0.02
Arsenic	mg/L	0.001	0.0055	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	0.013
Cadmium	mg/L	<0.0005	<0.0005	<0.0001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.00002
Chromium	mg/L	<0.001	0.039	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0001
Copper	mg/L	0.0006	0.0011	0.005	0.0007	<0.0005	<0.0005	0.0007	0.0005	0.0014
Lead	mg/L	0.0012	0.00019	0.002	<0.00005	0.00006	<0.00005	<0.00005	<0.00005	0.0034
Mercury	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0006
Nickel	mg/L	0.002	0.004	<0.001	0.003	<0.001	<0.001	0.002	0.003	0.011
Zinc	mg/L	0.012	0.006	0.054	0.006	0.014	<0.005	0.12	<0.005	0.008

Note: Shaded cells = exceedance of the ANZECC (2000) guideline

Source: AGE (2010) – After Table 5

The pH and EC for DRWB03 failed to stabilise prior to sampling and, as a result, the elevated pH and EC values recorded for that sample are not considered to be representative of the pH or EC of surrounding groundwater.

In summary, the groundwater monitoring indicates the following in relation to the existing groundwater quality within and surrounding the Project Site.

- Groundwater associated with the alluvial aquifer, with an EC of less than 630µS/cm, is suitable for human consumption. However, groundwater within the granodiorite and regolith aquifers is suitable only for stock watering.
- Groundwater within the granodiorite and regolith aquifers has nitrate levels in excess of the ANZECC guidelines while water within all aquifers has phosphorus and, in some cases, zinc levels in excess of the ANZECC guidelines. Elevated phosphorous, and possibly zinc, levels are considered to be as a result of previous land use practices, including the use of phosphorus and zinc-based fertilisers.

Groundwater Recharge, Discharge and Flow Directions

Recharge within the regolith and granodiorite aquifers depend on rainfall infiltrating the regolith aquifer and gradually migrating to the fractured rock system. Monitoring has shown that the regolith and fractured rock system are in hydraulic connection, with water levels in the paired monitoring bores showing the same elevation. As a result, AGE (2010) state that groundwater in the regolith is not perched.

Recharge within the alluvial aquifer in Majors Creek is primarily from the regolith and granodiorite aquifer system, surface runoff and incident rainfall.

The groundwater flow direction within the Project Site is typically from the north to south **Figure 4.19**.

Discharge from the granodiorite and regolith aquifers is primarily associated with Majors Creek. AGE (2010) note that base flow in Majors Creek, namely flow that is not associated with or immediately follows rainfall events, is primarily associated with groundwater discharge from the granodiorite or regolith aquifers.

In addition, a small spring is located in the upper section of Spring Creek (**Figure 4.18**). This spring is associated with discharge from the granodiorite and regolith aquifers. The Proponent has installed a V-notch weir within Spring Creek in the vicinity of the Dargues Reef Shaft. Flows across that weir have been monitored since April 2009 and indicate that Spring Creek has a base flow of approximately 0.3L/s. AGE (2010) state that this is primarily associated with discharge at the spring located approximately 1km upstream of the weir.

4.4.2.4 Surrounding Groundwater Users

AGE (2010) undertook a search of the NSW Office of Water- administered database of bores within a 5km radius of the Project Site. That search identified 13 registered bores within the search area (**Figure 4.18**). In addition, the Proponent undertook a census of existing privately owned bores and wells in the vicinity of the Project Site. A total of 25 bores or wells were identified. It is noted that there may be some overlap between the bores identified during the search for registered bores and those identified during the bore census.

The majority of bores in the vicinity of the Project Site are located within the village of Majors Creek, with three bores identified to the southwest and west of the Project Site and one bore identified to the east of the Project Site (**Figure 4.20**).

The database search and bore census indicates that majority of bores are within regolith or granodiorite aquifers and may be up to 30m deep. Groundwater use includes stock watering, watering of gardens and domestic use.

The closest bores to the proposed Dargues Reef Mine are Bores 16 and 17 located approximately 1.4km to 1.7km to the west of the mine respectively.

Finally groundwater modelling (see Section 4.5.5.6) indicates that groundwater from the granodiorite and regolith aquifers discharge to creeks and drainage lines within the Shoalhaven Catchment.

4.4.3 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures to ensure that groundwater users are not adversely impacted as a result of reduced groundwater availability and that environmental impacts are reduced to an acceptable level.

- Undertake consultation with the owners of bores that are predicted to be adversely impacted by the Project to ensure that those impacts are adequately mitigated or the owners compensated. Options include deepening or redrilling and re-equipping the existing bores or providing additional water from another source to compensate for the reduced groundwater supply.
- Release water source primarily from the harvestable rights dams at the rates identified in **Table 4.20** into Majors Creek at the confluence of Majors and Spring Creeks. These environmental discharges are to continue from the commencement of mining operations until 2 years after the cessation of dewatering operations.
- Negotiate an appropriate arrangement with the owners of Lot 210, DP755934 to allow construction or equipping of a bore to access groundwater within the Snobs workings prior to construction of that bore and extraction of water.
- Monitor groundwater levels in surrounding, privately-owned bores on request. The Proponent would ensure that all landholders in the vicinity of the anticipated zone of groundwater drawdown are briefed on the anticipated impacts and that an appropriate monitoring program is negotiated. In addition, a similar offer would be made to all other land owners with bores in the vicinity of the Project Site.

The Proponent would also undertake a review of the numerical groundwater model within 2 years of the commencement of mining operations to confirm the accuracy of the model and anticipated impacts. In the event that the actual impacts are significantly greater than those presented in AGE (2010), than the Proponent would consult with the NOW in relation the revised modelling results and would develop appropriate management and mitigation measures to address those impacts.

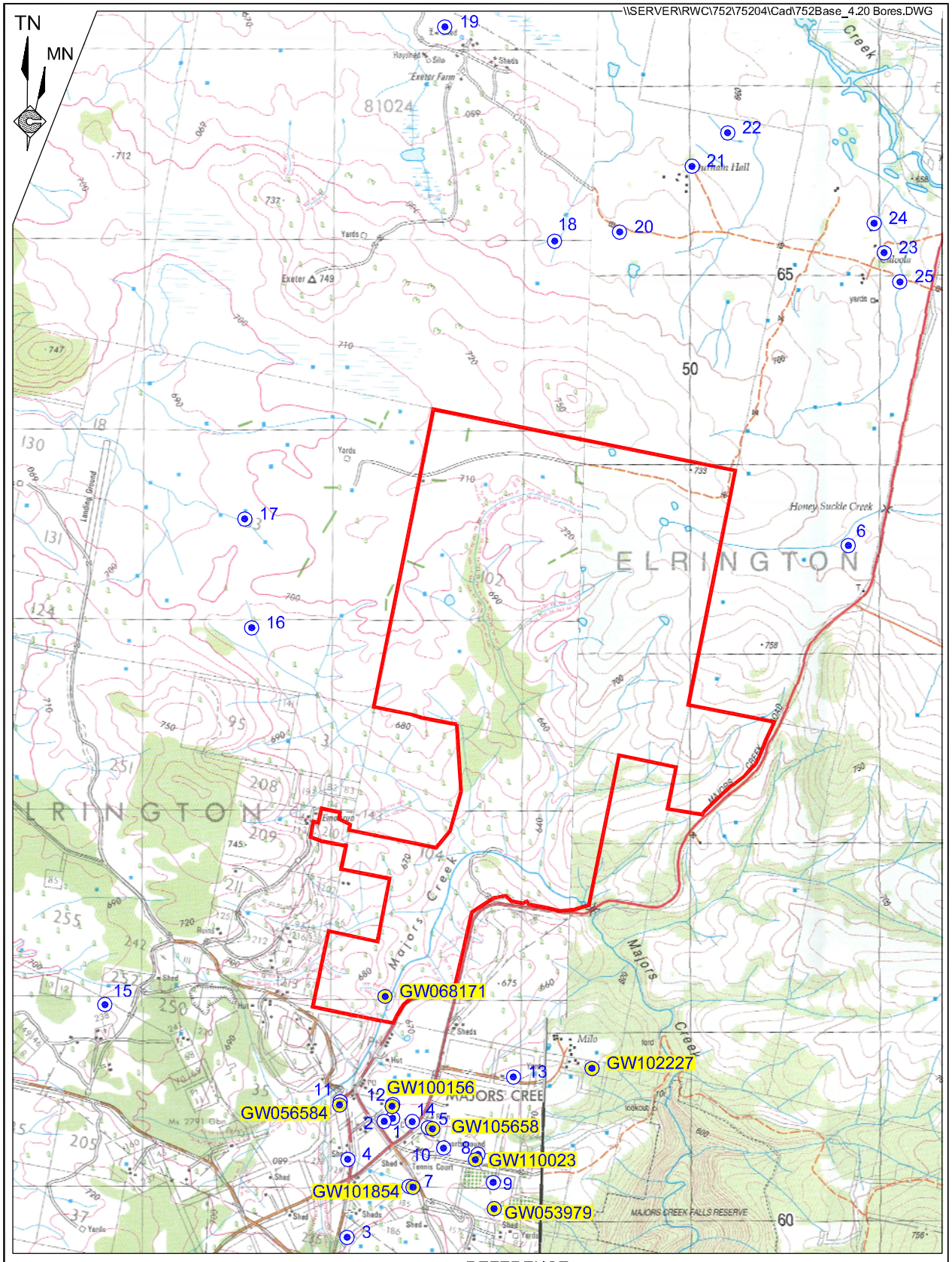


Figure 4.20
SURROUNDING BORES AND WELLS

In addition, the Proponent would implement the following hydrocarbon and chemical management and mitigation measures to minimise the potential for groundwater contamination associated hydrocarbon or chemical use.

- Store all hydrocarbon and chemical products within a bunded area complying with the relevant Australian Standard.
- Refuel all equipment within designated, sealed areas of the Project Site, where practicable.
- Undertake all maintenance works involving hydrocarbons, where practicable, within designated areas of the Project Site such as the maintenance workshop.
- Direct all water from wash-down areas and workshops to oil/water separators and containment systems.
- Ensure all hydrocarbon and chemical storage tanks are either self-bunded or bunded with an impermeable surface and a capacity to contain a minimum 110% of the largest storage tank capacity.

Finally**,** the Proponent would implement the following management and mitigation measures to minimise the potential for groundwater contamination associated with management of tailings material.

- Design and construct the tailings storage facility as described in Section 2.7 and in accordance with the requirements of the relevant government agencies. Key design parameters would be as follows.
  - Construct the floor and walls of the tailings storage facility in a manner that would achieve a permeability of less than $1x10^{-9}$m/sec.
  - Ensure that the tailings storage facility embankment is keyed into the underlying material in a manner that would prevent down slope migration of potentially contaminated groundwater from the facility.
  - Place residue uniformly around the perimeter of the tailings storage facility via several slurry spigots.
  - Construct seepage collection structures at the foot of the tailings storage facility embankment and ensure that any captured seepage is automatically pumped back to the tailings storage facility.
  - Install piezometers at appropriate intervals at the base of the tailings storage facility embankment and monitor these regularly to assess the integrity of the facility (see Section 4.5.6).

4.4.4 Assessment Methodology

4.4.4.1 Conceptual Groundwater Model

Prior to commencing detailed modelling, AGE (2010) constructed a conceptual groundwater model to provide an idealised and simplified representation of how the groundwater system operates given the available data. **Figure 4.21** presents an overview of the conceptual groundwater model which includes the following components.

- An approximately 15m thick veneer of regolith aquifer over a fractured granodiorite aquifer.

- Thin alluvial aquifer associated with Majors Creek.
- Recharge of the regolith aquifer from infiltration of incident rainfall.
- Recharge of the underlying granodiorite aquifer through seepage from the regolith aquifer and infiltration of incident rainfall.
- Recharge of the alluvial aquifer through seepage from the regolith and granodiorite aquifer, infiltration of incident rainfall and surface runoff.
- Discharge from all aquifers into streams and at springs, with limited evapotranspiration.

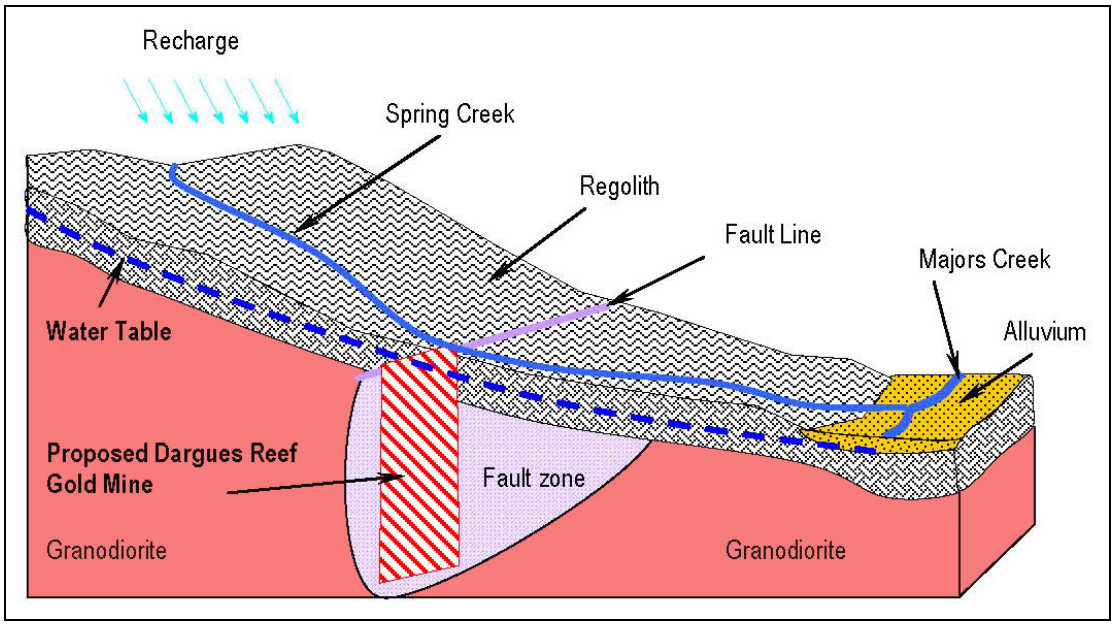


Figure 4.21
Conceptual Groundwater Model

Source: AGE (2010) – Figure 10.

4.4.4.2 Groundwater Discharge Zones

Groundwater modelling assumed groundwater discharge from the following locations.

- Natural springs and creeks.
- Dewatering of the proposed Dargues Reef Mine during mining operations. The rate of dewatering would be dependent on the rate of groundwater inflow to the mine.

- Removal of groundwater for mining-related purposes from the existing Snobs, Stewart and Mertons and United Miners workings. The location of the workings in shown in **Figure 4.18** and **Figure 4.22** presents a section through the workings. AGE (2010) estimate that the total volume of the workings is approximately 82 000m^2, from which approximately 49 000kL of water would be recoverable. For the purposes of modelling the Project-related groundwater impacts, AGE (2010) assumed that groundwater would be extracted from each of the workings as follows.
  - Snobs workings - 1.25L/s or 39.4ML/year.
  - Stewart and Mertons workings - 0.5L/s or 15.8ML/year.
  - United Miners workings - 0.75L/s or 23.7ML/year.

  As a result, the groundwater model assumed a total of 78.9ML/y would be extracted from the existing workings.

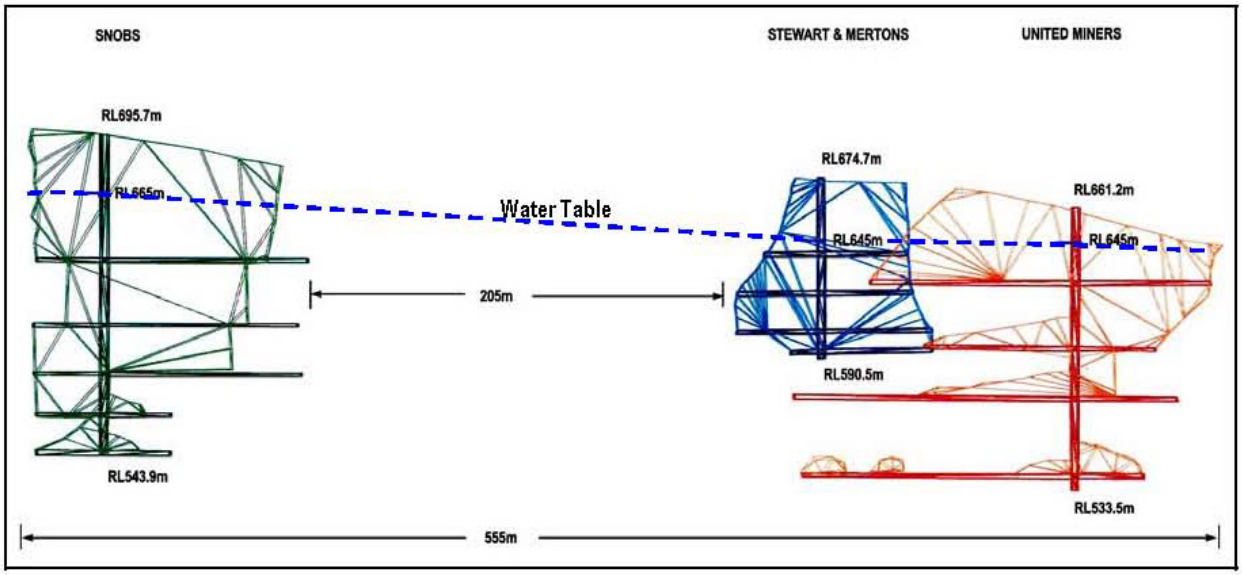


Figure 4.22
Section through Historic Workings

Source: AGE (2010) - Figure 9

4.4.4.3 Model Development

In order to determine the likely groundwater-related impacts associated with the Project AGE (2010) developed a numerical groundwater model using MODFLOW SURFACT. The MODFLOW code is the most widely used code for groundwater modelling and is presently considered an industry standard.

The groundwater model is described in detail in Section 12.3 of AGE (2010). In summary, however, the model was constructed with the following parameters and assumptions.

- An aerial extent of approximately 7km by 6km.
- The model was rotated approximately 30º to the west to align it with the northwesterly major drainage lines and southeasterly direction of groundwater flow.

- The model comprised cells which varied in size from 12.5m by 12.5m within the vicinity of Dargues Reef and the historic workings to 100m by 120m at the perimeter of the model.
- Seven model layers were created, with the first representing the alluvial aquifer with a thickness of 1m to 3m, the second representing the regolith aquifer with its base 15m below surface and the remaining layers representing the granodiorite aquifer with the base of the model at 600m below surface.
- Zones of higher hydraulic conductivity were incorporated based on the location of faults and lineaments either mapped or interpreted from geophysical data by the Proponent.
- The edges of the model were assumed to be no-flow boundaries.
- Recharge rates were determined during model calibration.
- Drain cells were constructed to simulate discharge to creeks. A nominally high drain conductance of 1 000m^2/day was applied to the drain cells.
- Dewatering of the proposed Dargues Reef Mine was simulated using drain cells which were progressively moved downwards, in monthly increments, to reflect the proposed 5 year mining schedule provided by the Proponent. For the purposes of modelling, it was assumed that during mining, all mined areas were open voids. However, following the completion of mining operations and during recovery of the groundwater levels, mined areas were assumed to have been backfilled, with a remaining permeability of 35%.
- Extraction of water from the existing workings was simulated using the Fractured Well package of SURFACT using an equivalent well diameter of 12m to take into account the storage of groundwater within the workings.
- Two specific yields, namely the drainable porosity, were assumed for the granodiorite aquifer. These were 0.001 and 0.01. AGE (2010) state that these reflect the expected range of specific yields for a granodiorite-hosted aquifer.

4.4.4.4 Model Calibration

In order to ensure that the groundwater model reflected as accurately as possible the actual hydraulic parameters of the aquifers within and surrounding the Project Site, the model was calibrated using the PEST software and associated utilities. This permitted model parameters to be adjusted until model-generated groundwater levels fit the observed levels as closely as possible. Section 12.4.1 of AGE (2010) provides a detailed description of the calibration procedure and results. However, the following provides a brief summary of the inputs and results of the calibration.

- Groundwater level measurements from 35 existing exploration holes the monitoring bores were used. These were assumed to reflect the long term average groundwater levels.

- Comparing the results of the calibrated model with the observed groundwater levels gave a root mean squared error of 3.9m. AGE (2010) state that given the observed head loss within the model domain is 88m, that this error level is considered acceptable.
- Recharge rates were determined to be approximately 45mm/year (6.3% of the annual rainfall) on the upper, flatter slopes and hill tops, 20mm/year (2.8% of the annual rainfall) to the steeper side slopes and 3mm/year (0.5% of the annual rainfall) to the low lying and thin alluvial areas adjacent to Majors Creek, that is the groundwater discharge zone. Recharge was applied uniformly throughout the year to correspond with the fairly evenly distribution of rainfall pattern.
- Hydraulic conductivities for each aquifer and for faults within the regolith and granodiorite aquifers were determined with reference to measured values, where available, and results of the calibrations. Table 9 of AGE (2010) presents the assumed hydraulic conductivities.

4.4.5 Assessment of Impacts

4.4.5.1 Inflow to Dargues Reef Mine

The Proponent anticipates that decline development would result in the decline achieving the maximum proposed depth extent of 500m below surface after approximately 2 years, with mining operations continuing for a further 3 years. The groundwater model simulated development of the mine in 60 one month increments, with all water estimated to flow into the mine removed as it is produced.

Figure 4.23 presents the estimated groundwater inflow into the proposed mine for specific yields of 0.001 and 0.01. In summary, the model predicts the following.

- Initial inflows would be expected to be between approximately 7.5L/s and 8.5L/s.
- As the decline progresses, the inflows would be expected to increase to be between approximately 9.0L/s and 10.0L/s until completion of the decline at the end of Year 2.
- Following completion of the decline, groundwater inflows are predicted to decline exponentially to approximately 7.2L/s at the end of Year 5.

AGE (2010) note that the predicted inflows are potentially a conservative overestimate as some faults may act as barriers to groundwater flow rather than conduits. It is also noted that the predicted inflows to the proposed mine would report to the mine sump and be pumped to the surface. It is anticipated that the following losses, amongst others, would occur.

- Water loss through moisture contained within ore and waste rock removed from the mine is estimated to be, on average, approximately 0.6L/s.
- Water loss through the ventilation system is estimated to be between approximately 0.14L/s and 0.18L/s.

As a result, it is likely that between approximately 9L/s and 6L/s would be pumped to the surface and would be available for mining-related purposes. It is noted that in developing the mine water balance, a conservative estimate of 4L/s has been used to take into account potential overestimates in the modelled inflows to the proposed mine (see Section 4.6.5).

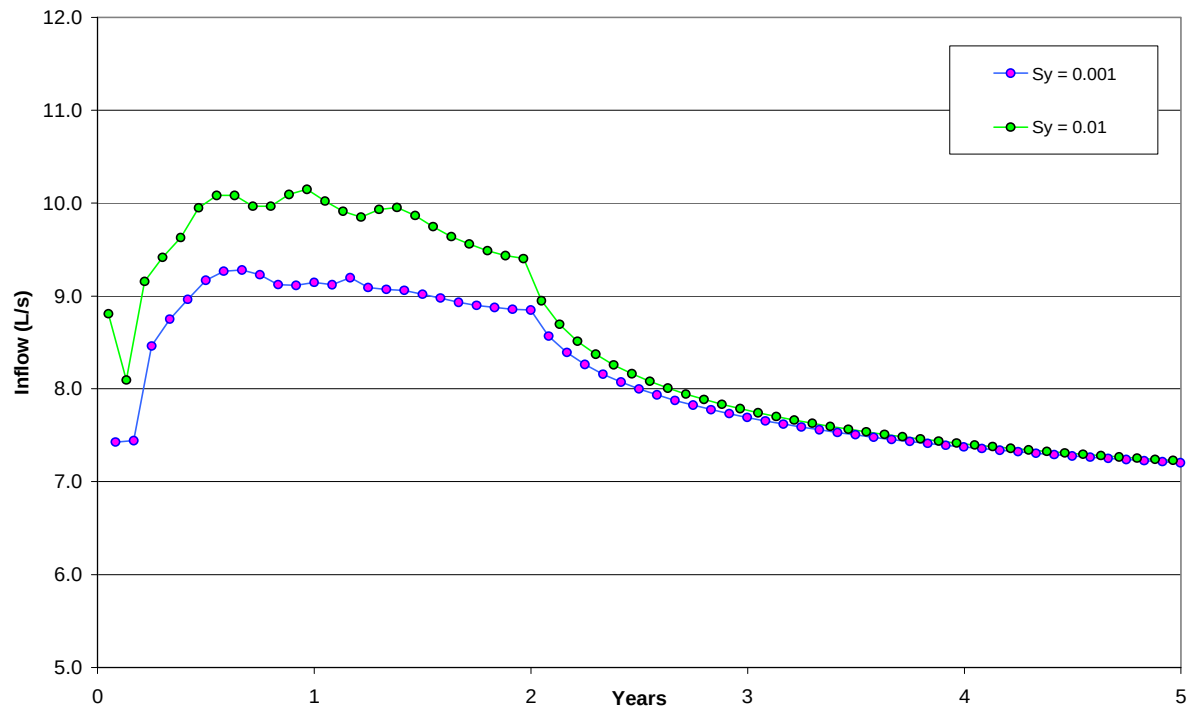


Figure 4.23
Predicted inflow to Dargues Reef Mine

Source: AGE (2010) – Figure 13.

4.4.5.2 Impact of Pumping from the Historic Workings

The model assumed a total extraction from the Snobs, Stewart and Mertons and United Miners workings of 2.5L/s, or 78.9ML/year, for the 5 year life of the mining operations. **Figure 4.24** presents the estimated drawdown hydrographs for each of the workings. The results of the modelling may be summarised as follows.

- Snobs workings – the groundwater level is predicted to fall approximately 70m to approximately 592m AHD or approximately 48m above the base of the workings.
- Stewart and Mertons workings - the groundwater level is predicted to fall approximately 28m to approximately 618m AHD or approximately 27m above the base of the workings.
- United Miners workings – the groundwater level is predicted to fall approximately 23m to approximately 622m AHD or approximately 88m above the base of the workings.

It is noted, however, that the model assumed continuous pumping from the underground workings. As indicated in Section 2.10.2.6, the Proponent would extract water for mining-related purposed from the historic workings only when insufficient water is available from the higher priority water sources, namely the proposed Dargues Reef Mine and the harvestable rights dams.

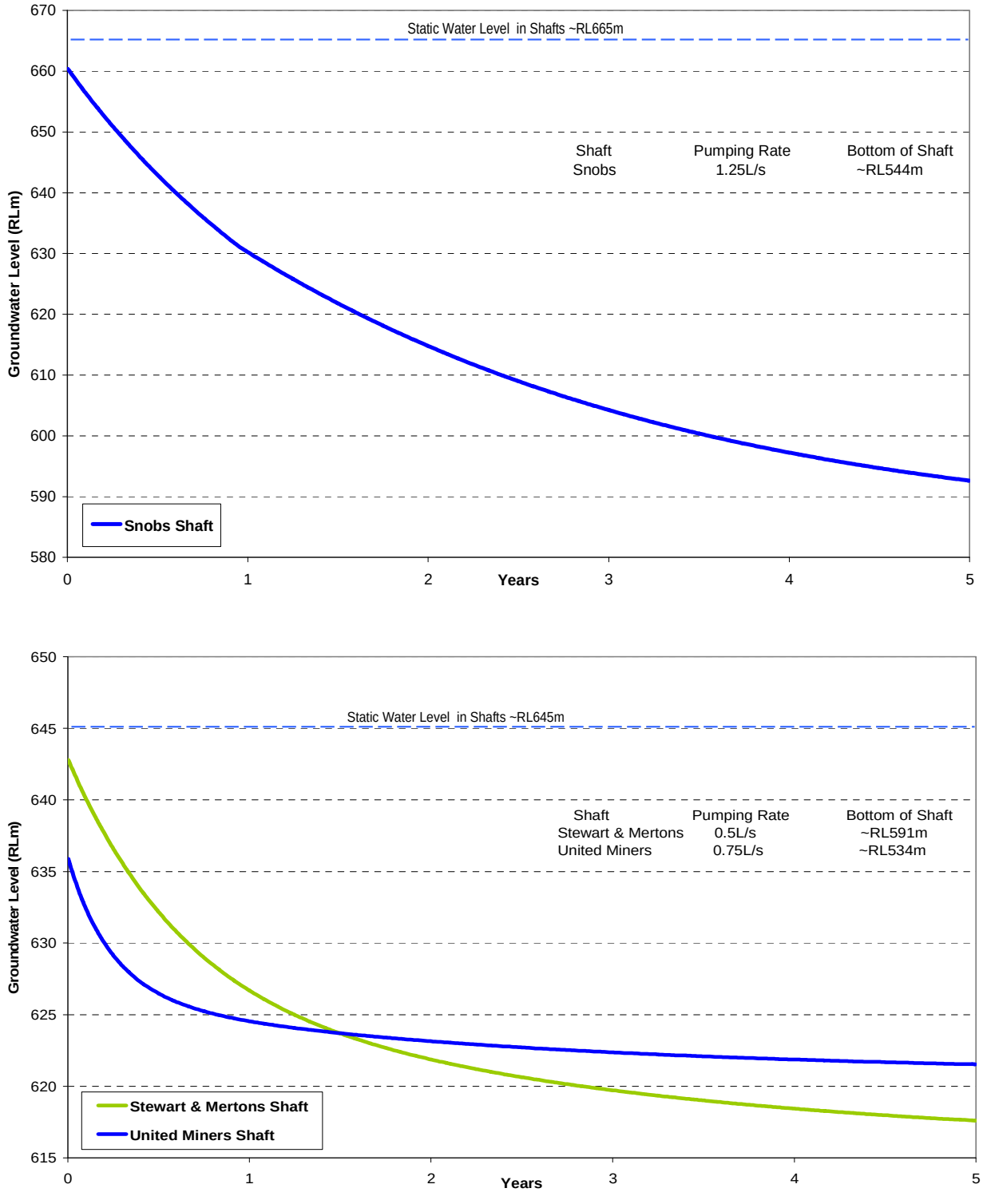


Figure 4.24
Predicted Groundwater Drawdown – Historic Workings

Source: AGE (2010) – Figures 14 and 15.

4.4.5.3 Impact on Piezometric Surface Levels

Figure 4.25 presents the anticipated piezometric or groundwater level surface at the end of mining operations, namely at the end of Year 5 and **Figure 4.26** presents the anticipated piezometric drawdown or the difference between the modelled pre-mining piezometric surface and the piezometric surface at the end of Year 5. These results may be summarised as follows.

- The 1m drawdown contour, or the maximum radius of measurable impact, extend approximately 2.5km from the proposed mine.
- Dewatering of the proposed mine is anticipated to have a more significant impact on groundwater levels than extraction of water from the historic workings.
- The drawdown pattern would be broadly concentric, with some influence from faulting.
- There would be between 1m to 5m of drawdown in the alluvium and underlying regolith along Majors Creek over a 1.5km reach of the creek.
- The entire reach of Spring Creek is expected to be within the 1m drawdown contour.
- The 1m drawdown contour extends approximately 1.4km into the Shoalhaven catchment.

4.4.5.4 Impact on Groundwater Discharge

Base flow, namely that flow that is not associated with individual rainfall events in surrounding creeks is largely dominated by groundwater inflows, either directly to the creek or to the alluvial aquifer, from the granodiorite or regolith aquifers. As noted in Section 4.4.5.3, an approximately 1.5km long section of Majors Creek and the majority of the reach of Spring Creek is expected to be within the 1m drawdown contour (**Figure 4.26**). Majors Creek, Spring Creek and a number of small unnamed drainage lines within the Shoalhaven Catchment were modelled as a groundwater discharge zones. The results of the modelling for Majors Creek are presented in **Figure 4.27** and the modelled reduction in groundwater discharge at all discharge locations is presented in **Table 4.20**. These results may be summarised as follows.

- The pre-mining groundwater discharge from the granodiorite and regolith aquifer to Majors Creek is approximately 3.5L/s. This is expected to decrease gradually during the 5 year life of the mining operations to approximately 1.8L/s, or a reduction of approximately 1.7L/s. Following the completion of mining operations at the end of Year 5, the rate of discharge is expected to recover rapidly to 0.3L/s by Year 8 or three years after the completion of mining operations.
- The pre-mining groundwater discharge from Majors Creek and the alluvial aquifer to the granodiorite aquifer is approximately 1.0L/s. This is expected to increase gradually during the 5 year life of the mining operations to approximately 1.1L/s, or an increase of approximately 0.1L/s. Following completion of mining, this is expected to recover completely within 12 months.

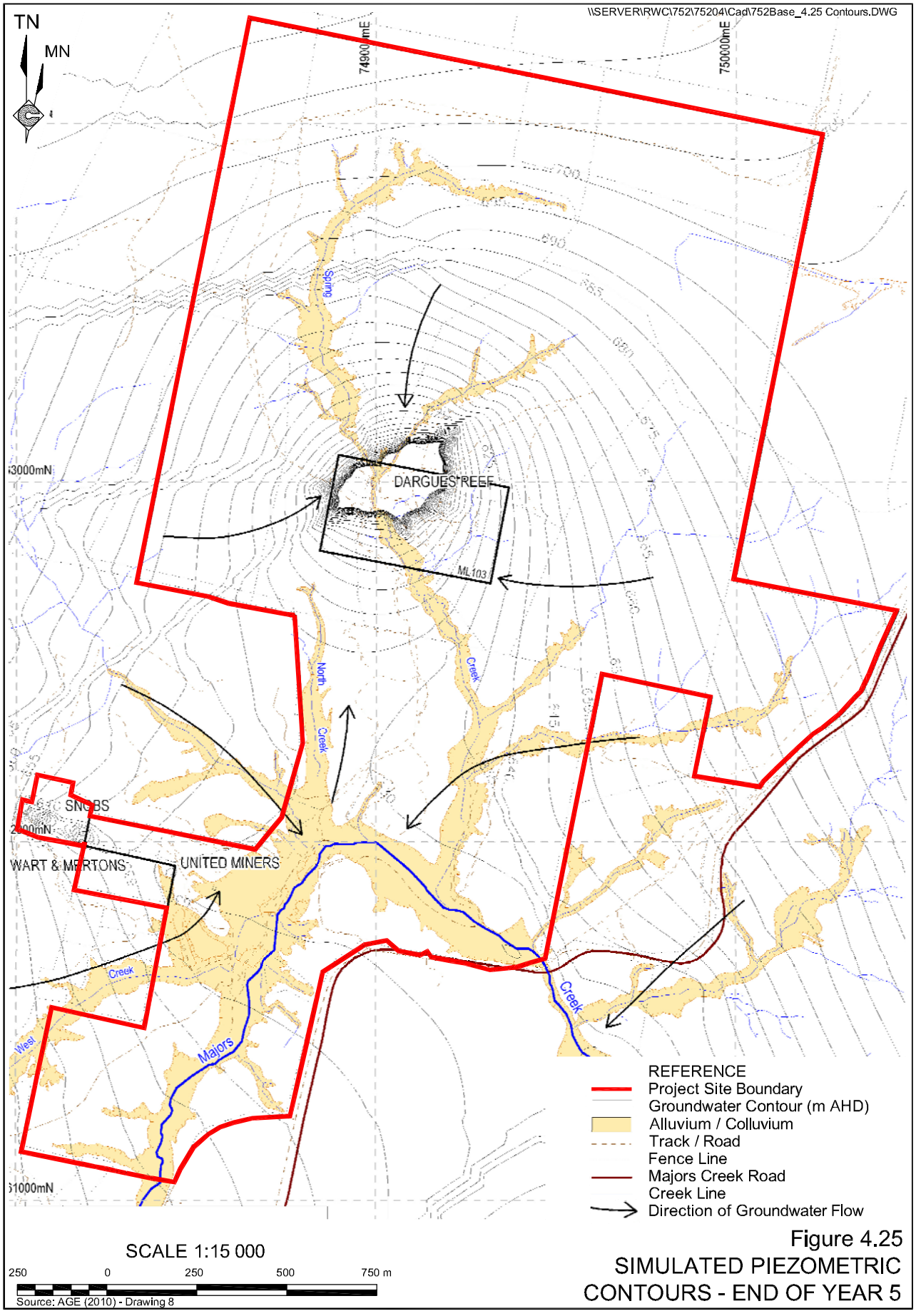


Figure 4.25
SIMULATED PIEZOMETRIC CONTOURS - END OF YEAR 5

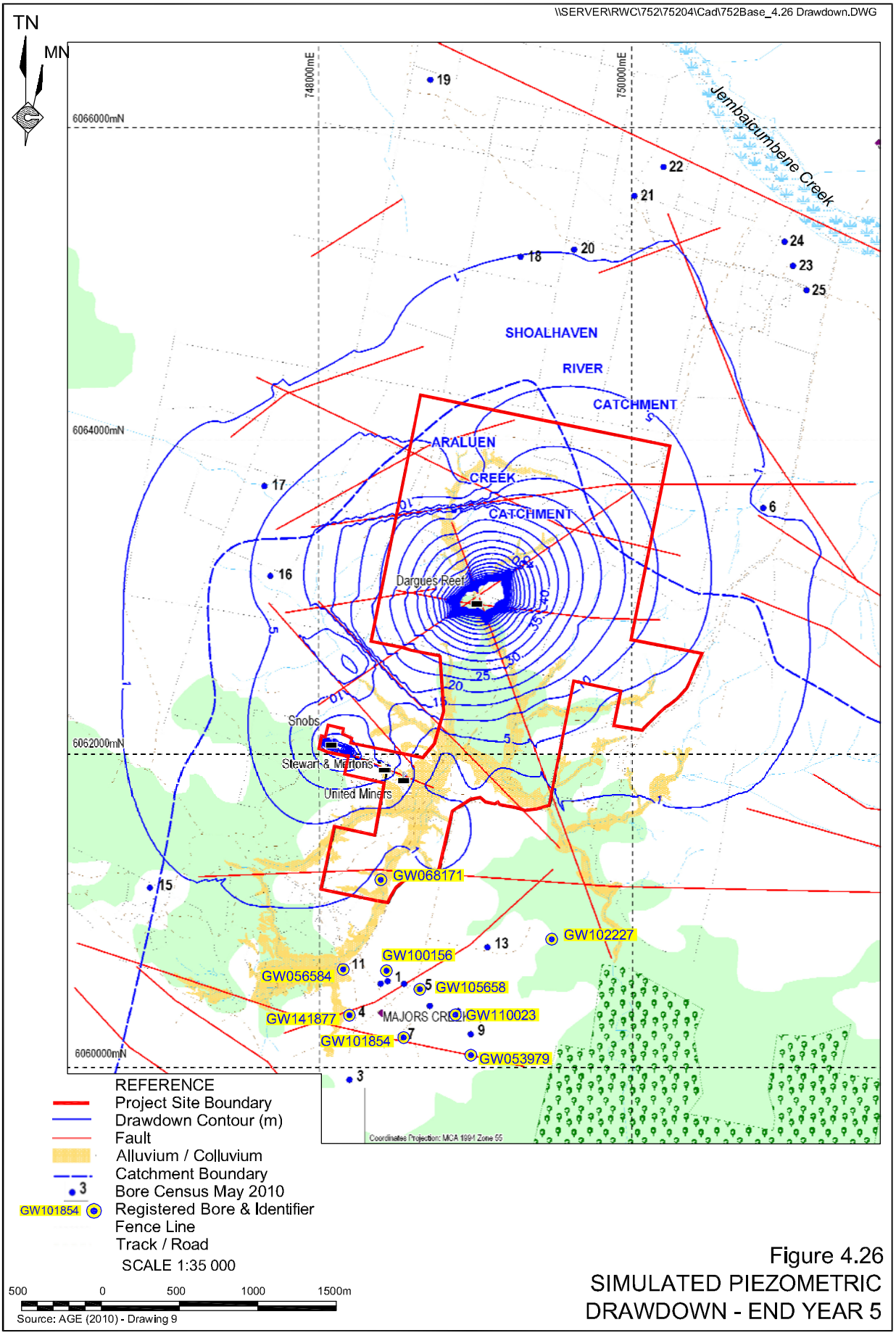


Figure 4.26
SIMULATED PIEZOMETRIC DRAWDOWN - END YEAR 5

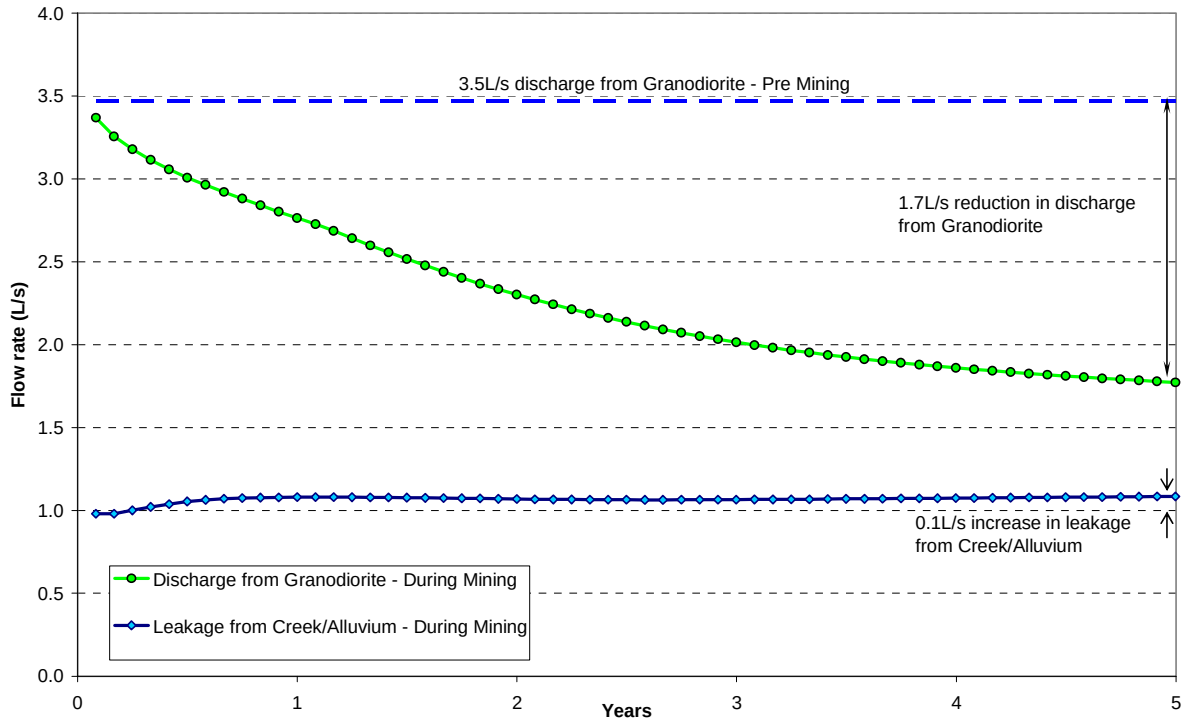


Figure 4.27
Simulated Majors Creek Discharge and Recharge

Source: AGE (2010) – Figure 16.

- The measured pre-mining base flow within Spring Creek is approximately 0.3L/s. AGE (2010) state that this base flow is expected to cease during the life of the mining operations and for up to 5 years following the completion of mining.
- As noted in Section 4.4.5.3, the 1m piezometric drawdown contour shown on **Figure 4.28** extends approximately 1.4km into the upper Shoalhaven Catchment. AGE (2010) note that the anticipated piezometric drawdown would extend below the upper catchment of a number of small, unnamed creeks, reducing discharge from the granodiorite aquifer to these creeks. The estimated reduction in discharge would increase slowly to be approximately 0.42L/s at the end of mining operations. This would recover gradually 0.32L/s by Year 8 or three years after the completion of mining operations.

As a result, the anticipated reduced base flow in Majors and Spring Creeks as a result of the Project is expected to increase gradually from nil at the commencement of mining operations to approximately 2.1L/s at the end of mining operations at the end of Year 5. This would recover rapidly to be 0.9L/s in Year 7 or 2 years after the completion of mining operations. As a result, the Proponent would ensure that a maximum of approximately 2.1L/s would be released at the confluence of Majors and Spring Creeks from the commencement of mining operations until 2 years after the completion of dewatering operations.

The Proponent contends that a combined reduction in base flow within the Shoalhaven Catchment is not significant or measurable. As a result, no compensatory flows are proposed in that catchment.

Table 4.20
Estimated Project-related Reduction in Groundwater Discharge

From	To	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Moruya Catchment (L/s)							←End of mining operations				
Granodiorite aquifer	Spring Creek	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Granodiorite aquifer	Majors Creek	0.7	1.2	1.5	1.6	1.7	1.2	0.6	0.3	0.1	0.05
Alluvial aquifer	Granodiorite aquifer	0.05	0.1	0.1	0.1	0.1	0	0	0	0	0
Total	**L/s**	**1.05**	**1.6**	**1.9**	**2.0**	**2.1**	**1.5**	**0.9**	**0.6**	**0.4**	**0.35**
	ML/year	**33.1**	**50.4**	**59.9**	**63.0**	**66.2**	**47.3**	**28.3**	**18.9**	**12.6**	**11.0**
Proposed Environmental Release (ML/year)		**33.1**	**50.4**	**59.9**	**63.0**	**66.2**	**47.3**	**28.3**	**-**	**-**	**-**
Shoalhaven Catchment (L/s)											
Granodiorite aquifer	Shoalhaven Catchment	0	0.1	0.2	0.31	0.42	0.42	0.4	0.32	0.22	0.1

Source: AGE (2010) - After Table 10

4.4.5.5 Impact on Groundwater Users

Figure 4.26 presents the location of bores surrounding the Project Site. Two bores, namely Bore 16 and Bore 17 are located within the anticipated 1m drawdown contour. As a result, the standing water levels and yields from these bores would be expected to decrease as a result of the Project. The Proponent has commenced negotiations with the owners of those bores, with a view to reaching an agreed outcome. Potential outcomes may include deepening or re-equipping bores, drilling new bores or providing water from the mine water supply for the duration of the anticipated impacts.

In addition, Bores 6, 15, 18 and 20 and Registered Bore GW068171 are located in the vicinity of the 1m drawdown contour. AGE (2010) note that this contour is typically considered to be the limit of Project-related impacts because groundwater levels may vary naturally by up to 1m. However, in light of the proximity of these bores to the anticipated 1m drawdown contour, the Proponent has also commenced negotiations with the owners of these bores with a view to monitoring standing water levels and yields within the bores. In the event that groundwater supply from the bores is adversely impacted by the Project, the Proponent would negotiate an appropriate arrangement with the owner of the bore in question.

Finally, it is noted that no other groundwater users or bores are expected to be adversely impacted by the Project.

4.4.5.6 Impact on Groundwater Dependent Ecosystems

AGE (2010) identifies that groundwater inflows to Majors and Spring Creeks would be reduced by up to approximately 1.8L/s and 0.3L/s respectively. As noted in the non-Aboriginal Heritage Assessment, summarised in Section 4.8. Majors and Spring Creeks have been significantly disturbed by previous gold-mining operations. In addition, as indicated on **Figure 4.14**, Gaia (2010) indicate that significant sections of both creek lines are classified as "Largely Disturbed Land". As a result, the Project is not expected to result in adverse impacts to groundwater dependent ecosystems as none are likely to exist within the Project Site.

4.4.5.7 Impact on Groundwater Quality

The Project is not expected to have any adverse impacts of groundwater quality for the following reasons.

- As identified in Sections 2.5.2 and 2.7.4, characterisation of the waste rock and tailings material indicated that both these materials are non-acid generating. As result, acidic leachate is not expected to be generated during mining, processing or tailings storage operations or from the final landform.
- Management and mitigation measures identified in Section 4.4.3 represent industry best practice would reduce the potential for groundwater contamination from chemicals and hydrocarbons to an acceptable level.
- The Proponent is not aware of cyanide or mercury being used during previous mining operations. As a result, disturbance or ongoing management of contaminated material as a result of the Project is not anticipated.
- The Braidwood Granodiorite is not known to contain significant concentrations of metals or metalloids that may pose a risk to the environment. As a result, as the Project would not result in the release of naturally-occurring elements that would result in adverse environmental impacts.
- As indicated in Section 2.6.6, no hazardous chemicals would be used during processing operations. As a result, the tailings material is not expected to generate leachate that would have significant adverse environmental impacts.

As a result, the Project would not result in adverse impacts on groundwater quality within or surrounding the Project Site. It is therefore concluded that a significant change in the quality of groundwater in the granodiorite, regolith or alluvial aquifers, is not expected to occur as a result of the Project.

4.4.5.8 Impact on Majors Creek Village Water Supply

It is noted that the village of Majors Creek is upstream of the Project Site. It is also noted that the bore census and search of the registered bore database indicated a number of bores or wells exist within the village of Majors Creek (**Figure 4.26**). However, the predicted extent of the drawdown of the piezometric groundwater level would not extend to the village of Majors Creek. As a result, the Proponent contends that no groundwater users within Majors Creek would be adversely impacted by the Project.

4.4.5.9 Impact on Araluen Village Water Supply

During the Proponent's community consultation it was identified that the community was concerned that the Project may result in a significant adverse impact on the water supply for the village of Araluen and surrounding water users, located approximately 20km downstream and approximately 500m lower in elevation than the Project Site. AGE (2010) note that the Project Site is at the very head of the Araluen Creek catchment and that previous groundwater studies at Araluen indicated that the total sustainable yield of the alluvial aquifers associated with Araluen Creek is between 8 028ML/year and 8 218ML/year. As a result, a reduced base flow of approximately 2.1L/s or approximately 66ML/year in Majors and Spring Creeks would not result in a significant impact on groundwater or surface water supplies at Araluen.

4.4.5.10 Groundwater Recovery

AGE (2010) modelled groundwater recovery following cessation of dewatering activities within the proposed mine and from the Snobs, Stewart and Mertons and United Miners workings at the end of Year 5. **Figure 4.28** presents the results of that modelling. In summary, groundwater levels are expected to rise significantly during the first year following the cessation of mining operations, with the rate of recovery slowing after that period. AGE (2010) note that groundwater levels are expected to be fully recovered within 5 years of the completion of mining operations.

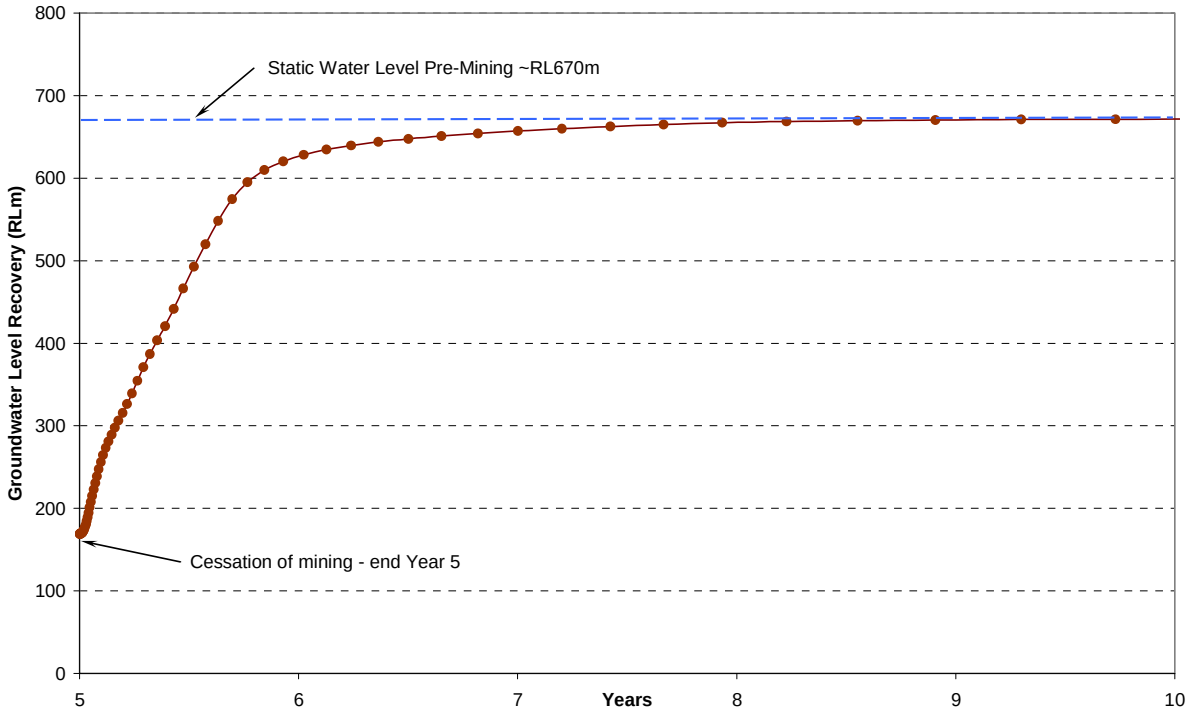


Figure 4.28
Anticipated Recovery of Groundwater Level – Dargues Reef Mine

Source: AGE (2010) – Figure 17.

In addition, Appendix 6 of AGE (2010) presents annual estimates of the groundwater drawdown contours during mining operations, namely Years 1 to 5, and following mining operations, namely Years 6 to 8. That modelling indicates that following the completion of mining operations and associated dewatering activities that the cone of depression shallows rapidly. This is reflected by the predicted rapid rise in water levels within the proposed Dargues Reef Mine. However, the extent of the cone of the depression remains broadly the similar during the Years 6 to 8 as it was during the final stages of mining operations. This is because the deepest sections of the lowered groundwater levels recover first, with the last few metres of recovery expected to take up to 5 years after the completion of mining operations to recover fully.

4.4.6 Monitoring

The Proponent would undertake the monitoring program identified in **Table 4.21** to provide on-going assessment of the impact of the Project and a proactive indicator of any adverse impacts on the groundwater regime, should they eventuate.

Table 4.21
Proposed Groundwater Monitoring Program

Monitoring Location[1]	Groundwater Level		Groundwater Quality		Pumping/discharge Volume
	Manual	Data loggers	Field	Laboratory	
Tailings storage facility piezometers	monthly			monthly	
Tailings storage facility collection pond	monthly			monthly	continuous
DRWB01	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB02	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB03	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB04	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB05	quarterly				
DRWB06	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB07	quarterly	Yes – 6 hourly	quarterly	6 monthly	
DRWB08	quarterly				
MCRC010	quarterly				
MCRC011	quarterly				
MCRC018	quarterly				
MCRC022	quarterly	Yes – 6 hourly			
MCRC029	quarterly	Yes – 6 hourly			
Snobs	quarterly		quarterly	6 monthly	continuous
Stewart & Mertons	quarterly				continuous
United Miners	quarterly		quarterly	6 monthly	continuous
Dargues Reef Mine			quarterly	6 monthly	continuous
Landowner Bores	quarterly		quarterly		

Note 1: See **Figure 4.16** for monitoring locations
Source: AGE (2010) – Table 12.

In summary, the monitoring program would include the following.

- Quarterly monitoring of groundwater levels in the bores, exploration holes and workings identified in **Table 4.21** using manual methods.
- Continuous monitoring of groundwater levels in 8 bores/exploration holes using an automated standing water level monitor to determine the groundwater response following rainfall events.
- Monthly monitoring of standing water levels and the following parameters within piezometers installed around the base of the tailings storage facility embankment and within the collection pond.
  - Alkalinity.
  - Major cations and anions.
  - Metals – (iron, lead, chromium, cadmium, zinc, arsenic, copper and nickel).
- Quarterly monitoring in the field of pH, temperature and EC of groundwater in the bores, exploration holes and workings identified in **Table 4.21.**
- Six monthly monitoring in the laboratory of groundwater in the bores, exploration holes and workings identified in **Table 4.21** for the following parameters.
  - Alkalinity.
  - Major cations and anions.
  - Nutrients – (ammonia, nitrate, nitrite).
  - Metals – (iron, lead, chromium, cadmium, zinc, arsenic, copper and nickel).
- Continuous monitoring of the volumes of all water pumped or permitted to flow around the Project Site using inline meters. This would include water pumped or permitted to flow:
  - from the Dargues Reef Mine to the surface and visa versa;
  - from the harvestable rights dams;
  - from the historic workings; and
  - to and from the tailings storage facility.

Data collected during the groundwater monitoring program would be reviewed on receipt and managed with other environmental monitoring data and would be reported in the Annual Environmental Management Report that would be prepared for the Project. In particular, the following would be implemented to ensure that adverse impacts associated with the Project are monitored and unexpected impacts identified and appropriate action implemented in a timely manner.

- Review of all data on receipt against previous monitoring results. Where the review indicates a sudden or unexpected change, then further investigations would be initiated.

- A formal assessment of the groundwater model would be undertaken within two years of the commencement of mining operations to ensure that the observed groundwater data matches the expected groundwater impacts.
- Annual analysis of monitoring data and trends in the site's Annual Environmental Management Report.
- If groundwater leakage from the tailings storage facility is identified during the monitoring program, relevant government agencies would be notified and amendments would be made to the tailings management procedures within the Project Site. These would ensure that measures would be implemented to reduce the volume of water discharged and to capture any water discharged for return to the tailings storage facility.

Finally, the frequency of monitoring and the parameters to be monitored would reviewed following the initial 12 months of the groundwater monitoring program.

4.5 SURFACE WATER

4.5.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**soil and water** - *including a detailed site water balance and potential water quality impacts on the environment and other land users*"

Based on the risk assessment undertaken for the Project (see Section 3.3), specific surface water-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Reduction in environmental flows.
- Pollution of downstream waters as a result of discharge of dirty, saline or contaminated water.
- Changes to hydrology of creeks and drainage lines.
- Changes to local flood regimes.
- Soil erosion and/or increased sediment load in waterways.

The surface water assessment was undertaken by Strategic Environmental and Engineering Consulting (SEEC). This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 4 (Volume 1) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "SEEC (2010a)". It is noted that SEEC also prepared the Soils and Land Capability Assessment. That report, presented in full as Part 8 (Volume 2) of the Specialist Consultants Studies Compendium and referred to as SEEC (2010b), includes data relied upon during the assessment of surface water related impacts.

The surface water assessment was managed by Mr Andrew Macleod BSc(Hons), CPSS, CPESC of SEEC.

4.5.2 Existing Environment

4.5.2.1 Local and Project Site Drainage and Catchments

The existing drainage and catchments within and surrounding the Project Site are described in detail in Section 4.1.2 and are shown on **Figures 4.2** and **4.3**. In summary, the southern section of the Project Site occurs within the Moruya Catchment, with surface waters draining to Majors Creek, either directly or via Spring Creek.

Surface waters within the northern-most section of the Project Site, within the Shoalhaven Catchment, flow generally northwards, merging with the Shoalhaven River, again, either directly or via Jembaicumbene or Back Creeks. It is noted that no surface disturbing activities are proposed within the Shoalhaven Catchment. As a result, the Surface Water Assessment has focused on surface water impacts within the Moruya Catchment. It is, however, noted that the Groundwater Assessment has determined that, at the end of the mining operations, the extent of groundwater impacts would extend into the Shoalhaven Catchment and may result in marginally reduced surface water flows within that catchment. These impacts, however, would be temporary, with groundwater levels expected to be largely recovered within 1 year of the cessation of mining operations and fully recovered within 3 years.

4.5.2.2 Existing Water Storages and the Proponent's Harvestable Right

Figure 4.3 presents the existing surface water storages within the Project Site. In summary, SEEC (2010a) estimate that to total volume of existing surface water storages within the Project Site is approximately 9ML.

As indicated in Section 2.2.4, the Proponent proposes to construct 8 dams to harvest surface water for use for mining-related purposes. Those dams would be constructed in accordance with the Proponent's Harvestable Right which, based on the location and size of the Project Site, permit extraction of water from dams on ephemeral first or second order streams with a total capacity of 34.5ML. Construction of those dams forms a component of this application and construction and management of the dams is described in detail in Section 2.2.4.

4.5.3 Assessment Criteria

The *Moruya River Water Quality and River Flow Objectives*, published by NOW, identifies Majors and Spring Creeks as "uncontrolled streams" and "upland rivers". **Table 4.22** presents the water quality and river flow criteria that have been adopted as part of this assessment. These are based on the objectives identified in the above document.

4.5.4 Management and Mitigation Measures

The following management and mitigation measures would be implemented to minimise the potential for adverse Project-related impacts on surface waters within and surrounding the Project Site. For convenience, these measures have been divided into general management and mitigation measures, sediment and erosion control measures and water quality measures. Proposed surface water monitoring is described in Section 4.5.7.

Table 4.22
Relevant Water Quality and River Flow Objectives

Objective	Indicator	Criteria
Water Quality Objectives		
Aquatic Ecosystems	Total phosphorus	20 µg/L
	Total nitrogen	250 µg/L
	Salinity (electrical conductivity)	30–350 µS/cm
	Turbidity	2–25 NTU
	pH	6.5–8.0
	Chemical contaminants or toxicants	Based on ANZECC 2000 Guidelines
	Biological assessment indicators	Based on ANZECC 2000 Guidelines
Visual Amenity	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%.
Primary and Secondary Contact Recreation	Faecal coliforms	No significant Project-related adverse change
	Enterococci	
	Algae & blue-green algae	
	Nuisance organisms	
	Chemical contaminants	
	Visual clarity and colour	
	Surface films	
Livestock water supply	Algae & blue-green algae	No significant Project-related adverse change
	Salinity (electrical conductivity)	
	Thermotolerant coliforms (faecal coliforms)	
	Chemical contaminants	
River Flow Objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	No significant Project-related adverse change
Protect natural low flows	Protect natural low flows	
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows.	
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.	
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds.	
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	
Minimise effects of dams on water quality	Minimise downstream water quality impacts of storage releases.	
Make water available for unforeseen events	Ensure river flow management provides for contingencies.	
Maintain or rehabilitate estuarine processes and habitats	Maintain or rehabilitate estuarine processes and habitats.	

Source: After *Moruya River Water Quality and River Flow Objectives*, published by NOW and SEEC (2010a) - Tables 10 and 11

General Management and Mitigation Measures

- Prepare a detailed *Surface Water, Sediment and Erosion Control Plan,* including a description of surface water management structures and procedures to ensure that the criteria identified in Section 4.4.3 and any additional criteria included in the Environment Protection Licence or project approval, assuming that they are granted, are achieved.
- Ensure that the site access road is treated using chemical dust suppressants or similar to ensure that regular watering is not required.

Sediment and Erosion Control Measures

- Ensure that best-practice erosion and sediment control measures as identified in Landcom (2004) and DECC (2008) are implemented during both the construction and operational stages of the Project.
- Construct appropriate sediment basins of sufficient size to contain a five-day, 75th percentile rain depth of 18mm during construction of the Project and a 20-day, 90th percentile rain depth of 73.7mm during operation of the Project.
- Ensure that sediment basins have a minimum of 0.6m of freeboard and a spillway that is sized and lined for stability in a 100-year annual recurrence interval (ARI) rain event.
- Ensure that water discharged from the sediment basins has a total suspended sediment concentration of less than 50mg/L. SEEC (2010a) notes that achieving this commitment may require flocculation.
- Ensure that accumulated water within sediment basins is removed from the basins within 5 days of the end of a rain event.
- Ensure that water within the sediment basins is not used for mining-related activities unless the volume of the sediment basins have been included in the harvestable right calculations.
- Ensure that the upper limit of the Sediment Storage Zone, as defined in Landcom (2004), is identified with a peg and accumulated sediment removed as required.
- Ensure that surface water flows are diverted away from disturbed areas and that potentially sediment-laden flows from disturbed areas are diverted to sediment basins. All diversion structures would be sized and lined for stability in a 10-year ARI time-of-concentration rain event during construction of the Project and the 20-year ARI time-of-concentration rain event during operation of the Project.
- Ensure that disturbed areas are stabilised through the use of vegetation or artificial covers to achieve a long-term C-factor of 0.05 (equivalent to 70% grass cover). Where such areas are to be subjected to channelized water flows, they should be stabilised within 10 days of completion of construction and before they convey any flows.

- Inspect all surface water control structures at least quarterly and following any rainfall event of more than 10mm in 24-hours to ensure their adequacy and identify where remedial action is required.
- Ensure that all roads within the Project Site are constructed in accordance with DECC (2008b).
- Construct table drains along the sides of roads within the Project Site, with regular turn-out drains constructed at-grade approximately every 50m.
- Continue to maintain and upgrade, as required, the existing soil conservation measures in areas of active and stabilised gullying.

Water Quality Measures

- Ensure that the tailings storage facility is effectively sealed to prevent leakage.
- Ensure that potential surface water run on onto the tailings storage facility is diverted around the facility using a surface water diversion structured designed to effectively convey the 100-year ARI, time-of-concentration flow from the upstream catchment.
- Ensure that all fuel and chemical storage, delivery and handling areas are appropriately sealed and bunded and that overflow pipes are installed in a manner that would minimise the potential for pollution in the event of overfilling.

4.5.5 Site Water Balance

4.5.5.1 Introduction

In order to demonstrate a suitable water supply for the Project, SEEC (2010a) prepared a water balance. This sub-section provides an overview of the proposed water sources, the Project's water requirements, the modelling methodology and the results of that modelling.

4.5.5.2 Water Requirements

As described in Section 2.10.2.6, the Project would require a maximum of approximately 130ML of water per year, principally for processing operations. Other water uses would include underground operations, equipment wash down, etc.

It is noted that as the majority of mining-related water is for processing operations, the amount of makeup water required will be proportional to the mine's production rate. As noted in Section 2.4.6, production is anticipated to increase from approximately 161 000t/year in Year 1 to a maximum production rate of approximately 354 000t/year in Year 4 before decreasing to approximately 108 000t/year in Year 5. As a result, the amount of makeup water that would be required would also increase to a maximum of approximately 130ML/year, in Year 4 before decreasing towards the end of the life of the Project. For the purposes of this assessment, the maximum water requirement of 130ML/year has been assumed.

In addition to the above makeup water requirements, the Proponent would require water for dust suppression operations. SEEC (2010a) estimate that based on an assumed 3ha of exposed, unsealed surfaces and a watering requirement of 4mm/m^2/day, that approximately 0.12ML/day of water would be required for dust suppression purposes. Taking into account the fact that dust suppression is only required on non-rain days, SEEC (2010a) estimate that approximately 18.4ML /year would be required for dust suppression purposes.

Finally, as identified in Section 4.4.3, the Proponent proposes to release water at the confluence of Majors and Spring Creeks at the rates identified in **Table 4.20** to compensate for the expected Project-related reduction in groundwater discharge to those creeks. That water would be released from the commencement of mining operations until 2 years after the cessation of mine dewatering operations.

As a result, the anticipated maximum Project-related water requirement would be approximately 215ML/year.

4.5.5.3 Water Sources

As indicated in Section 2.10.2.6, the Proponent would obtain the required make up or new water for mining-related purpose from the following sources.

1. Groundwater that would be removed from the proposed Dargues Reef Mine during mining operations. This water would be preferentially used for mining-relate purposes
2. Surface water from the proposed harvestable rights dams, to be preferentially used for environmental flows.
3. Groundwater from the historic Snobs, Stewart and Mertons and United Miners workings, to be preferentially used for mining-related purposes.

The Groundwater Assessment (AGE, 2010) determined that between 9L/s and 10L/s of groundwater would flow into the proposed Dargues Reef Mine during construction of the decline, reducing to approximately 7L/s during the final stages of mining operations (see Section 4.4.5.1 and **Figure 4.23**). However, the Proponent anticipates that water losses associated with circulation of mine ventilation air and removal of broken rock from the mine would account for approximately 1L/s of that water. In addition, further water losses are expected as a result of water retention within the proposed mine. As a result, for the purposes of this water balance, the Proponent has conservatively assumed that 4L/s, or 126ML/year, of water would be required to be removed from the proposed mine and would therefore be available for mining-related purposes.

As a result, additional water would be required for mining-related purposes from other sources. The Proponent anticipates that this water would preferentially be drawn from the historic Snobs, Stewart and Mertons and United Miners workings (**Figure 2.3**). A maximum of 79ML/year of water would be extracted from the historic workings.

The maximum water requirement for mining-related purposes is anticipated to be approximately 148ML. The proposed Dargues Reef and historic workings are conservatively estimated to be capable of providing approximately 205ML/year. As a result, these sources are expected to be able to adequately supply the Project's mining-related water requirements. The Proponent would be able to adjust extraction rates from the historic workings to ensure that there is not an oversupply of water that would be required to be discharged.

In addition, the Proponent would preferentially extract water for environmental release from each of the harvestable rights dams in a manner that would draw each down at approximately the same rate. As indicated in Section 2.2.4, the Proponent proposes to construct eight dams under its harvestable right. These dams, together with all other water storages within the Project Site, with the exception of the tailings storage facility, would have a combined volume of less than 34.5ML. SEEC (2010a) undertook an assessment of the capacity of the proposed dams to provide sufficient water for the proposed environmental flows.

4.5.5.4 Modelling Methodology

The water balance was determined using software developed by SEEC called RATES. That software uses 100 years of daily rainfall data and takes into account the daily runoff, infiltration, evaporation and water demand patterns. Section 5.3.1 of SEEC (2010a) presents the assumptions and inputs used during the modelling. In summary, these are as follows.

- Initial rainfall loss of 5mm per day and ongoing rainfall loss of 85% to account for infiltration and groundwater recharge.
- Daily rainfall records from the Bureau of Meteorology's Braidwood Wallace Street station from 1 January 1903 to 31 December 2002. Evaporation data have also been drawn from this station. No shading or covering to reduce evaporation of water storages is assumed.
- Water removed for environmental releases sourced from the proposed harvestable right dams at a maximum rate of 2.1L/s or 66/2ML/year.
- In the event that water is not available from the harvestable rights dams then water for environmental releases is sourced from the historic workings.

4.5.5.5 Modelling Results

The results of the water balance modelling are presented in Section 5.3.2 of SEEC (2010a) and may be summarised as follows.

- The primary and secondary water sources provided sufficient water for the proposed mining operations for 86.5% of days modelled.
- During the driest year in the 100 years modelled, approximately 66ML of water would have been required to have been drawn from the historic workings for a maximum of 270 days. It is noted that the Groundwater Assessment assumed groundwater extraction from the historic workings of 78.8ML/year.
- On average, approximately 12ML/year of water would be required to be drawn from the historic workings.

4.5.5.6 Conclusion

In summary, the modelling indicates the following.

- During the 100 year modelling period, the harvestable right dams would be able to supply water for environmental flows 97% of the time.
- During the driest year on record, the harvestable right dams would have run dry for a total of 182 days and approximately 33ML would have been reqired to be drawn from the historic workings. As noted in Section 5.5.4.3, there would be sufficient capacity from the historic workings to meet that demand even at maximum production.
- The harvestable rights dams would have been able to supply 100% of the water for environmental releases on 71 or the 100 years modelled.

Finally, SEEC (2010a) notes that the results of the water balance modelling are conservative for the following reasons.

- The modelling assumes a constant rate of release of 2.1L/s. In reality, that rate of release would vary in accordance with the identified rates in **Table 4.20.**
- It is probability that the period during which the maximum rate of release would coincide with a year with rainfall similar to the driest year in the 100 year modelled is low.

4.5.6 Assessment of Impacts

4.5.6.1 Introduction

This sub-section provides an overview of the surface water impact assessment presented in SEEC (2010a). The sub-section focuses particularly on anticipated sediment and erosion control and water quality and river flow-related impacts and the modelling undertaken to determine the anticipated impacts.

4.5.6.2 Sediment and Erosion Control

The susceptibility of soils within the Project Site to erosion was determined based on information obtained during the soils assessment presented in (SECC (2010b)). The erosion hazard was determined using the Revised Universal Soil Loss Equation (RUSLE). That assessment predicted the following.

- An annual soil loss of 260t/ha/year (Soil Loss Class 3 – moderate erosion hazard) over the area proposed for the access road, box cut and processing infrastructure. This equates, in the absence of adequate control measures, to a potential impact of 6 630t/year of soil erosion.
- An annual soil loss of 576t/ha/year (Soil Loss Class 5 – high erosion hazard) on steeper land within the footprint the proposed tailings storage facility. This equates to 7 488t/year of soil erosion in the absence of adequate control measures.

SEEC (2010a) state that the potential sediment and erosion control risks may be adequately managed through implementation of the mitigation and management measures identified in Section 4.5.4 of this document and Section 7.1 of SEEC (2010a). As a result, SEEC (2010a) conclude that Project-related sediment and erosion control impacts would not be significant.

4.5.6.3 Modifications to Drainage Paths

It is noted that the tailings storage facility would be constructed in the headwaters of an unnamed ephemeral drainage line that forms a tributary to Spring Creek. As identified in Section 2.7.2, the floor and embankment of the facility would have a permeability of less than $1x10^{-9}$m/day. In addition, surface waters from upslope of the facility would be diverted around the facility and would be directed to natural drainage downstream of the facility within the same catchment.

In light of the above, SEEC (2010a) indicate that the modification of the natural drainage path would be very localised and would not divert any water from one catchment to another. As a result, the impact would not be significant.

4.5.6.4 Modifications to Groundwater Recharge

SEEC (2010a) note that the Project would result in construction of a number of areas of impervious surfaces, including roads, hardstand and concrete areas and buildings. As a result, groundwater recharge may be marginally reduced during the life of the Project. However, as these structures would be largely removed at the end of the Project, the pre-mining recharge rates would be re-established. As a result, reduced recharge-related impacts would be temporary and would not be significant. In addition, any temporary impacts would be compensated for by the return of approximately 2.1L/s of base flow at the confluence of Majors and Spring Creeks.

4.5.6.5 Discharge of Pollutants

Introduction

SEEC (2010a) assessed the existing surface water quality and the anticipated surface water quality following development of the Project using the computer program *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC). This sub-section provides an overview of the methodology used during that modelling and the results of the assessment.

Modelling Methodology

The following assumptions were used during modelling of surface water quality.

- The MUSIC modelling domain was established based on a proposed area of disturbance of approximately 24ha (the proposed disturbance area). It is noted that the proposed tailings storage facility and box cut were excluded from modelling because both structures would be internally draining.
- Climate assumptions used during the modelling were prepared by the Sydney Catchment Authority for the Shoalhaven Catchment. Section 6.2.5.3 of SEEC (2010a) presents a detailed overview of the climate assumptions used.
- Land use was assumed to be agricultural, with 99% of the modelled area assumed to be pervious.

- Infiltration rates were based on Macleod (2008) and assumed 0.5m of sandy loam. SEEC (2010a) state that the properties of the two soil landscape units observed within the Project Site, namely the Braidwood and the Bushy Hill Soil Landscape Units (see Section 4.12) were sufficiently similar to allow them to be treated as a single unit for the purposes of the surface water quality modelling.
- Assumed water quality parameters from disturbed sections of the Project Site are presented in Table 8 of SEEC (2010a), which, in turn is based on water quality parameters prepared by the Sydney Catchment Authority for the Shoalhaven Catchment.
- Sediment basins were assumed to be constructed and operated in accordance with Landcom (2004) and DECC (2008a) requirements. The total assumed capacity of the basins was 6 000m^3, with a surface area of 4 000m^2.
- The site access road was assumed to be constructed in accordance with DECC (2008b), including roadside table drains with at-grade turn-out drains every 50m on both sides of the road. The site access road was assumed to be 75% impervious.
- The offices, processing areas, workshops, yards, storage areas and haul road were assumed to have an effective impervious area that is 50% of their total area.
- The roofs of buildings were assumed to be plumbed into an 40 000L rainwater tank and that water was assumed to be used at a rate of 2 835L/day, based on the anticipated number of employees.

Modelling Results

Table 4.23 presents the results of the MUSIC modelling. The results may be summarised as follows.

- Water flow – the Project is expected to increase annual surface water flows by 1.3% or approximately 1.7ML/year. SEEC (2010a) state that this increase is not significant.
- Total suspended solids – the Project is expected to reduce the amount of suspended solids discharged annually from the proposed disturbance area by approximately 85% or 6 860kg/year.
- Total phosphorus – the Project is expected to reduce the amount of phosphorus discharged annually from the proposed disturbance area by approximately 72% or 17.12kg/year.
- Total nitrogen – the Project is expected to reduce the amount of nitrogen discharged annually from the proposed disturbance area by approximately 52% or 84.1kg/year.
- Gross pollutants – the Project is expected to reduce the amount of gross pollutants or large material such as vegetation or rubbish to nil.

Table 4.23
MUSIC Modelling Results

MUSIC Model Number	Description	Flow (ML/yr)	TSS[1] (kg/yr)	TP[1] (kg/yr)	TN[1] (kg/yr)	GP[1] (kg/yr)
1	Pre-development	48.1	8,050	23.9	161	23.3
2	Operational stage without surface water management	64.4	24,300	21.9	137	1,810
3	Operational stage including surface water management	49.8	1,190	6.78	76.9	0
2 vs 3	Treatment Train Effectiveness	-23%	-95%	-69%	-44%	-100%
1 vs 3	Pre-development vs Operational stage comparison	+3.5%	-85%	-72%	-52%	-100%
Note 1: TSS = total suspended solids; TP = total phosphorus; TN = total nitrogen; GP = gross pollutants						
Source: SEEC (2010a) – Table 9.						

4.5.6.6 Compliance with Moruya River Water Quality and River Flow Objectives

Table 4.24 presents a summary of the assessment of Project-related impacts against the Moruya River Water Quality and River Flow Objectives.

Table 4.24
Impact Assessment - Moruya River Water Quality Objectives

Page 1 of 3

Objective	Indicator	Impact Assessment
Water Quality Objectives		
Aquatic Ecosystems	Total phosphorus	The Project would result in reduced discharge of phosphorus, nitrogen and suspended solids
	Total nitrogen	
	Turbidity	
	Salinity (electrical conductivity)	Project Site soils are non saline. As a result, Project-related impacts would be negligible.
	pH	There are no known acid generating materials within the Project Site and the Project's EPL would control the pH of discharge water. As a result, Project-related impacts would be negligible.
	Chemical contaminants or toxicants	All contaminants would be appropriately contained. As a result, Project-related impacts would be negligible.
	Biological assessment indicators	The Project is unlikely to discharge waters which might affect riparian ecology. In addition, natural base- and storm-flow regimes would be maintained to limit potential ecological impacts. As a result, Project-related impacts would be negligible.
Visual Amenity	Visual clarity and colour	Suspended sediment loads are predicted to be reduced. As a result, Project-related impacts would be negligible.

Table 4.24 (Cont'd)
Impact Assessment - Moruya River Water Quality Objectives

Objective	Indicator	Impact Assessment
Water Quality Objectives (Cont'd)		
Primary and Secondary Contact Recreation	Faecal coliforms	Modelling predicts a beneficial effect on water quality because of the reduction in pollutants presently generated by agricultural land uses. As a result, Project-related impacts would be negligible.
	Enterococci	
	Chemical contaminants	
	Visual clarity and colour	
	Algae & blue-green algae	
	Nuisance organisms	The Project is unlikely to discharge waters which might affect biological activity or create conditions that might increase the numbers of nuisance organisms. As a result, Project-related impacts would be negligible.
	Surface films	Suspended sediment and gross pollutant loads are predicted to be reduced. As a result, Project-related impacts would be negligible.
Livestock water supply	Algae & blue-green algae	The Project is unlikely to modify water quality or flow conditions that might encourage algal growth. As a result, Project-related impacts would be negligible.
	Salinity (electrical conductivity)	Project Site soils are non saline. As a result, Project-related impacts would be negligible.
	Thermotolerant coliforms (faecal coliforms)	The Project would be unlikely to modify water quality or flow conditions that might increase the levels of thermotolerant coliforms. As a result, Project-related impacts would be negligible.
	Chemical contaminants	All contaminants would be appropriately contained. As a result, Project-related impacts would be negligible.
River Flow Objectives		
Protect pools in dry times	Protect natural water levels in pools of creeks and rivers and wetlands during periods of no flows.	AGE (2010) estimate that the Project could reduce the base flow in Majors and Spring Creeks by up to 2.1L/s due to reduced groundwater discharge. This, however, would be mitigated through a compensatory discharge of 2.1L/s.
Protect natural low flows	Protect natural low flows	
Protect important rises in water levels	Protect or restore a proportion of moderate flows ('freshes') and high flows.	The Project would not involves any harvesting of surface above the Proponent's existing Harvestable Right. As a result, Project-related impacts would be negligible.
Maintain wetland and floodplain inundation	Maintain or restore the natural inundation patterns and distribution of floodwaters supporting natural wetland and floodplain ecosystems.	The Project would not significantly alter existing surface water runoff within the Project Site. As a result, Project-related impacts would be negligible.
Mimic natural drying in temporary waterways	Mimic the natural frequency, duration and seasonal nature of drying periods in naturally temporary waterways.	The Project would be unlikely to impact the existing frequency, duration or seasonality of drying periods in creeks within the Project Site. As a result, Project-related impacts would be negligible.
Maintain natural flow variability	Maintain or mimic natural flow variability in all streams.	

Table 4.24 (Cont'd)
Impact Assessment - Moruya River Water Quality Objectives

Objective	Indicator	Impact Assessment
River Flow Objectives (Cont'd)		
Maintain natural rates of change in water levels	Maintain rates of rise and fall of river heights within natural bounds.	The Project would increase the amount of impervious surfaces within the Project Site. However, proposed sedimentation basins would act to temporarily detain that additional runoff. As a result, Project-related impacts would be negligible.
Manage groundwater for ecosystems	Maintain groundwater within natural levels and variability, critical to surface flows and ecosystems.	Groundwater inflows into Majors and Spring Creeks are expected to be reduced by approximately 2.1L/s. However, the Proponent proposes to release approximately 2.1L/s as a compensatory flow, into Majors Creek. As a result, Project-related impacts would be negligible.
Minimise effects of weirs and other structures	Minimise the impact of instream structures.	No instream structures, other than those permitted under the Proponent's Harvestable Right and the tailings storage facility, would be constructed.
Minimise effects of dams on water quality	Minimise downstream water quality impacts of storage releases.	Not applicable. Any releases of water from small, harvestable-right dams on the Project Site would be via the surface-level overflow.
Make water available for unforeseen events	Ensure river flow management provides for contingencies.	Surface water harvesting would only be up to the Proponent's Harvestable Right and groundwater losses would be either negligible or compensated from through a compensatory release of 2.1L/s to Majors Creek. As a result, Project-related impacts would be negligible.
Maintain or rehabilitate estuarine processes and habitats	Maintain or rehabilitate estuarine processes and habitats.	Not applicable.
Source: SEEC (2010a) – After Section 6.2.6		

4.5.6.7 Erosion Management

It is noted that the Proponent and preceding owners of the land within the northern section of the Project Site have undertaken soil conservation works in the vicinity of areas of active gullying on Spring Creek. These works have partially stabilised the gullies and the Proponent would continue to implement and maintain such works. As a result, SEEC (2010a) state that the Project would not result in any significant adverse soil conservation or erosion management-related impacts.

4.5.6.8 Sewage Management

As indicated in Section 2.8, a biocycle or similar sewage treatment plant would be installed within the Project Site to appropriately treat waste water generated by the Proponent's employees and contractors. This would result in treated effluent being used to irrigate sections of the Project Site. SEEC (2010a) state that soils within the Project Site are well suited to surface or near-surface irrigation of treated wastewater.

4.5.7 Monitoring

The Proponent would prepare a detailed *Surface Water, Sediment and Erosion Control Plan*, including surface water monitoring. In summary, the surface water monitoring program would be undertaken at the following locations (**Figure 4.3**).

- Location 1 – Majors Creek upstream of the confluence of Spring and Major's Creek.
- Location 2 – Majors Creek downstream of the confluence of Spring and Major's Creek.
- Location 3 – downstream of the tailings storage facility. It is noted that this sampling location would be incorporated into the *Tailings Management Plan*.
- Location 4 – Spring Creek downstream of main Project infrastructure and sediment basin outlets.
- Compensatory flow discharge point.

Sampling would be undertaken quarterly for the following.

- Field measurements.
  - Field pH.
  - Field Electrical Conductivity.
  - Dissolved Oxygen.
  - Oxidation Reduction Potential.
  - Temperature.
- Laboratory analysis.
  - pH.
  - Electrical Conductivity.
  - Total Suspended Solids.
  - Major cations i.e. sodium, potassium, calcium.
  - Major anions i.e. chloride and sulphate.
  - Total Kjeldahl Nitrogen (organic nitrogen plus ammonia nitrogen).
  - Total Oxidized Nitrogen (also referred to as NOx-N = nitrate + nitrite nitrogen forms).
  - Ammonia Nitrogen.
  - Total Phosphorus and Reactive Phosphorus.
  - Metals (aluminium, arsenic, total iron and filterable iron, zinc).

In addition, the Proponent would monitor the volume of water discharged as part of the Proponent's commitment to implement a compensatory base flow within Majors Creek. The results of the monitoring program would be presented in the *Annual Environmental Management Report* that would be prepared for the Project.

4.6 ABORIGINAL HERITAGE

4.6.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "***Heritage** – both Aboriginal and non-Aboriginal*". In addition, the DECCW and Palerang Council identified key issues to be assessed in relation to Project-related impacts on Aboriginal heritage (see **Appendix 2**).

Based on the risk assessment undertaken for the Project (see Section 3.3), specific Aboriginal heritage-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Destruction of impacted site.
- Cumulative reduction of the in-situ archaeological record.
- Loss or destruction of items of heritage significance.

An Aboriginal Heritage Impact Assessment has been completed by Mr John Appleton (BA (Hons)) of Archaeological Surveys & Reports Pty Ltd to address the DGRs and assess the impact of the Project on items of Aboriginal heritage significance. That report, which is referred to hereafter as ASR (2010a) is presented in full as Part 5a (Volume 2) of the *Specialist Consultant Studies Compendium.* This section of the *Environmental Assessment* provides a summary of that report. It is noted that Mr Appleton also undertook the Non-Aboriginal Heritage Assessment (ASR, 2010b) which is discussed in detail in Section 4.7.

4.6.2 Consultation with the Aboriginal Community

4.6.2.1 Relevant Guidelines

ASR (2010a) states that consultation with the Aboriginal community was undertaken in accordance with the document *Guidelines for Aboriginal Cultural Heritage Impact and Community Consultation* published by then Department of Environment and Climate Change in 2005 (the 2005 Guidelines). It is noted that the DECCW has subsequently released further consultation guidelines, namely *Aboriginal Cultural Heritage Consultation Requirements for Proponents* dated April 2010 (the 2010 Guidelines).

As indicated in Section 4.6.2.2, ASR commenced consultation with the Aboriginal community in January 2010. In addition, the Planning Focus Meeting for the Project was held on 18 March 2010. As a result, the Aboriginal heritage assessment was substantially commenced prior to the commencement of the 2010 Guidelines. Finally, the DGRs issued by the Department of Planning on 23 April 2010 and the Environmental Assessment Requirements issued by the DECCW 1 April 2010 both require that consultation be undertaken in accordance with the 2005 Guidelines.

4.6.2.2 Consultation Program

The following presents a summary of the consultation undertaken for the Aboriginal Heritage Impact Assessment. For convenience, the description of the consultation activities has been divided into stages 1 to 4 in accordance with the descriptions provided in the 2005 and 2010 Guidelines.

Stage 1 – Notification and Registration of Interest

On 10 February 2010 ASR wrote to the following organisations requesting that they provide lists of Registered Aboriginal Stakeholders. Responses were received from those organisations marked with an asterisk.

- the Office of the Registrar administering the *Aboriginal Land Rights Act 1983**;
- the Aboriginal Heritage Planning Officer, DECCW (Dubbo);
- Palerang Council*; and
- NSW Native Title Services.

In addition, an advertisement was placed in the *Tallaganda News* (published 3 February 2010), the *Queanbeyan Age* (published 5 February 2010) and the *Canberra Times* (published 30 January 2010) inviting all Aboriginal stakeholders with an interest in the Project to register their interest.

As a result of the above, the following 11 organisations or individuals were identified as potentially having an interest in the Project.

- Ngunawal Elders Corporation.
- Ngunawal Heritage Aboriginal Corporation.
- Buru Ngunawal Aboriginal Corporation Traditional Carer Group.
- Konanggo Aboriginal Cultural Heritage Services.
- Yurwang Gundana Consultancy Cultural Heritage Services.
- King Browns Tribal Group Pty Ltd.
- Bega Traditional Elders Council (formerly Yulembruk Merung Ngarigo Consultancy Pty Ltd).
- Walbunja Aboriginal Corporation.
- Batemans Bay LALC.
- Ngambri LALC.
- Little Gudgenby River Tribal.

A letter was provided to each of the above on 22 March 2010 providing.

- an overview of the Project; and
- a suggested survey methodology.

As a result of the consultation, one of the registered organisations, namely the Ngambri Local Aboriginal Land Council (LALC) withdrew from the consultation process. Responses indicating a desire to be consulted and participate in the survey were received from the remaining registered organisations.

Stage 2 – Presentation of Information about the Project

During Stage 1, ASR contacted or was contacted by a number of the registered organisations in relation to the Project and the proposed survey methodology. As a result of that consultation, it became apparent that there was 'some differences of opinion' between some of the stakeholders. ASR concluded that that holding a meeting to discuss the Project would only lead to even greater animosity. As a result ASR elected to provide the information that would otherwise have been presented at a stakeholder meeting by mail. That information was presented in the letters described in Stage 1 and sent on 22 March 2010.

During preparation for the survey, ASR agreed with the registered stakeholders that it would be appropriate that each would be engaged in the survey for 1 day.

Stage 3 – Gathering Information about Cultural Significance

Section 4.6.4 presents an overview of the survey methodology used during the field survey and Section 4.6.5 presents a summary of the results of the field survey which was undertaken between Tuesday 4 May and Monday 10 May 2010.

In addition, following completion of the field survey, each of the registered stakeholders who assisted with the survey were requested to provide a written summary of the results of the survey on the day that they attended and an overview of any additional relevant information for inclusion in the Aboriginal Heritage Impact Assessment. The following registered stakeholders provided written responses. Responses were accepted up until the draft report was finalised on 27 July 2010.

- Konanggo Aboriginal Cultural Heritage Services.
- Ngunawal Heritage Aboriginal Corporation.
- Buru Ngunawal Aboriginal Corporation.

None of the responses included any additional information other than the information obtained during the field survey.

Stage 4 – Review of Draft Cultural Heritage Assessment Report

A draft hard copy of the Aboriginal Heritage Assessment report was provided to each of the registered stakeholders on 2 August 2010, with a request to review the report and provide feedback by close of business 1 September 2010. As of 3 September 2010, responses had been received from the following organisations and individuals. Copies of that correspondence is presented in Appendix xiii of ASR (2010a) and feedback and recommendations included in that correspondence has been considered during finalisation of ASR (2010a).

- Buru Ngunawal Aboriginal Corporation.
- Ngunawal Heritage Aboriginal Corporation.
- Batemans Bay Local Aboriginal Land Corporation.

4.6.3 Previously Identified Sites and Predictive Model

4.6.3.1 Previously Identified Sites

A search was made of the Aboriginal Heritage Information Management System (AHIMS) Site Register maintained by the Culture and Heritage Division of DECCW for all sites within a search area of 5km east-west and 6km north-south, centred on the Project Site.

The search identified one site, an open camp site, located to the west of Red Hill outside the Project Site. ASR (2010a) states that this is probably an artefact scatter.

No other relevant surveys were identified by ASR (2010a).

4.6.3.2 Predictive Model

In developing a predictive model for site distribution within the Project Site, ASR (2010a) notes that the following factors are likely to affect the distribution of items of Aboriginal heritage significance.

- The location(s) where Aboriginal people are most likely to have been.
- The location(s) where Aboriginal people were most likely to have left evidence of their activities.
- The degree to which remaining evidence is observable in the present record.

ASR (2010a) note that Aboriginal people would have been most likely to visit those areas that were richest in resources, including available water, food resources, stone raw material sources, shelter, suitable surfaces for rock art and proximity to mythological natural features. In addition, Aboriginal people would have been likely to have visited areas along identified access or travel routes. ASR (2010a) state that the Project Site contains:

- no reliable water source;
- no exposures of suitable store raw material;
- no rock overhangs; and
- in the absence of both water and shelter, there were unlikely to be any places where potential archaeological deposits (PADs)would be likely to occur.

In addition, ASR (2010a) notes that the Project Site has been extensively disturbed. This disturbance included large scale clearing of vegetation, large and small scale alluvial and hard rock mining, establishment (and abandonment) of settlements and other structures and ongoing agricultural and mineral exploration-related operations. Also, as indicated in Section 4.1.2.3, erosion within the Project Site is a naturally active process that has been exacerbated by previously land use practices. As a result, the potential for the preservation of objects of Aboriginal heritage significance has been reduced, although some ground disturbing activities may actually expose artefacts that may not otherwise have been visible.

As a result, ASR (2010a) propose the following predictive model for sites of Aboriginal heritage significance within the Project Site.

- Isolated artefacts - may be present and visible anywhere.

- Low-density artefact scatters - may be present and visible anywhere, however debitage would be unlikely to be visible.
- Scarred and carved trees – may occur on any trees over 150 years old.
- Engravings and/or grinding grooves – unlikely to occur.
- PADs– unlikely to occur.
- Shelters, overhangs and art sites – unlikely to occur.
- Stone quarries – unlikely to occur.
- Shell middens – unlikely to occur.
- Burials – unlikely to occur.
- Bora rings – unlikely to occur.
- Stone arrangements – unlikely to occur.
- Cultural associations – none are known.

4.6.4 Survey Methodology

The field survey was undertaken from Tuesday 4 May to Monday 10 May 2010. As indicated in Section 4.6.2.2, 10 Aboriginal organisations requested to participate in the survey. As there was 'some differences of opinion' between a number of the organisations and individuals who registered an interest in the Project, ASR (2010a) arranged for each organisation to provide a representative for one day of the survey. **Table 4.25** presents the agreed roster for the survey. Those organisations marked with an asterisk did not arrive for the survey as agreed.

Table 4.25
Survey Roster

Date	Organisation
4 May 2010	• Ngunawal Heritage Aboriginal Corporation* • Buru Ngunawal Aboriginal Corporation Traditional Carer Group*
5 May 2010	• Konanggo Aboriginal Cultural Heritage Services* • Walbunja Aboriginal Corporation
6 May 2010	• Bega Traditional Elders Council* • Batemans Bay LALC*
7 May 2010	• Ngunawal Elders Corporation • Yurwang Gundana Consultancy Cultural Heritage Services
10 May 2010	• King Browns Tribal Group Pty Ltd • Little Gudgenby River Tribal
Note 1: * indicates an organisation that participated in the survey.	
Source: ASR (2010a) – After Section 6.1	

At the start of each survey day, Mr John Appleton would meet the Aboriginal representatives as agreed at 9.30am outside the Majors Creek Hotel. When the representatives did not arrive, Mr Appleton would wait until 9.50 before commencing the survey. Prior to commencing the survey, Mr Appleton would discuss and agree with the Aboriginal representatives present on the day the area to be surveyed and the type of sites that may be found. On the second and subsequent survey days, Mr Appleton would also show the Aboriginal representatives any previously identified sites.

Field surveys were undertaken on foot, with particular emphasis made on examining disturbed or exposed areas, including vehicle tracks, dams and stock pads and areas of erosion. In addition, mature trees of an age to support scars or carvings were identified and inspected. Field surveys commenced each day after 9.30am and were typically complete by 3.30pm. The weather was generally dry and sunny with light ideal for observing any artefactual material present.

All sites identified were measured and described in a field log, photographed and their location recorded using a hand held GPS. Table 1 of ASR (2010a) presents an overview of the effectiveness of the survey.

4.6.5 Survey Results

The results of the Aboriginal Heritage Impact Assessment are presented on **Figure 4.29** and **Table 4.26**. In summary, five sites of Aboriginal heritage significance were identified. None of the sites would be disturbed by the Project. However, one site, namely GT OS1, was located in close proximity to the downstream toe of the tailings storage facility embankment. In light of this, the Proponent redesigned the facility slightly to ensure a minimum 20m buffer between the recorded location of the artefact and toe of the embankment. In addition, the proposed transmission line would be constructed in close proximity to GT OS2. The Proponent has committed to implement the management and mitigation measures identified in Section 4.6.6.

Table 4.26
Aboriginal Heritage Survey Results

Site Identifier	Site Classification	Description
GT OS1	Open Scatter	Three artefacts within 50m of each other comprising a silcrete flake and core and a metasedimentary flake.
GT OS2	Open Scatter	Two artefacts comprising silicified metasedimentary proximal fragment of a flake and a metasedimentary core/scraper.
GT OS3	Isolated artefact	Single artefact comprising a quartz proximal fragment of a flake.
GT OS4	Open Scatter	Three artefacts comprising a black chert flake, a quarts flaked piece and a silcrete flake
GT OS5	Isolated artefact	Single artefact comprising a silcrete flake
Note 1: **Figure 4.27** presents the location of each identified site.		
Source: ASR (2010a) – Table 2		

ASR (2010a) notes that a single site, namely an "open camp site" or artefact scatter was identified in the vicinity of the Project Site during a search of the AHIMS database and that the identified sites within the Project Site may be considered representative of that single site.

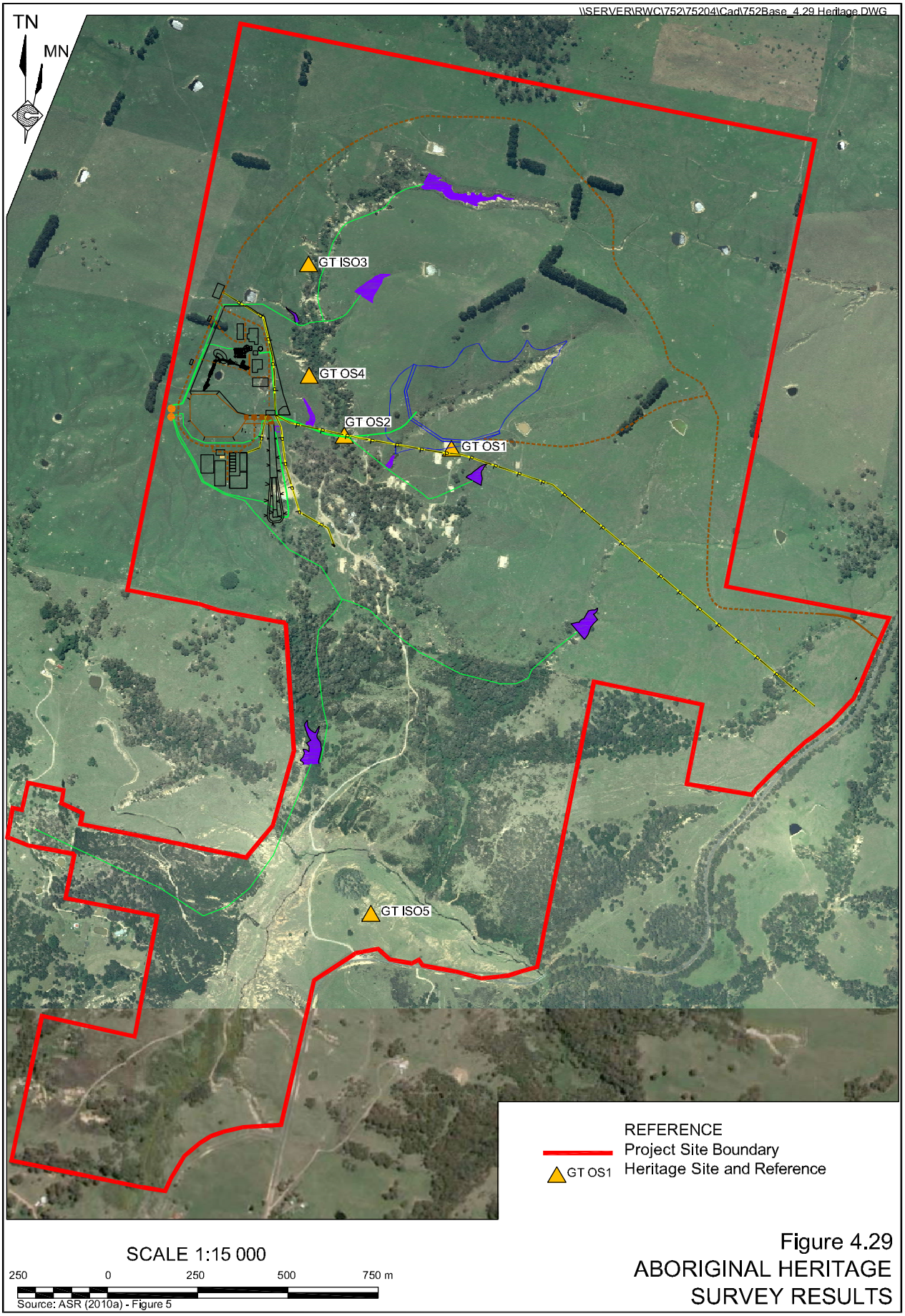


Figure 4.29
ABORIGINAL HERITAGE SURVEY RESULTS

4.6.6 Management and Mitigation Measures

The following Aboriginal heritage mitigation measures and management procedures would be implemented throughout the life of the Project.

- Sites GT OS1 & GT OS2 would be re-identified in the field with the assistance of a suitably qualified archaeologist and community representative(s). An appropriate fence on all sides of the site would be erected, access to the fenced area would be restricted and appropriate signage would be displayed.
- All other sites would be identified on plans held by the Environmental Manager and Mine Surveyor and activities in the vicinity of those sites would be prohibited. Those sites would not be fenced to limit the potential for inappropriate identification and disturbance of the sites.
- If items of suspected Aboriginal heritage significance are identified throughout the life of the Project, the following procedures would be implemented.
  - **Step 1** - No further earth disturbing works would be undertaken in the vicinity of the suspected item of Aboriginal heritage significance.
  - **Step 2** - A buffer of 20m x 20m would be established around the suspected item of Aboriginal heritage significance. No unauthorised entry or earth disturbance would be allowed with this buffer zone until the area has been assessed.
  - **Step 3** - A qualified archaeologist or the DECCW would be contacted to make an assessment of the discovery. Mitigation procedures would then be developed and implemented based on the assessment.
- If, throughout the life of the Project, suspected human remains are identified, the following procedures would be implemented.
  - **Step 1** - the suspected skeletal remains would not be touched or disturbed.
  - **Step 2** - A buffer zone of 50m x 50m would be established around the suspected remains and all work in the vicinity of the suspected remains would be suspended until the area has been assessed.
  - **Step 3** - The NSW Police and the DECCW would be contacted to make an assessment of the discovery. If appropriate, mitigation procedures would then be developed in consultation with the registered stakeholders.

4.6.7 Impact Assessment

The likelihood of adverse Project-related impacts on Aboriginal sites or items of cultural heritage significance within the Project Site is considered to be negligible for the following reasons.

- The field survey did not identify any Aboriginal sites or items of cultural heritage significance within sections of the Project Site that would be disturbed.
- The mitigation measures and management procedures identified in Section 4.6.6 would ensure that any identified Aboriginal sites or items of cultural heritage significance would be appropriately protected.

As indicated in Section 4.6.2.2 the registered stakeholders were provided with a draft of ASR (2010a) on 2 August 2010 and were requested to respond to the draft by 1 September 2010. Responses were received from three organisations. The responses indicated that each group agree with the recommendations of the ASR (2010a). In addition, the following recommendations/comments were made.

- Should additional sites be identified then the relevant stakeholders should be consulted prior to any ground disturbing activities. The Proponent agrees with this recommendation.
- The Buru Ngunawal Aboriginal Corporation requested that subsurface testing should be undertaken at sites to be disturbed. As none of the identified sites would be disturbed, the Proponent contends that there is no requirement for subsurface test work.
- The Buru Ngunawal Aboriginal Corporation requested that sites officers be present during or prior to any ground disturbing activities. Given the density of sites identified, the Proponent contends that this is not justified.

4.7 NON-ABORIGINAL HERITAGE

4.7.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "***Heritage*** *– both Aboriginal and non-Aboriginal*".

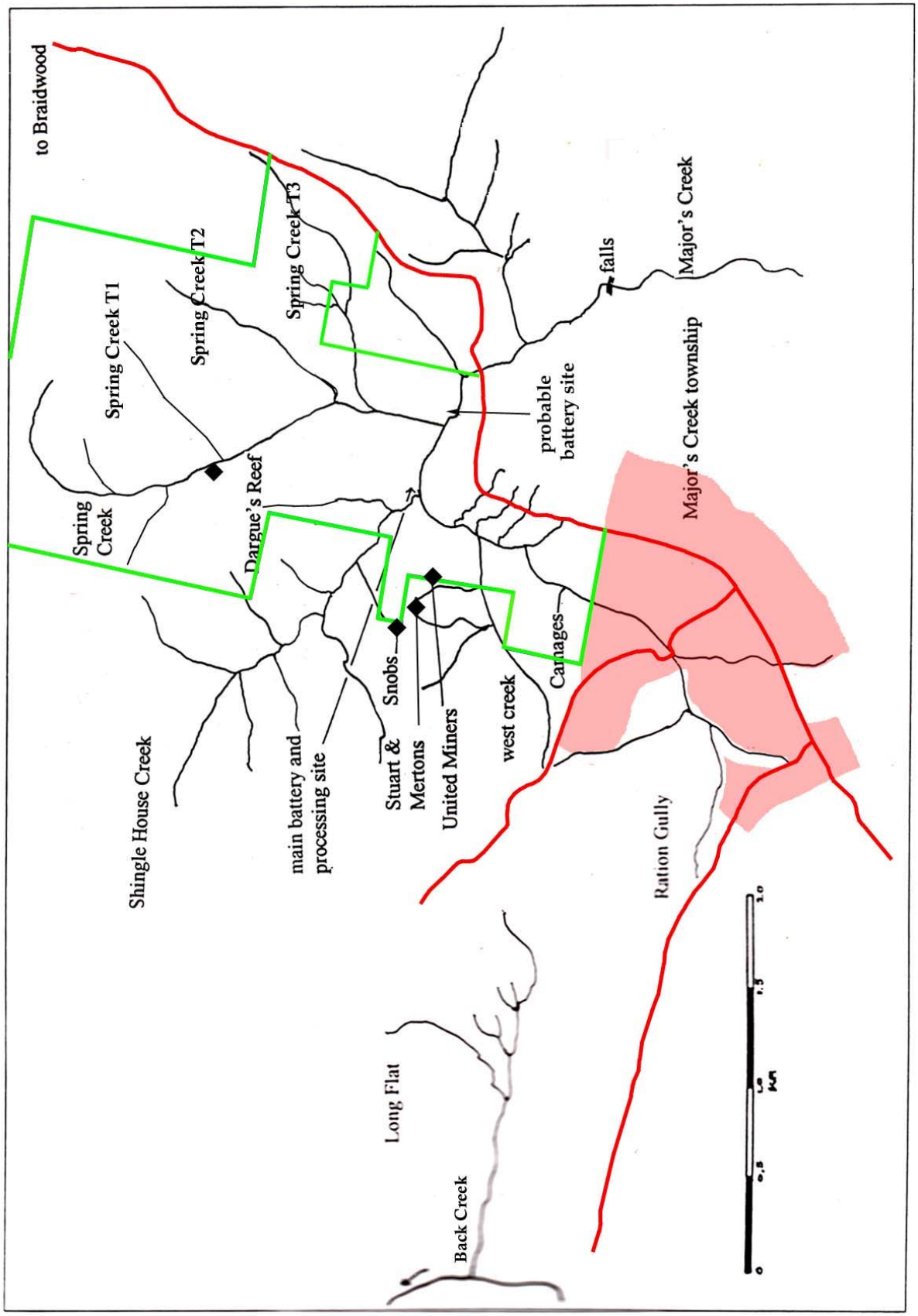
Based on the risk assessment undertaken for the Project (see Section 3.3), specific non-Aboriginal heritage-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include loss or destruction of items of heritage significance.

A non-Aboriginal Heritage Impact Assessment has been completed by Mr John Appleton (BA (Hons)) of Archaeological Surveys & Reports Pty Ltd to address the DGRs and assess the impact of the Project on items of non-Aboriginal heritage significance. That report, which is referred to hereafter as ASR (2010b) is presented in full as Part 5b (Volume 2) of the *Specialist Consultant Studies Compendium.* This section of the *Environmental Assessment* provides a summary of that report. It is noted that Mr Appleton also undertook the Aboriginal Heritage Assessment (ASR, 2010a) which is discussed in detail in Section 4.6.

4.7.2 Recorded History of the Project Site

Section 3 of ASR (2010b) presents a summary of the background to the discovery of gold in Australia and more specifically in the vicinity of the Project Site. In addition, that section also provides a detailed chronology of the non-Aboriginal history of the Majors Creek Goldfield. **Table 4.27** provides a brief overview of that chronology. It is noted that in establishing the chronology, ASR (2010b) relied heavily on Dunshea (1997), McGowan (2000), McGowan (undated) and Pearson and McGowan (undated).

It is noted that the term "Majors Creek Goldfield" is a collective name for the area in which a number of mining operations were undertaken over a period of over eighty years from 1851 to the late 1930s. During that time, the number of operations, style of mining undertaken and population within the vicinity of the Project Site varied depending on availability of water, changes in mining technology and economic circumstances. **Figure 4.30** presents a plan showing the approximate location of a number of the historic mining operations.



Source: ASR (2010b) – **Figure 5**

Figure 4.30
Historic Mining Areas – Majors Creek Goldfield

Table 4.27
Majors Creek Goldfield Chronology Summary

Date	Majors Creek Population	Event
Feb 1851	?	First payable gold in Australia discovered at Ophir.
Oct 1851	600-700	Gold is found by Mrs Baxter of "Irish Corner". By the end of 1851, there were between 600 and 700 people living in Majors Creek.
Feb 1853	?	Dry diggings towards head of the Majors Creek with several deep shafts and tunnelling. Panning and cradling principal mining methods.
1854 to 1856	123 to 250	Rain and cold weather resulted in reduced mining activity.
1857 to 1861	?	Chinese miners arrive. Increased mining activity, principally using panning, cradling, sluices, long toms (a 3m to 5m long cradle) and puddling (a circular drum or hole in the ground used to mix water and alluvial ore).
1865-1866	200	Pillar Company dug 30m tunnel with tramway into Red Hill. Focus of mining activity moves to Araluen.
1869 to 1872	?	Start of hard rock mining, with crusher batteries installed in Majors Creek and shafts dug in a number of locations. Some issues with refractory ore (ore that is not amenable to processing using gravity methods). Alluvial mining principally undertaken by Chinese. Hard rock mining largely abandoned by 1872.
1877	171	Dargues Reef worked by a party of 24 working shareholders, plus 8 or 10 hired hands. Sluicing and limited hard rock mining only mining activities.
1880	?	A crushing mill, furnaces and arastras (large rock used to crush smaller rocks) constructed. Processing operations not successful.
1883	66	Limited mining operations, with only two miners extracting hard rock ore.
1888 to 1890	?	A stone cracker, centrifugal roller, quartz mill, two Frue vanners concentrators (a gravity-type concentrator) and a steam engine installed at Dargues Reef and 600 tons of ore extracted. A chlorination plant to refine refractory ore was also constructed but the site was closed by 1890.
1893 to 1900	?	Limited mining operations, principally sluicing.
1901 to 1905	?	Hard rock mining operations undertaken at Dargues Reef, United Miners and Thompsons Blow. There is a suggestion that cyanide leaching was undertaken.
1906 to 1916	?	Gradual decline in hard rock mining.
1916 to 1926	?	Limited alluvial mining.
1930's	?	Government subsidies encourages limited alluvial and hard rock mining. Mining operations ceased by 1940s.
Source: ASR (2010b) – After Section 3.		

4.7.3 Registered Sites of Heritage Significance

Searches of the following were made on 26 June 2010 to identify registered sites of heritage significance.

- *Tallaganda Local Environment Plan 1991* – Schedule 1.
- NSW Heritage Branch - State Heritage Inventory listing of places of heritage significance.
- National Trust listing of places of heritage interest.

No registered sites were identified within the Project Site.

4.7.4 Survey Methodology

Items of heritage significance were originally identified during the Aboriginal heritage assessment and their location identified for later follow up. Mr Appleton returned to the identified sites following completion of the Aboriginal heritage survey to photograph and assess the structures, items and places for their heritage significance.

4.7.5 Survey Results

Section 5 of ASR (2010b) presents a detailed description of the artefacts, including photographs, identified during the non-Aboriginal heritage survey. The following presents an overview of that description.

- Ceramic fragments – two ceramic and other glass fragments were identified in the vicinity of Gamage's claim (**Figure 4.30**). These could not be placed into a historical context.
- Dargues Reef railway – ore material was transported from the Dargues Reef Mine to stamp batteries in Majors Creek by rail. A second rail line transported ore from Snobs Mine to Majors Creek, joining the Dargues Reef line. These lines are now preserved as a series of shallow cuttings, depressions and eroding causeways. A rail-truck bogie was identified in the vicinity of the rail line, as were two twisted lengths of track protruding from rabbit warrens. Measurements from the rail bogie indicate that the rail line had an indicative inner track width of approximately 60cm.
- Stamp battery – the foundations and a shoe from a stamp battery were located adjacent to piles of uncrushed ore near the junction of Spring and Majors Creeks.
- Dredge shelves or buckets– three dredge shelves were located midway between the confluence of Majors and Spring Creeks and the Majors Creek Road bridge. ASR (2010b) note that McGowan (2000 and undated) do not mention the use of dredges at Majors Creek.
- Puddling holes – ASR (2010b) states that a number of depressions observed within the Project Site may be associated with puddling, particularly by Chinese miners.
- Magazine – A small explosives magazine was constructed in the western bank of a tributary to Spring Creek.
- Shaft cage – A shaft cage was identified in the vicinity of the Dargues Reef shaft.
- Water Races – Finally, ASR (2010b) notes that water races are a common feature of the landscape within the Project Site. These races may have been constructed by small scale or larger miners to divert surface water flows to the active mining areas. Alternatively, some may have been constructed or converted to support agricultural operations.

4.7.6 Management and Mitigation Measures

As noted in Section 4.7.7, ASR (2010b) note that the Project would not result in disturbance to any of the identified artefacts. As a result, the Proponent would implement the following management and mitigation measures to minimise the potential for inadvertent impacts to items of potential heritage significance.

- Identify on plans held by the Environmental Manager and Mine Surveyor, where relevant, all identified sites and ensure that activities in the vicinity of those sites are appropriately managed.
- If items of suspected non-Aboriginal heritage significance are identified throughout the life of the Project, the following procedures would be implemented.
  - **Step 1** - No further earth disturbing works would be undertaken in the vicinity of the suspected item of non-Aboriginal heritage significance.
  - **Step 2** - A buffer of 20m x 20m would be established around the suspected artefact. No unauthorised entry or earth disturbance would be allowed with this buffer zone until the area has been assessed.
  - **Step 3** - A qualified archaeologist would be contacted to make an assessment of the discovery. Mitigation procedures would then be developed and implemented based on the assessment.

4.7.7 Impact Assessment

ASR (2010b) undertook an assessment of the significance of the identified artefacts in accordance with the NSW Heritage Council criteria for heritage assessment. These are as follows.

- Criterion (a) an item is important in the course, or pattern, of NSW's Cultural or natural history (or the local area).
- 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 (or the local area).
- Criterion (c) an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
- Criterion (d) an item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons (or the local area).
- Criterion (e) an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the local area).
- Criterion (f) an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the local area).
- 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 (or the local area).

ASR (2010b), based on Pearson and McGowan (undated), state that the following attributes are likely to result in an alluvial or hard rock mining site having historical significance. These are consistent with the NSW Heritage Council-identified criteria above.

- Clear evidence of mine workings.
- Clear evidence of machinery and equipment.
- Clear evidence of a processing site with substantial evidence.
- Clear evidence of settlement or habitation.
- Evidence of ethnicity.

ASR (2010b) notes that the Majors Creek Goldfield has witnessed over eighty years of mining, including simple pan and cradle sluicing, Long Toms, puddling, hydraulic sluicing, reef mining, and possibly dredging. However, very little remains of any one clearly identifiable discrete mining activity or of datable layers of mining activities or temporal markers. As a consequence, while there is widespread evidence of the combined activities and impacts from mining, there are very few artefacts that may be temporally placed in context with the recorded history of Project Site.

ASR (2010b) notes that, while the Project Site does have clear evidence of mine workings, it does not have clear evidence of machinery or equipment, a processing site, habitation or ethnicity of those work worked within the Project Site. In addition, the mine workings visible today represent a overlay of many mining events overprinted one over the top of another, with no clear evidence of activities at a particular point in time. As a result, ASR (2010b) states that the Project Site does not have the attributes that warrant its assessment as being of heritage significance.

Finally, with the exception of a number of water races within the footprint of the tailings storage facility and the Processing Plant, the proposed activities would not disturb the identified items of heritage significance. The water races that would be disturbed are not considered to be significant and extensive examples of such races would remain within the Project Site.

As a consequence, ASR (2010b) conclude that the Project Site contains no structures, relics or items of heritage significance and, as a result, the Project would not result in any significant adverse impacts on items of non-Aboriginal heritage significance.

4.8 BUSHFIRE

4.8.1 Introduction

Based on the risk assessment undertaken for the Project (see Section 3.3), specific bushfire related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Initiation of fire leading to impacts on the Project Site.
- Initiation of fire leading to impacts beyond the Project Site.

This section identifies the dominant vegetation type(s) within the Project Site and surrounding landholdings in order to determine the potential bushfire hazard associated with the Project. In identifying the bushfire hazard, the document "*Planning for Bushfire Protection*" produced by NSW Rural Fire Service in consultation with the then Planning NSW (now Department of Planning) in 2001 (RFS, 2001). RFS (2001) forms the basis of the identification of bushfire hazard. It is noted that information required for this assessment was drawn from the Ecology Assessment (Gaia, 2010).

The Bushfire Assessment was prepared by R.W. Corkery & Co. Pty Ltd based, in part, on information provided in Gaia (2010).

4.8.2 Existing Environment – Assessment of Bushfire Hazard

4.8.2.1 Vegetation

As identified in Section 4.3, significant sections of the Project Site have been cleared of large trees and shrubs, with those areas now supporting grasslands, regenerating wattles, woody weeds or limited vegetation. Vegetated areas that remain are, predominantly along Spring Majors Creeks and their tributaries. **Figure 4.31** provides an interpretation of the vegetation within and surrounding the Project Site and surrounding land based on the classifications provided by RFS (2001). The classifications of RFS (2001) have been designated to provide some indication of flammability and therefore bushfire hazard and are broadly grouped, from most flammable to least, as follows.

- Group 1 - forest;
- Group 2 - woodlands and heath; and
- Group 3 - rainforests, shrubland, open woodlands, mallee, grassland.

Within each group, RFS (2001) assigns classes to describe the various vegetation types within these broader groups. The Project Site vegetation is classified as follows (see **Figure 4.31**).

- Group 2, Class 6. Categorised as woodland with trees of 10m to 30m high, foliage cover of 10% to 30% and understorey of low trees, tall shrubs and/or grasses. This classification includes Communities 1 and 2 of Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 25t/ha is assigned to this vegetation type by RFS (2001).
- Group 2, Class 13. Categorised as open scrub with trees of greater than 2m in height, foliage cover of 10% to 30% and a mixed understorey. This classification includes Communities 3 and 4 of Gaia (2010) (Section 4.3.4.3). A maximum fuel load of 15t/ha is assigned to this vegetation type by RFS (2001).
- Group 2 (no class). Categorised as exotic tree plantation. This classification includes Community 5 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 15t/ha is assigned to this vegetation type by RFS (2001).

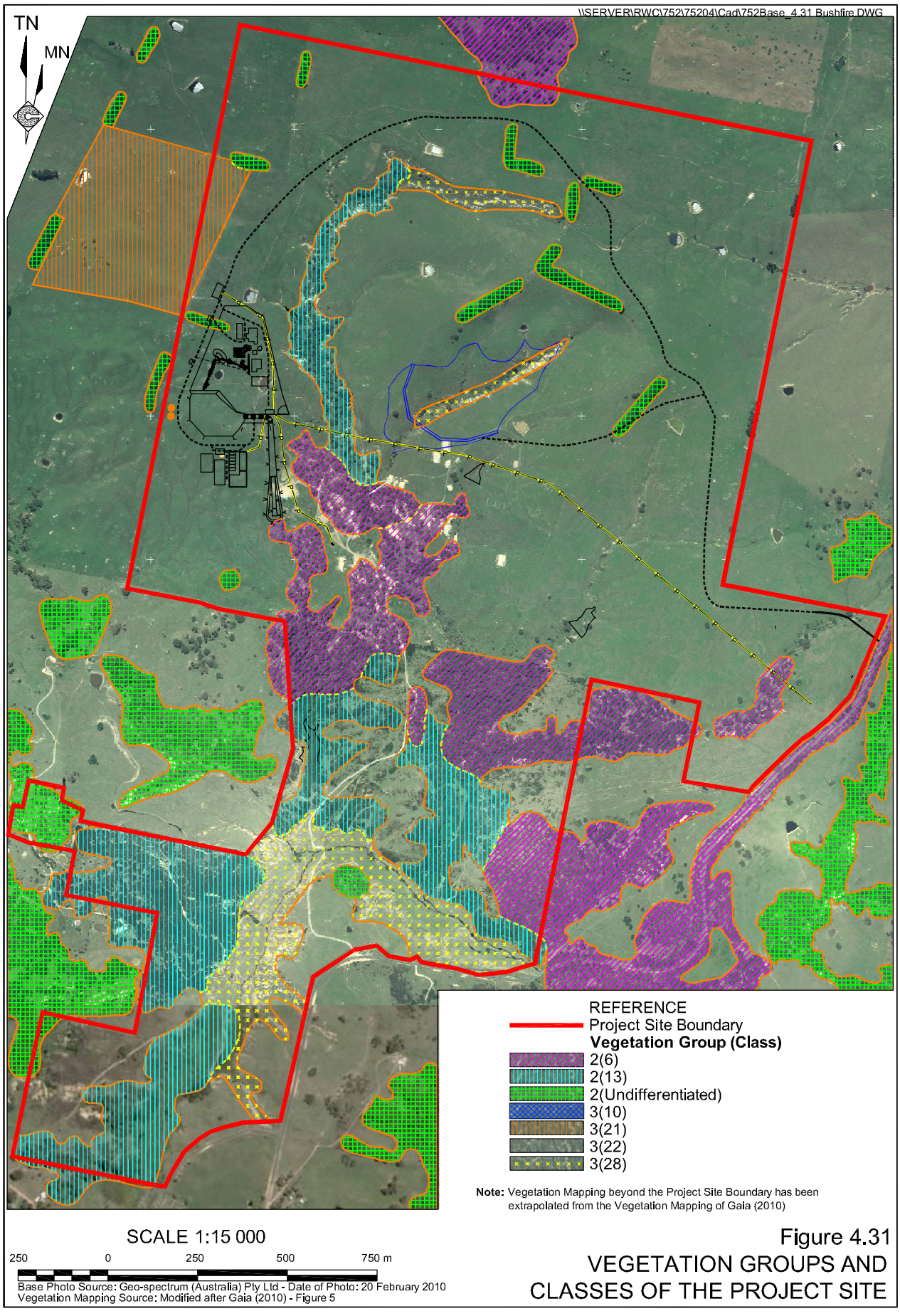


Figure 4.31
VEGETATION GROUPS AND CLASSES OF THE PROJECT SITE

- Group 3, Class 26. Categorised as native grassland where environmental factors prevent the growth of trees and shrubs. This classification includes Community 6 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 3t/ha is assigned to this vegetation type by RFS (2001).
- Group 3, Class 22. Categorised as native dominated pasture. This classification includes Community 7 as described in Gaia (2010) and (see Section 4.3.4.3). A maximum fuel load of 6t/ha is assigned to this vegetation type by RFS (2001).
- Group 3, Class 21. Categorised as exotic dominated pasture. This classification includes Community 8 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 6t/ha is assigned to this vegetation type by RFS (2001).
- Group 3, Class 28. Categorised as largely disturbed land with some grass coverage. This classification includes Community 9 as described in Gaia (2010) (see Section 4.3.4.3). A maximum fuel load of 3t/ha is assigned to this vegetation type by RFS (2001).

The vegetation of the landholdings surrounding the Project Site are similar to within the Project Site, that is, the surrounding area is dominated by cleared agricultural land interspersed with woodland and open forest vegetation, predominantly along drainage lines, elevated land or areas with greater topographic relief. Approximately 5km south of the Project Site is a large area of woodland and dry sclerophyll forest (Group 1, Class 5) which occupies a steep valley between the settlements of Majors Creek and Araluen.

4.8.2.2 Slope Classification

Slopes within the Project Site are typically between 5^{o} and 10^{o}.

4.8.2.3 Hazard Assessment

The bushfire hazard assessment takes into account not only the vegetation and associated bushfire hazard within the Project Site, but the vegetation immediately surrounding the Project Site and the local area generally.

For the purpose of the bushfire hazard assessment, parameters associated with the Group 3 grassland and pasture dominated vegetation and Group 2 woodland / open forest vegetation have been used to assess the hazard associated with the Project. **Table 4.28** presents the parameters for each assessment which were then compared to RFS (2001) to determine bushfire hazard (referred to as bushfire attack category in RFS (2001)).

Table 4.28
Bushfire Hazard Assessment

Assessment	Vegetation Classification	Slope	Distance to Activities	Category of Bushfire Attack
Group 2	Woodland and Open Forest	$>5^{o}$ to 10^{o}	>30m, <50m	High
Group 3	Grassland	$>5^{o}$ to 10^{o}	<20m	Low
Sourced: Based on Appendix 3.3 of RFS (2001)				

A high category of bushfire attack describes a site or asset where

> *"attack by burning debris is significant with radiant heat levels and flame threatening some building elements (screened glass)."*

Specific construction requirements (Level 2 construction in accordance with Section 3 of Australian Standard (AS) 3959 – 1999) should be considered.

A low category of bushfire attack describes a site or asset where

> *"minimal attack from radiant heat and flame due to the distance of the site from the vegetation, although some attack by burning debris is possible. There is insufficient threat to warrant specific construction requirements."*

Based on the above bushfire attack categories, the Project Site could be affected by bushfire and precautionary measures should be developed for implementation in the event of a significant bushfire event locally.

4.8.3 Safeguards and Controls

4.8.3.1 Management of a Local Bushfire Event

Acknowledging the 'High' bushfire attack category associated with the woodland / open forest vegetation within and surrounding the Project Site, the construction of buildings within the Project Site should consider the Level 2 requirements of AS 3959 – 1999. Notably, the entire length of the access road would traverse grassland / pasture vegetation which has a low bushfire attack categorisation. As such, an immediate method of egress from the Project Site would be available to Project personnel in the event of bushfire attack on the Project Site.

In the event of a local bushfire event threatening the Project Site, mine management would follow all instructions provided by the NSW Rural Fire Service (RFS) or police. Access to all Project Site water storages would be provided to the RFS and any reasonable assistance offered to RFS or police personnel.

4.8.3.2 Management of Project Site Operations

The Project Site operations that may increase the risk of bushfire, and the controls proposed to limit the risk posed by these are presented in **Table 4.29**.

4.8.4 Assessment of Impact

The Project Site operations would increase the number and type of ignition sources in the local area. The proposed controls and safeguards, in conjunction with general clearing activities associated with the Project would, however, ensure that a lowered bushfire hazard was maintained within the Project Site.

Table 4.29
Bushfire Hazard – Activities and Controls

Activity	Possible Ignition Source	Safeguards and/or Controls
Refuelling	• Spilt fuel ignited by spark	• Refuelling undertaken within designated fuel bays or within cleared area of the Project Site. • Vehicles to be turned off during refuelling. • No smoking policy to be enforced in designated areas of the Project Site. • Fire extinguishers maintained within site vehicles and refuelling areas.
General Activities	• Cigarette • Rubbish, eg. glass, metal.	• No smoking policy to be enforced in designated areas of the Project Site. • Focus on housekeeping to be maintained by mine management. • Water cart available to assist in extinguishing any fire ignited. • Site vehicles to carry a fire extinguisher.

4.9 TRAFFIC AND TRANSPORTATION

4.9.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Traffic**" – *including a detailed description of the measures that would be implemented during construction and operation to minimise the impacts on Majors Creek road and Araluen Road*. The DGRs specify that the Environmental Assessment include "*a detailed description of the measures that would be implemented during construction and operation to minimise impacts on Majors Creek Road and Araluen Road.*" Both the NSW Roads and Traffic Authority (RTA) and Palerang Shire Council identified key issues to be assessed in relation to traffic and the impact of Project-related transport on the local road network (see **Appendix 2**).

Based on the risk assessment undertaken for the Project (see Section 3.3), specific traffic-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Temporary inconvenience to commuters if stopped for road works.
- Increased traffic congestion.
- Elevated risk of accident/incident on local roads.
- Accelerated road pavement deterioration.

The DGRs require that the traffic assessment take into account the *Guide to Traffic Generating Development* (RTA, 2002) and *Road Design Guide* (RTA, 1999).

A Traffic Impact Assessment has been completed by Mr Terry Lawrence (M.Urb.Plan) of Transport and Urban Planning (TUP) to address the DGRs and assess the impact of the Project on local traffic and roads. This section of the *Environmental Assessment* provides a summary of the assessment report, which is presented in full as Part 6 (Volume 2) of the *Specialist Consultant Studies Compendium* and is referred to hereafter as TUP (2010). The assessment considers existing traffic levels and road conditions, the proposed changes to traffic levels resultant from the Project and the likely impact on the road network, road users and land uses.

4.9.2 Existing Environment

4.9.2.1 Principal Road Network

The roads that would be affected by traffic generated by the Project are as follows.

- Majors Creek Road.
- Araluen Road.
- Captains Flat Road.
- Coghill Street.
- Wallace Street.

Figure 4.32 identifies each of these roads, all of which form part of the main road network of the Palerang local government area. Captains Flat Road, Coghill Street and Wallace Street (to Lascelles Street) are regional roads, ie. public roads of secondary importance within the state-wide context. Regional roads comprise both classified roads that are not State roads and some important but not classified council roads. Councils exercise roads authority powers, have financial asset management responsibility and determine road works priorities for regional roads.

Araluen Road and Majors Creek Road are local roads. Local roads are any unclassified public road for which Council is the road authority and which are not either state or regional roads. Councils exercise roads authority powers and have financial responsibility for local roads.

It is noted that those heavy vehicles that would travel through Braidwood to destinations further afield would do so via the Kings Highway, a State road. In addition, the Proponent anticipates that all heavy vehicles using the Kings Highway would utilise that section of the highway to the north of Braidwood. The Proponent does not anticipate that any Project-related heavy vehicles would travel on the Kings Highway to the east of Braidwood.

4.9.2.2 Traffic Volumes

Traffic volume and classification counts were undertaken on the road network between 12 and 19 February 2010. **Figure 4.33** and **Table 4.30** present the annual average daily traffic (AADT) traffic volumes on the identified roads for an average weekday (5 day average) and full week (7 day average / AADT) including the number and proportion of heavy vehicles.

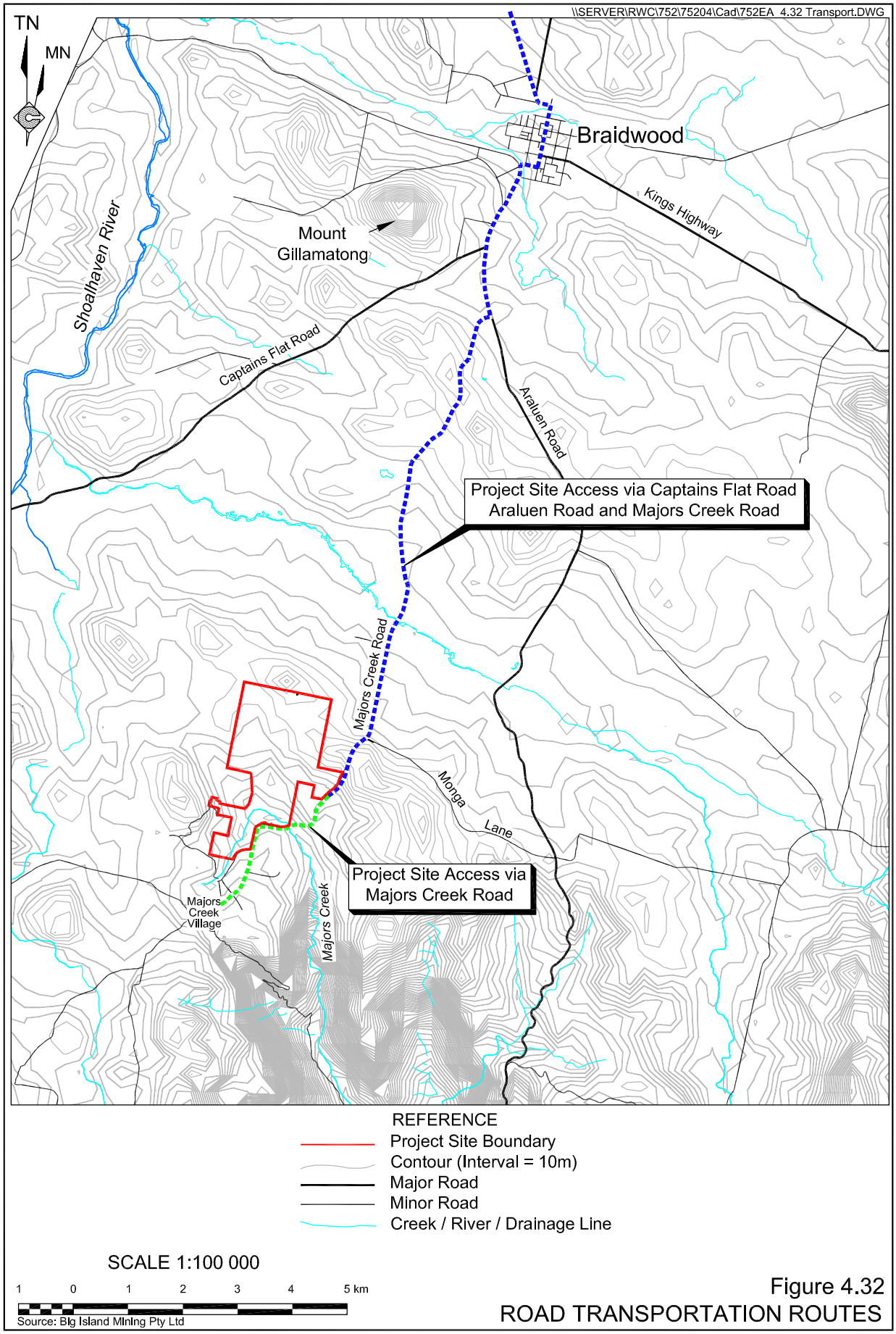


Figure 4.32
ROAD TRANSPORTATION ROUTES

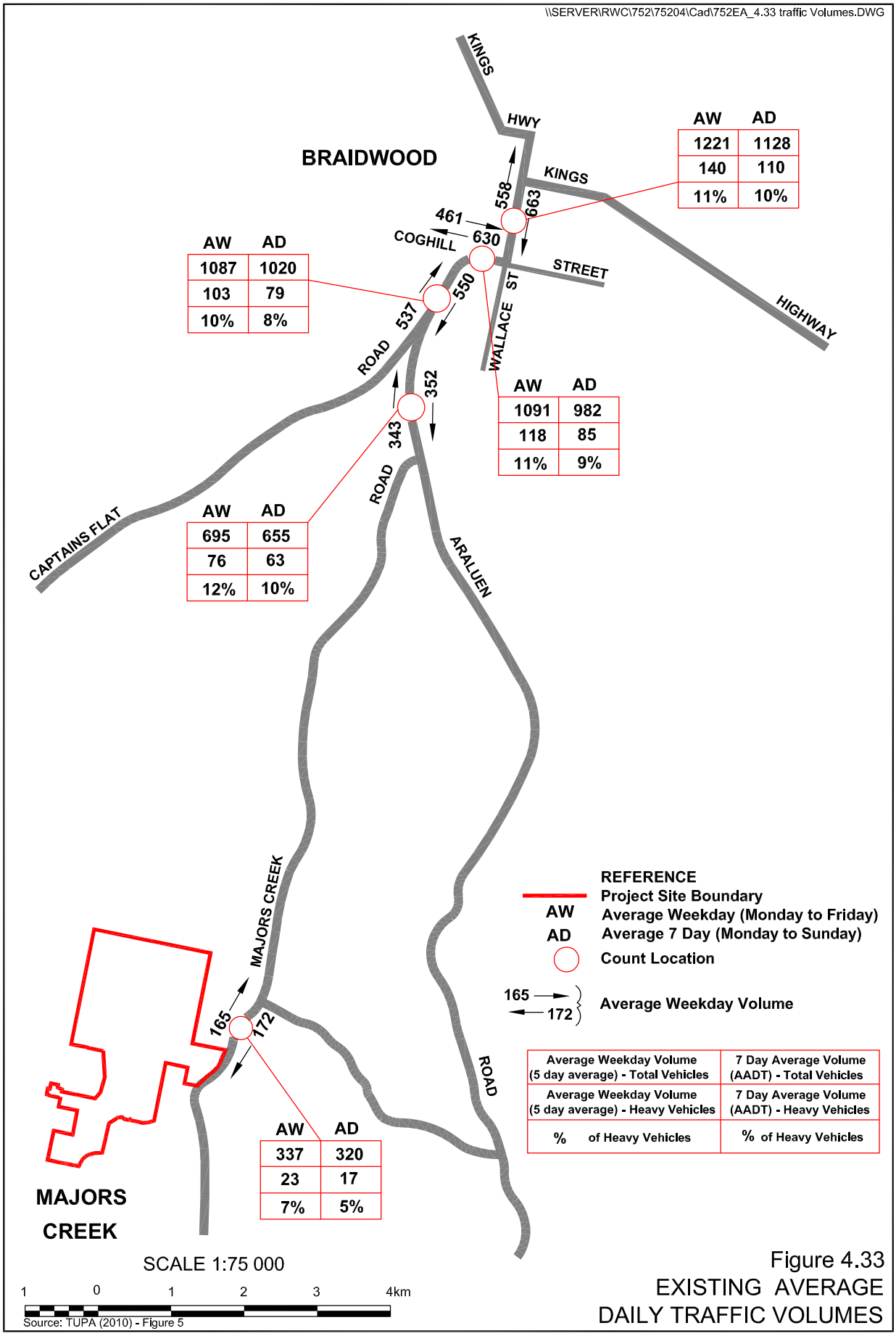


Figure 4.33
EXISTING AVERAGE DAILY TRAFFIC VOLUMES

Table 4.30
Two Way Daily Traffic Volumes Including Heavy Vehicles

Road	5 Day Average (Weekday)			7 Day Average (AADT)		
	Light Vehicles (%)	Heavy Vehicles (%)	Total (%)	Light Vehicles (%)	Heavy Vehicles (%)	Total (%)
Majors Creek Road	314 (93%)	23 (7%)	337 (100%)	303 (95%)	17 (5%)	320 (100%)
Araluen Road	619 (88%)	76 (12%)	695 (100%)	592 (90%)	63 (10%)	655 (100%)
Captains Flat Road	984 (90%)	103 (10%)	1087 (100%)	941 (92%)	79 (8%)	1020 (100%)
Coghill Street	973 (89%)	118 (11%)	1091 (100%)	893 (91%)	85 (9%)	982 (100%)
Wallace Street	1081 (89%)	140 (11%)	1221 (100%)	1018 (90%)	110 (10%)	1128 (100%)
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 3.2						

4.9.2.3 Maximum Hourly Traffic Volumes and Traffic Conditions

Table 4.31 presents the maximum two-way hourly traffic volumes for various periods during the average weekday as recorded in the traffic counts between 12 and 19 February 2010.

Table 4.31
Maximum Hourly Two Way Traffic Volumes Using

Road	Time Period				
	6am-9am	9am-3pm	3pm-7pm	7pm-10pm	10pm-6am
Majors Creek Road	28	24	34	12	7
Araluen Road	67	52	66	13	8
Captains Flat Road	97	79	100	35	13
Coghill Road	73	81	105	36	13
Wallace Street	88	93	115	43	4
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 3.3					

4.9.2.4 Relevant Road Standards

Rural Roads

The Roads & Traffic Authority's *"Road Design Guide"* (RTA, 1999) is the primary road design reference for NSW roads. **Tables 4.32** and **4.33** provide the Road Design Guide recommended lane and shoulder widths for different traffic flows.

Table 4.32
Lane Widths for Two Lane Two Way Rural Roads

AADT (vehicles/day)	No. of Lanes	Lane Width (m)
1-150	1	3.5
150-500	2	3.0
500-2000	2	3.0-3.5
> 2000	2	3.5
Source: RTA Road Design Guide		

Table 4.33
Shoulder Widths for Two Lane Two Way Rural Roads

AADT (vehicles/day)	Shoulder Width (m)
1-500	1.0-1.5
500-1000	1.0-2.0
Over 1000	2.0-3.0
Adjacent to barrier lines	3.0
Source: RTA Road Design Guide	

Shoulder sealing of 0.5m from the edge of the travel lane is recommended when the AADT is less than 2 000 vehicles per day (vpd) and 1.0m when the AADT is greater than 2 000vpd. It should be noted that most council/local rural roads including regional roads, do not have sealed shoulders and typically use gravel shoulders.

Standards for Town Roads in Rural Areas

There is no particular road width standard for town roads in rural areas which have lower speed limits of 60km/hr or less. Travel lane widths on two way, two lane town roads are typically 3.0 to 3.5 metres wide depending on AADT traffic volumes. Shoulder areas which can be used for parking or as a pull off area and can be 2.0m to 3.0m wide or more and may or may not be sealed. Kerb and gutter may or may not be provided depending on a range of factors.

Level of Service

Level of Service (LOS) is used as a performance standard for roads (and intersections). Level of Service is a qualitative assessment of the quantitative effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays and freedom to manoeuvre. There are six Levels of Service for roads. The following descriptions are for roads with interrupted traffic streams, such as rural roads.

- LOS A: this, the top level is a condition of free flow.
- LOS B: this level is in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream.
- LOS C: this service level is also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre in the traffic stream.
- LOS D: this level is close to the limit of stable flow but is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream.
- LOS E: this occurs when traffic volumes are at or close to capacity and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream.
- LOS F: this service level is in the zone of forced flow. With it the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs and queuing and delays result. In short the traffic demand exceeds the capacity of the road or lane.

The desirable Level of Service for rural roads is Level of Service C or above, ie. A, B or C.

Table 4.5 of the RTA's "*Guide to Traffic Generating Developments*" defines maximum (peak) hour Levels of Service Volume Thresholds for 2 lane rural roads. For rural roads with rolling terrain and where heavy vehicles comprise 10% to 15% of the total volumes, Level of Service A occurs when two way traffic volumes are less than 310 to 360 vehicles per hour (vph). For rural roads with level terrain and the same proportion of heavy vehicles, Level of Service A occurs when two way traffic volumes are less than 530 to 560vph.

4.9.2.5 Existing Road Conditions

Majors Creek Road

- Majors Creek Road is a two lane, sealed rural road that connects the village of Majors Creek to Araluen Road (a distance of approximately 11.85km).
- Majors Creek Road typically has a sealed pavement generally 5.8m wide with gravel shoulder on both sides of between 1.0m and 1.5m. Currently Majors Creek Road does not meet the minimum pavement width requirement of the Road Design Guide for the AADT flows of 150 to 500, namely 2 x 3m lane width.
- The maximum two way traffic volume is 34vph. Therefore, as the percentage of heavy vehicles is 5% (7 day AADT), Majors Creek Road currently operates with a LOS A.

Araluen Flat Road

- Araluen Road is a two lane, sealed rural road. The distance between Majors Creek Road and Captains Flat Road is approximately 1km.
- Araluen Road is 6.2m wide with a sealed pavement and gravel shoulders of between 1.5m and 2.0m. Araluen Road is considered to meet the minimum pavement width requirement of the Road Design Guide for the AADT flows of 500 to 2000 vehicles, namely 2 x 3m or 3.5m lane width. The shoulder arrangement of Araluen Road does not meet the Road Design recommendation.
- The maximum two way traffic volume is 66vph. Therefore, as the percentage of heavy vehicles is 10% (7 day AADT), Araluen Road currently operates with a LOS A.

Captains Flat Road

- Captains Flat Road is a two lane, sealed rural road. The distance between Araluen Road and Coghill Street is approximately 2km.
- Captains Flat Road maintains a 7.0m wide sealed pavement with gravel shoulders of variable widths. Captains Flat Road is considered to meet the minimum pavement width requirement of the Road Design Guide for the AADT flows of 500 to 2000 vehicles, namely 2 x 3m or 3.5m lane width. The shoulder arrangement of Captains Flat Road does not meet the Road Design recommendation.
- The maximum two way traffic volume is 100vph. Therefore, as the percentage of heavy vehicles is 8% (7 day AADT), Captains Flat Road currently operates with a LOS A.

Coghill Street / Wallace Street

- Coghill and Wallace Streets are town roads within the Braidwood township with 50km/hr speed limits. Both streets form part of a regional road that connects to the Kings Highway at Lascelles Street and form part of the school bus route to Captains Flat Road, Araluen Road and Majors Creek Road.
- Coghill Street between Bombay Street and Wallace Street provides a sealed road pavement for two (2) lanes of traffic and wide shoulders. Both roads provide the pavement width and wide shoulders nominated as standard for rural town roads.
- The maximum hourly two way traffic volumes on both roads is relatively low (105vph and 115vph respectively). Both Coghill and Wallace Streets provide LOS A.

4.9.2.6 Road Safety

Three year accident statistics from April 2006 to March 2009, the road network between Lascelles Street, Braidwood and the Project Site were obtained from the RTA. There was a total of four accidents during this period, including 2 injury accidents and one fatality on the road network. This included two run off the road accidents on Araluen Road and one run off the road accident on Majors Creek Road. Only one of these accidents involved a truck, with there being no particular pattern with regard to the accidents (TUP, 2010).

4.9.2.7 Bus Routes

A daily bus service is operated between Batemans Bay and Canberra via Braidwood by Murrays Coaches. These buses use the Kings Highway through Braidwood at 8.55am and 4.05pm.

There are five school bus services that use sections of the road network between Braidwood and the Project Site. These buses operate between 7.00am and 8.30am in the morning and 3.00pm and 5.00pm in the afternoon on school days. There are also several school bus routes that use sections of the Kings Highway between Braidwood and Bungendore, Goulburn and Nerriga.

4.9.2.8 Local Weather Conditions

It is understood that the area around Majors Creek experiences low level cloud and fog on occasions throughout the year. It is noted that Majors Creek Road has long sections of road where no centreline is provided. Centreline road marking generally assists drivers when conditions are foggy.

4.9.3 Project-related Roadworks and Traffic

4.9.3.1 Vehicle Access

As noted in Section 2.2.3 and illustrated on **Figure 2.2**, a new intersection with Majors Creek Road would be constructed to provide vehicle access to the Project Site. This would be a sealed intersection based on an RTA basic (BA) right turn (R) and left turn (L)_rural intersection type (BAR and BAL) (as specified in *Guide to Traffic Engineering Practice — Part 5: Intersections at Grade* [Austroads, 2005]).

4.9.3.2 Internal Road

As also described in Section 2.2 and illustrated on **Figure 2.1**, the Proponent would construct a site access road from Majors Creek Road to the proposed processing operations of the Project Site. The site access road would have a sealed 7.0m wide pavement with sealed shoulder, for the initial 50m from Majors Creek Road, The remainder of the road would be a 6.0m wide gravel road, with 1.0 metre wide shoulders.

4.9.3.3 Traffic Generation

Site Establishment Phase

Construction of Project Site infrastructure, including the proposed new intersection with Majors Creek Road, is expected take approximately 5 months to complete.

Traffic travelling to and from the Project Site each day would include low loaders, semi-trailers, truck and dog trailers, other smaller trucks including concrete agitator vehicles and light vehicles. The majority of these vehicles would be drawn from the local and regional area around Braidwood.

Table 4.34 presents the average traffic levels that would be generated during the Project's construction phase.

Table 4.34
Site Establishment Phase Traffic Generation

Source of Traffic	Daily Traffic Movements (Average)		
	Light Vehicles	Heavy Vehicles	Total Vehicles
Majors Creek Road – North of Site Entrance	24	6	30
Majors Creek Road – South of Site Entrance	6	0	6
Total	**30**	**6**	**36**
Source: Mining Plus Pty Ltd			

Operations Phase

The Proponent proposes to use a small (20 seater) bus to take the shift mine workers to and from work each day. Two shifts are proposed which will involve up to four bus movements, ie. 2 arrivals and 2 departures each day. Additional light vehicle movements will be associated with the movement of other staff and visitors to and from the Project Site.

Heavy vehicles coming to the Project Site will include delivery vehicles for consumables which will typically be large rigid trucks and 19 metre semi-trailers, as well as product (concentrate) trucks which will be 19 metre semi-trailers.

Table 4.35 presents the average daily traffic levels that would be generated during the site operations phase (at maximum production).

Table 4.35
Operations Phase Traffic Generation

Source of Traffic	Daily Traffic Movements (Average)		
	Light Vehicles	Heavy Vehicles	Total Vehicles
Majors Creek Road – North of Site Entrance	16	18	34
Majors Creek Road – South of Site Entrance	4	0	4
Total	**20**	**18**	**38**
Source: Mining Plus Pty Ltd			

Product (concentrate) delivery trucks are expected to transport the concentrate to port at Wollongong, Sydney or Newcastle or to customers within Australia via the Kings Highway to the north of Braidwood.

4.9.4 Environmental Controls and Management

4.9.4.1 Design Features

Project Site Entrance

The treatment for the proposed site access road intersection with Majors Creek Road has been based on the recommendations of TUP (2010), and the requirements of the *Road Design Guide* (RTA, 1999) and "*Part 5: Intersections at Grade*" of the Austroads Guide to Traffic Engineering Practice series (Austroads, 2005).

The intersection would have adequate sight distance in Majors Creek Road to meet safe intersection sight distance requirements for the posted speed limit and the recorded 85th percentile vehicle speed at this location which are 100km/hr and 97km/hr respectively (TUP, 2010). Allowing for the 5% upgrade south to north in Majors Creek Road, the required sight distance at the intersection is 215m to the south and 235m to the north. TUP (2010) confirms that the available sight distance at the proposed location exceeds these requirements. The Proponent would regularly inspect and clear long grass and bushes that grow in the road shoulder to maintain the maximum possible sight distance.

Site Access Road

The site access road would incorporate the following features.

- Horizontal alignment complying with the maximum grades and changes of grade outlined in the *Australian Standards for Off-Street Commercial Vehicle Facilities*. Maximum vertical grades would be approximately 10%.
- The gravel surface of the road would be graded treated with chemical suppressants to minimise dust generation.
- The road layout would ensure that all vehicles would enter and exit the site in a forward direction.

In addition, the on-site maximum vehicle speed would be signposted and restricted to 40km/hr.

4.9.4.2 Operational Controls

The operational controls to be employed as part of the Project would include the following.

- All heavy vehicles transporting concentrate would be loaded using a front-end loader fitted with a bucket load indicator. All vehicles would be loaded in a manner that would ensure that they were not overloaded.
- A speed limit of 40km/hr on the site access road and 20km/hr in the operational sections of the Project Site.

- All regular heavy vehicle movements associated with the Project would be scheduled for between 7:00am and 6:00pm, where practicable. Furthermore, the movement of heavy vehicles to and from the Project Site would, where practicable be avoided during the hours of 7.00am to 8.30am and 3.00pm to 5.00pm on school days to avoid potential conflict with the local school bus services.
- A Code of Conduct for all drivers would be developed and enforced for all heavy vehicles that travel to and from the Project Site regularly. The Code of Conduct would stipulate safe driving practices must be maintained at all times and nominate the maximum vehicle speed on Majors Creek Road of 80km/hr for heavy vehicles travelling to and from the Project Site. The code would also include specific requirements for practices to be adopted during periods of fog, such as the use of headlights / fog lights and adopting vehicle speeds appropriate to the conditions as required.
- Any complaints received would be immediately investigated and substantiated incidents acted on decisively, which could include the banning the offending driver(s) from the Project Site.

In addition, the Proponent would manage traffic during the construction of the new intersection in accordance with a works specific Traffic Management Plan and the relevant Australian Standards. All safety procedures to be adopted during intersection construction works would be incorporated into a Section 138 Permit sought under the *Roads Act 1993*.

4.9.4.3 Contribution to Ongoing Road Maintenance and Upgrades

The Proponent recognises that the additional heavy vehicle movement generated by the Project may result in some pavement deterioration on Majors Creek Road, change to traffic conditions for local road users. In recognition of this, the Proponent has negotiated an arrangement with Palerang Council to provide for a range of up-front road upgrades (focussed on improving road safety features) and ongoing Section 94 contributions to road maintenance throughout the life of the Project. The commitments made with respect to road upgrade and maintenance (and agreed to in principle by Palerang Council) are as follows.

Road Upgrades

- Provide centreline road marking along the full length of Majors Creek Road between the Araluen Road and Majors Creek immediately, irrespective of whether project approval is granted. This will assist drivers using Majors Creek Road to drive on the left of the centreline at all times, particularly those times of low visibility, and will assist in maintaining road safety.
- Provide signage/delineation and appropriate barriers such as guardrails at the culverts on Majors Creek Road at 4.4km and 4.9km from the intersection of Majors Creek Road and Araluen Road, as well as at the bridge structure over Honeysuckle Creek. The Proponent has committed to completing this road upgrade prior to the commencement of the operational phase of transport operations.

- Provide pavement widening on curves and crests on Majors Creek Road at the following chainages, as measured from the intersection of Majors Creek road and Araluen Road.
  - Reverse curve between 2.4km and 2.7km.
  - Curve at 3.25km.
  - Crest at 3.8km.
  - Curve at 4.3km.
  - Curve at 4.5km.
  - Curve and crest near Morgans Lane at 5.3km and 5.5km.
  - Crest at 6.9km.
  - Crest at 7.75km.
  - Crest at 8.2km.

  The noted road pavement widening would be undertaken in lieu of Section 94 Contributions during the initial 12 months of the operations phase of transport operations. No significant environmental impacts associated with these works are anticipated.

Road Maintenance

- The Proponent would formalise a Section 94 Contributions Plan with Palerang Council following the granting of project approval.
- Road pavement widening works would be undertaken in lieu of Section 94 contributions during the initial 12 months of the operations phase of transport operations.

4.9.5 Assessment of Impacts

4.9.5.1 Intersection Suitability

The proposed new intersection for the Project Site would be designed and constructed to RTA standards for a Basic Rural intersection incorporating BAL and BAR treatments for the left turn and right turn into the Project Site. The intersection would be able to accommodate articulated vehicles, such as semi-trailers, turning right into and left out of the Project Site. The Proponent does not anticipate that articulated vehicles would be required to travel to the south of the access road intersection. Suitable environmental controls, including a 50m sealed section of the site access road, would be provided near the entrance to prevent dust. from being carried into Majors Creek Road.

As noted in Section 4.9.4.1, the intersection would provide for safe intersection sight distance requirements for the posted speed limit and this would be maintained through clearing of vegetation as necessary.

TUP (2010) has confirmed, through reference to the warrants for Rural Turn Lanes provided by the RTA *Road Design Guide*, that due to the low volume of traffic using Majors Creek Road and the small number of heavy vehicle movements generated by the Project, the provision of a left turn acceleration lane for heavy vehicles leaving the Project Site is not warranted.

4.9.5.2 Traffic Conditions

Tables 4.36 and **Figure 4.34** compare the existing traffic volumes on the roads for an average weekday (5 day average) with the predicted traffic levels when traffic generated by the Project is included.

Table 4.36
5 Day Average (Weekday) Two Way Daily Traffic Volumes

Road	Existing			Predicted (Construction)		
	Light Vehicles (%)	Heavy Vehicles (%)	Total	Light Vehicles (%)	Heavy Vehicles (%)	Total
Construction Phase						
Majors Creek Road	314 (93%)	23 (7%)	337	344 (92%)	29 (8%)	373
Araluen Road	619 (88%)	76 (12%)	695	649 (89%)	82 (11%)	731
Captains Flat Road	984 (90%)	103 (10%)	1087	1 014 (90%)	109 (10%)	1 123
Coghill Street	973 (89%)	118 (11%)	1 091	1 003 (89%)	124 (11%)	1 127
Wallace Street	1 081 (89%)	140 (11%)	1 221	1 111 (88%)	146 (12%)	1 257
Operational Phase						
Majors Creek Road	314 (93%)	23 (7%)	337	334 (88%)	41 (12%)	375
Araluen Road	619 (88%)	76 (12%)	695	639 (87%)	94 (13%)	733
Captains Flat Road	984 (90%)	103 (10%)	1087	1 004 (89%)	121 (11%)	1 125
Coghill Street	973 (89%)	118 11%	1 091	993 (88%)	136 (12%)	1 129
Wallace Street	1 081 (89%)	140 (11%)	1 221	1 101 (88%)	158 (12%)	1 259

Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 4.1

It is notable that the predicted traffic generation from the Project would not increase the traffic volume on any road significantly, with no road moving from a lower Road Design Guide AADT class to a higher class. (see **Table 4.32**).

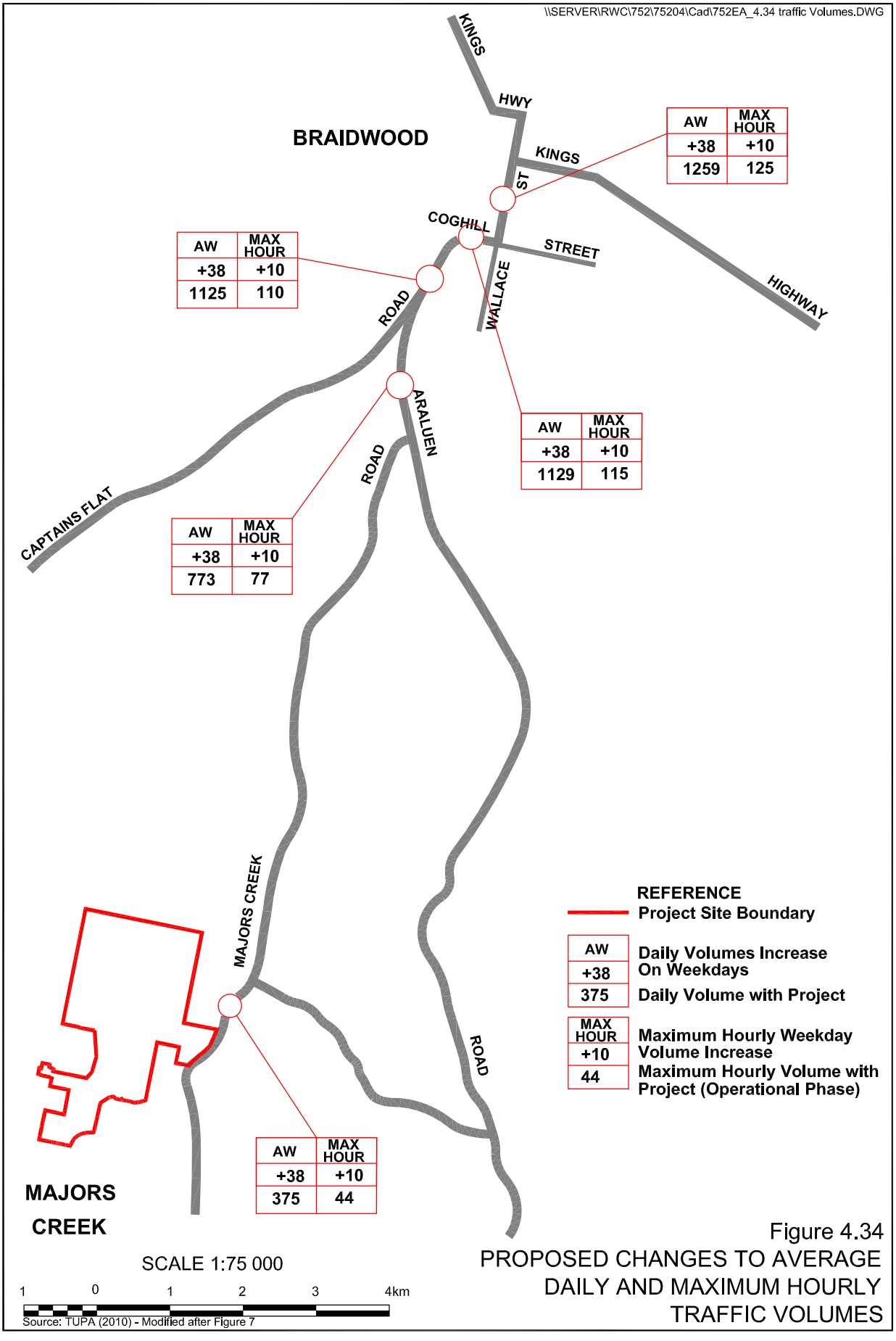


Figure 4.34
PROPOSED CHANGES TO AVERAGE DAILY AND MAXIMUM HOURLY TRAFFIC VOLUMES

A review of **Table 4.36** illustrates the following.

- Over most of the road network, the increase in total traffic volumes due to the Project would range between 3.1% and 5.6%. While on Majors Creek Road, the increase in total traffic volume would be greater (11.3%). However, it is noted that Majors Creek Road also carries relatively low total traffic volume (337vpd on a weekday) than the other roads on the transportation route.
- The proportion of heavy vehicles using the road network would increase by 1% on most sections of the road network, when compared to the existing 2010 traffic volumes. Once again the proportional increase on Majors Creek Road would be comparatively larger (5%) given the relatively low traffic volumes carried by this road. In all cases, the proportion of heavy vehicles proposed to use these roads would remain between 8% (on Majors Creek Road during construction) and 13% (on Araluen Road at maximum production).

Tables 4.37 and **Figure 4.32** identify the traffic volume increase due to Project-related traffic during the busiest hour on a weekday (typically between 6.00am and 9.00am and/or between 3.00pm and 7.00pm).

Table 4.37
Maximum Hourly Two Way Traffic Volumes on the Road Network with the Project

Road	Existing Maximum Hourly Volumes		Additional Maximum Hourly Volumes from Project	Total Volumes with Project	
	6am-9am	3pm-7pm		6am-9am	3pm-7pm
Majors Creek Road	28	34	+10	38	44
Araluen Road	67	66	+10	77	77
Captains Flat Road	97	100	+10	107	110
Coghill Road	73	105	+10	83	115
Wallace Street	88	115	+10	98	125
Source: Traffic Counts 12 – 19 February 2010. Modified after TUP (2010) – Table 4.2					

TUP (2010) considers the Project-related increase in the maximum one hour period of 10vph on the road network to be small in real terms and would have a very minor impact on existing traffic conditions on these roads. A range of between 38vph to 110vph for the rural roads remains consistent with a Level of Service A operation (see Section 4.9.2.4). Similarly, maximum hourly two way traffic volumes with the Project on Coghill and Wallace Streets (town roads) (115vph and 125vph) are also relatively low and representative of good traffic conditions (Level of Service A).

TUP (2010) notes that the proposed increase in hourly traffic movements would not have any measurable impact on intersection capacity and or vehicle delay.

4.9.5.3 Road Conditions

While small, the additional heavy vehicle movements generated by the Project would contribute to limited pavement deterioration on sections of the local road network, in particular those sections of the road network that do not currently comply with the *RTA Road Design Guidelines*. In particular the longer articulated vehicles, ie. 19 metre semi-trailers, may accelerate damage to road edges on the narrower roads such as Majors Creek Road. Majors Creek Road, which has a sealed pavement of (on average) 5.8m wide, is expected to experience some damage to the edge of the sealed pavement particularly on curves and bends, from the increased number of articulated vehicles travelling to and from the Project Site. The Proponent has committed to contributing to the ongoing maintenance of Majors Creek Road through the establishment of a Section 94 Contributions Plan with Palerang Council. The Proponent anticipates that these contributions would be allocated to remediation and preventative maintenance on those sections of the transport route most susceptible to heavy vehicle damage.

Given Wallace Street, Coghill Street, Captains Flat Road and Araluen Road generally have sealed pavements between 6.2m and 7.0m wide and satisfy *RTA Road Design Guidelines* regarding pavement width for the anticipated traffic volumes with the project, the potential for Project-related traffic to contribute significantly or noticeably to pavement deterioration is considered very small.

4.9.5.4 Road Safety

Considering the relatively minor changes to traffic volumes using the local road network, and the proposed operational controls and safeguards to be implemented (such as road upgrades, speed limit restrictions and the implementation of a Driver Code of Conduct), TUP (2010) does not consider the Project-related traffic would result in a significant reduction in local road safety. If anything, the proposed operational controls and safeguards would improve road safety conditions locally. In addition, no reduction in existing level of service is expected as a result of the Project.

4.10 AIR QUALITY AND ENERGY

4.10.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Air Quality**" and "**Energy**". The DGRs specify that in assessing "Energy", the Environmental Assessment must "*Calculate the scope 1, 2 and 3 emissions of the mining operations and describe what measures would be implemented to ensure these operations are energy efficient.*"

Based on the risk assessment undertaken for the Project (see Section 3.3), specific air quality-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Dust generation resulting in potential nuisance dust impacts (moderate to high risk).

- Dust generation resulting in potential health impacts.
- Dust generation resulting in impacts on biota.
- Greenhouse Gas Emission.

The DGRs also require that the assessment of air quality refer to *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (DEC, 2005) and *Approved Methods for Sampling and Analysis of Air Pollutants in NSW* (DEC, 2007).

An Air Quality and Greenhouse Gas Assessment was undertaken by PAEHolmes (PAEH) to address the DGRs and assess the impact of the Project on local air quality. The assessment was completed by Ms Judith Cox (B.Eng. (Hons) and Ms Francine Triffett (BA) of PAEH. This section of the *Environmental Assessment* provides a summary of the assessment report which is presented in full as Part 7 (Volume 2) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "PAEH (2010)". The following sub-sections describe and assess the existing air quality environment, identify the air quality management issues and the proposed air quality controls, safeguards and mitigation measures. Additionally, the assessment of the residual impacts upon the air quality following the implementation of these safeguards and mitigation measures is also presented.

4.10.2 Existing Environment

4.10.2.1 Introduction

Air quality guidelines and goals refer to levels of "pollutants" in air which include both existing and operational sources. In order to fully assess impacts against all the relevant air quality guidelines and goals, it is therefore necessary to compile information or estimates on the existing concentration of airborne particulates, dust deposition and gases, including those contributing to climate change ("greenhouse gases"). In the absence of site-specific air quality data for some "pollutants", background levels are described through reference to monitoring undertaken at the closest available location.

4.10.2.2 Particulate Matter, Total Suspended Particulates and Deposited Dust

The generation of 'dust' would be one of the main air quality issues relevant to the Project. Depending upon the size and concentration of particles in the air and their composition, airborne dust has the potential to affect human health as well as contribute to the general degradation of the environment. The term *"particulate matter"* refers to a category of airborne particles typically less than 50µm in aerodynamic diameter and ranging down to 0.1µm in size. The human respiratory system has a built-in defensive system that prevents particles greater than 10µm in diameter from reaching sensitive areas of the respiratory system. As a result particles less than 10µm (PM_{10}) and 2.5µm ($PM_{2.5}$), if in high enough concentration, may adversely affect human health.

As particles larger than 10µm can also contribute to environmental degradation, the air quality assessment also considers the total mass of particles suspended in the air, ie. Total Suspended Particulates (TSP). Particles that have an aerodynamic sufficiently large so as not to be suspended in air (typically >35µm) are referred to as deposited dust.

No air quality monitoring data is available within or in the vicinity of the Project Site. However, it is noted that the Project Site is situated in a rural area with no major sources of air pollution. As a result the local air quality is likely to be good and concentrations of pollutants are unlikely to exceed any of the air quality criteria.

Particulate Matter

DECCW collects PM_{10} data in the rural areas of Albury, Bathurst and Wagga Wagga using a TEOM (Tapered Element Oscillating Microbalance) to provide continuous recordings of PM_{10} concentrations. **Table 4.38** presents a summary of recent PM_{10} data collected by DECCW in these locations. The annual average PM_{10} concentrations at all three locations are within the DECCW criteria of 30μg/m^3. The average PM_{10} concentration over all sites and all years is 21μg/m^3. PAEH (2010) considers it likely that many of the air quality exceedances experienced at the three sites are due to significant weather events such as bushfires and dust storms or agricultural activities such as when broad acre cultivation and/or the preparation of land for cropping takes place.

TSP and Dust Deposition

While data for local TSP concentration and dust deposition is not available, PAEH (2010) notes that there is an approximate relationship between annual dust deposition and TSP concentrations that can be applied in areas where road traffic is not the dominant source of particulate matter. Areas experiencing 4g/m^2/month typically experience annual TSP concentrations of 90μg/m^3. PAEH (2010) also note that in locations such as that of the Project Site, 40% of TSP will typically be in the PM_{10} size range. To estimate background TSP and dust deposition, these approximate relationships have been applied.

$$\text{TSP} = \frac{PM_{10}}{0.4} = 53\mu g/m^3$$

$$\text{Dust deposition} = \frac{53}{90} \times 4.0 = 2.4 g/m^2/\text{month}$$

Summary of Existing Air Quality

Taking into account PM_{10} data collected at rural monitoring sites and the approximate relationships between PM_{10}, TSP and dust deposition in locations where traffic is not the dominant source of particulate matter, PAEH (2010) has assumed the following background dust and particulate matter concentrations for the local area.

- Annual average TSP: 53μg/m^3.
- Annual average PM_{10}: 21μg/m^3.
- 24 hour maximum PM_{10}: daily varying[5].
- Dust deposition: 2.4g/m^2/month.

[5] As the background 24 hour PM_{10} concentration will vary each day, the assessment of PAEH (2010) has adopted the approach that the predicted 24-hour average PM_{10} concentration (increment attributable to the Project) should not exceed 50μg/m^3 at the nearest residences.

Table 4.38
PM_{10} Monitoring Data from DECCW Rural Monitoring Sites

	Albury		Bathurst		Wagga Wagga	
	Monthly Average	Maximum 24-hour Average	Monthly Average	Maximum 24-hour Average	Monthly Average	Maximum 24-hour Average
Month	**2007**					
January	46	**198**	24	**66**	36	**105**
February	23	49	17	37	42	86
March	27	101	15	25	31	76
April	33	95	20	40	37	69
May	18	32	14	47	26	59
June	11	16	9	14	17	30
July	11	20	9	21	15	29
August	13	24	12	20	18	35
September	15	22	17	31	20	37
October	20	36	28	33	33	68
November	14	30	13	49	19	31
December	*15*	*28*	*12*	*21*	*19*	*56*
Annual average	*21*	-	*16*	-	*26*	-
Month	**2008**					
January	21.7	37.2	16.3	27.1	25.0	64.3
February	18.2	56.1	13.3	40.5	14.7	53.6
March	27.3	54.2	17.1	31.2	36.5	64.6
April	32.1	**124.8**	14.8	41.9	2.1	**294.9**
May	-	-	-	-	24.1	49.9
June	11.8	22.5	9.2	22.1	18.2	35.0
July	9.9	36.1	11.3	41.7	15.9	53.6
August	10.0	18.2	10.3	40.6	15.1	28.5
September	18.5	105.1	16.3	**63.0**	30.9	245.9
October	18.9	40.6	15.7	33.7	30.1	59.0
November	13.3	24.0	13.1	27.2	19.2	48.3
December	14.8	124.2	15.9	30.9	21.4	68.6
Annual average	*18*	-	*14*	-	*21*	-
Month	**2009**					
January	21.7	128.9	17.3	26.9	34.3	88.2
February	45.3	**249.7**	18.7	52.4	58.1	224.0
March	23.7	65.7	23.9	51.5	40.3	100.3
April	23.6	105.7	24.3	224.4	-	-
May	17.1	27.0	13.6	24.4	30.1	56.2
June	9.6	16.1	8.4	29.2	11.7	33.9
July	11.1	15.6	8.3	19.8	14.3	26.9
August	12.7	21.0	14.2	31.6	17.0	30.5
September	13.3	26.5	92.9	**2114.4**	27.7	162.2
October	13.3	29.4	14.4	42.4	17.8	53.8
November	27.5	143.4	27.2	96.6	44.6	**297.4**
December	15.8	58.5	19.1	61.4	23.8	120.9
Annual average	*20*	-	*24*	-	*29*	-
Month	**2010**					
January	20.8	53.9	18.1	**43.3**	27.9	52.0
February	11.8	24.1	10.2	19.9	16.8	43.5
March	19.1	**60.8**	14.6	39.4	23.8	**64.9**
April	14.8	26.1	12.3	28.1	17.8	39.3
Annual average	*17*	-	*14*	-	*22*	-
Average (All Years)	***19***		***18***		***25***	
Average (All Years and Sites)	***21***					

Bold identifies maximum 24-hour average concentration each year
Source: Modified after PAEH (2010) – Table 5.1

4.10.2.3 Greenhouse Gases

Greenhouse gases would be produced as a consequence of the Project through the use of fuel to power mobile equipment within and to and from the Project Site. The effects of greenhouse gas emissions on global temperatures, now referred to as "climate change", are well documented and an assessment of greenhouse gas emissions has been included in this assessment. In accordance with global reporting protocols, emissions of greenhouse gases are reported as CO_2 equivalent (CO_2-e).

For assessment and reporting purposes, background greenhouse gas emissions are considered to be those reported by the Department of Climate Change (DCC) for NSW in 2007 (DCC, 2009), namely 162.7Mt CO_2-e.

4.10.3 Potential Sources of Air Contaminants

4.10.3.1 Particulate Emissions

The main sources of particulate emissions (dust) that would be generated by the Project would include:

- vegetation clearing, soil stripping, soil stockpiling and soil replacement;
- excavation, haulage and use of overburden as part of box cut development, infrastructure establishment, tailings storage facility construction and construction of other hardstand areas;
- road construction and delivery of road construction materials;
- ore crushing and screening;
- wind erosion off exposed surfaces and stockpiles; and
- general movement of heavy vehicles on unsealed roads within the Project Site.

4.10.3.2 Greenhouse Gas and Other Gas Emissions

The primary source of greenhouse gas emissions from the Project would be a result of the combustion of fuel by diesel-powered equipment and vehicles, including front-end loaders, excavators, bulldozers, graders, drill rigs and haul trucks. Additional greenhouse gas emissions would be generated by electricity purchased to power the processing plant and offices.

Although carbon dioxide (CO_2) would be the principal gas produced, greenhouse gases emitted as a result of the Project would also include limited amounts of carbon monoxide (CO), methane (CH_4), oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and non-methane volatile organic compounds (NMVOCs). All greenhouse gas levels, however, are expressed as CO_2-e units.

4.10.4 Assessment Criteria

4.10.4.1 Particulate Matter, Total Suspended Particulates and Dust Deposition

Goals Applicable to PM_{10} and $PM_{2.5}$

Emissions of PM_{10} and $PM_{2.5}$ particles are considered important pollutants in terms of impacts due to their ability to penetrate into the respiratory system.

The DECCW PM_{10} assessment goals as expressed in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005) are:

- a 24-hour maximum of 50µg/m^3; and
- an annual average of 30µg/m^3.

The National Environment Protection Council (NEPC) has also developed a set of advisory reporting standards goals for $PM_{2.5}$ which are:

- a 24-hour maximum of 25µg/m^3; and
- an annual average of 8µg/m^3.

The NEPM goals for $PM_{2.5}$ have not been adopted in NSW for assessment of projects and hence are not considered further in this assessment.

Goal Applicable to Total Suspended Particulates

The annual goal for TSP is given as 90µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC). This goal was developed before the more recent results of epidemiological studies suggested a relationship between health impacts and exposure to PM_{10} concentrations.

Goals Applicable to Deposited Dust

In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4g/m^2/month. **Table 4.39** presents the allowable increase in dust deposition relative to the ambient levels.

Table 4.39
DECC Goals for Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	2g/m^2/month	4g/m^2/month
Source: Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, (DEC 2005)		

4.10.4.2 Greenhouse Gas Emissions

There are no specific guidelines are provided for maximum emissions of greenhouse gases. It is noted, however, that Australia is a signatory to the Kyoto Protocol which requires developed countries to meet national targets for greenhouse gas emissions over the five year period from 2008 to 2012. Australia's annual target is 108% of the 1990 emissions.

4.10.5 Assessment Methodology

4.10.5.1 Particulate Matter Emissions

PAEH (2010) has assessed the potential particulate matter-related impacts of the Project, in accordance with the DECCW published guidelines for the assessment of air pollution sources using dispersion models (DEC, 2005), using a modified version of the US EPA ISCST3 model (ISCMOD). The model incorporates mathematical algorithms to estimate dispersion of a plume of dust, taking into account the location of emission sources and volume of dust produced at each location, as well as the effects of wind and topography on the estimated dust plume. This model has been accepted by DECCW for assessing the dispersion of dust in the atmosphere.

Particle-size Categories and Plume Dispersion Modelling

The modelling has been based on the use of three particle-size categories, namely 0µm to 2.5µm – $PM_{2.5}$, 2.5µm to 10µm – PM_{10} and 10µm to 30µm - $PM_{10\text{-}30}$. The distribution of particles has been derived from measurements published by the SPCC (SPCC, 1986) which is as follows.

- $PM_{2.5}$ is 4.7% of the TSP.
- $PM_{2.5\text{-}10}$ is 34.4% of TSP.
- $PM_{10\text{-}30}$ is 60.9% of TSP.

The ISCST3 model attempts to estimate the dispersion of a plume of dust using actual meteorological data, including wind speed and direction, each hour over the modelling period, and calculating the relevant dust concentration and deposition rate at specified locations. In the present case, the co-ordinates of surrounding residences were entered into the model as point receptors (**Figure 4.7**). The data for each residence was then averaged over each 24-hour period and for the entire year, with the maximum 24-hour values for PM_{10} and deposited dust representing the highest concentration or amount deposited at that location in any 24-hour period during the year.

Meteorological Conditions

As noted in Section 4.1.3.5, wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction) data have been collected from the Project Site meteorological station. DECCW have listed requirements for meteorological data that are used for air dispersion modelling in the document "*Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW*" (DEC, 2005). The requirements, and review of data collected from the Project Site meteorological station, are as follows.

- Data must span at least one year. The data used during modelling spans 12 months from March 2009 to March 2010.
- Data must be at least 90% complete. The data contains 8 209 usable hourly records, or 94.4% of the potentially available data.
- Data must be representative of the area in which emissions are modelled. The data was collected within the Project Site.

As noted in Section 4.1.3.5, the onsite meteorological data from March 2009 to March 2010 was used by PAEH (2010) to calculate the proportional occurrences of Pasquill Gifford Stability Classes (see **Table 4.2**). A review of **Table 4.2** identifies that the most common stability class for the Project Site is Class D (59.7%), indicating that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time. The frequency of E and F class conditions (slow dispersal conditions) are much lower at 23% (combined).

Particulate Matter Emissions (Dust Inventory)

Particulate matter emitting activities were represented by a series of volume sources positioned according to the location of activities during Year 3 of the Project (the year during which the greatest level of production and waste rock movement is scheduled). **Figure 4.35** provides an illustration of the locations of dust generating activities within the Project Site during Year 3 of mining operations. The locations of these activities have been placed where they would be likely to generate the highest concentration of particulate matter at residences surrounding the Project Site and represent the following concurrent activities.

- Stripping topsoil from the tailings storage facility (Locations 1 & 2).
- Placement of topsoil in stockpiles surrounding the tailings storage facility (Locations 3, & 5).
- Operation of a grader on the tailings storage facility access road (Location 4).
- Wind erosion from soil stockpiles (Locations 6 to 8).
- Haulage of ore from the underground to the ROM pad and waste rock from the temporary Waste Rock Emplacement back underground (Locations 9 to 12).
- Tipping of ore on the ROM pad and loading of ore to the ROM hopper (Location 13).
- Haulage of topsoil to the Waste Rock Emplacement and spreading of soil over the final landform (Location 14).
- Operation of the primary crusher and ball mill (Location 15).
- Loading of processed material (concentrate) to stockpile (Location 16).
- Vehicle movements on the site access road (Locations 17 to 32).

The quantity of dust generated by each activity has been established through reference to emission factors developed, both locally and by the US EPA. These emission factors applied are considered to be the most up-to-date methods for determining dust generation rates. **Table 4.40** presents the estimated dust emissions for the modelled worst-case dust generation scenario. It is noted that the estimates presented in **Table 4.40** assume the implementation of the operational controls presented in Section 4.10.6.

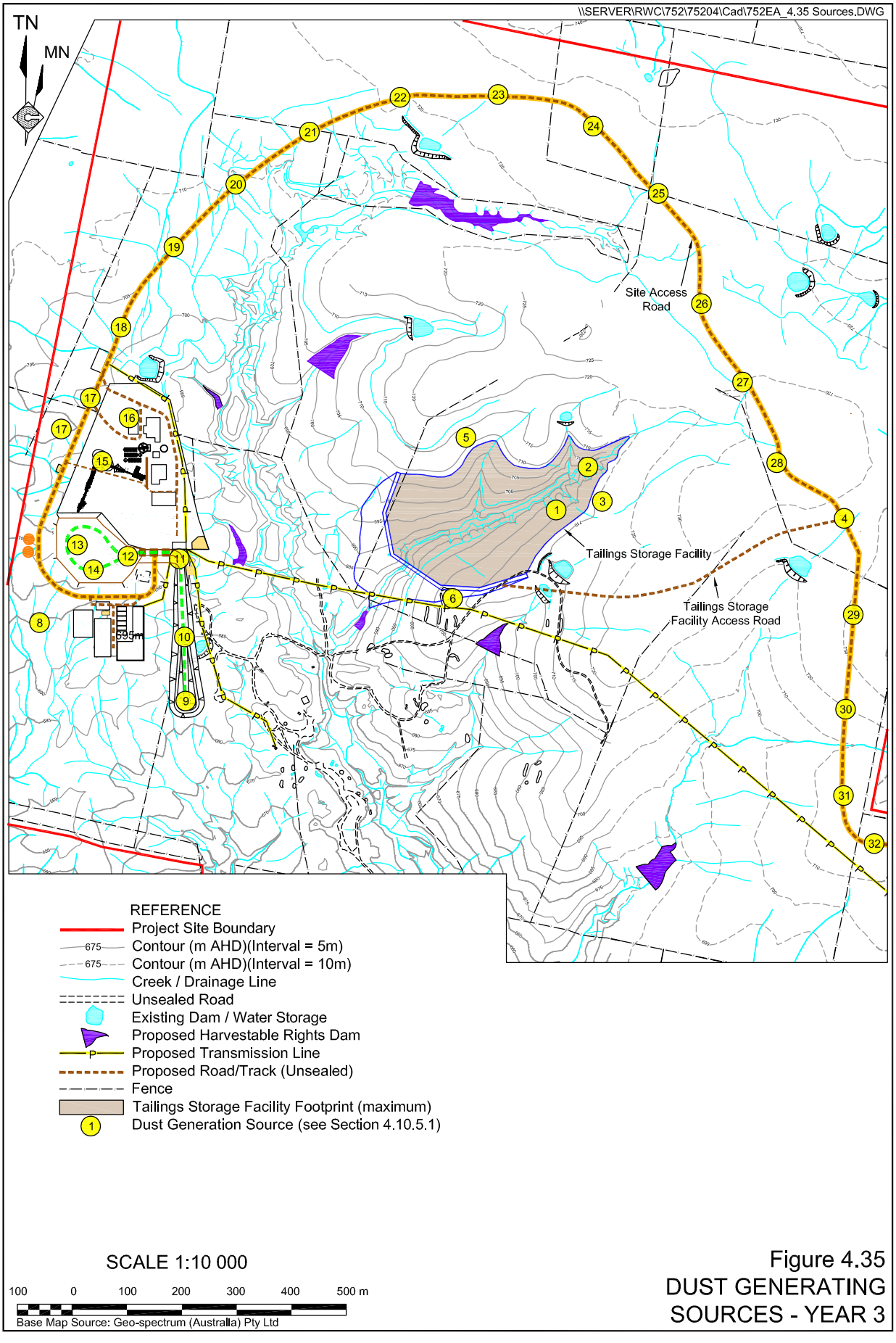


Figure 4.35
DUST GENERATING SOURCES - YEAR 3

Table 4.40
Estimated Dust Emissions of the Project (Year 3)

ACTIVITY	TSP Emission (kg/yr)
Topsoil Management	
Dozers/excavators stripping topsoil	179
Wheeled loader loading topsoil from tailings storage facility	53
Emplacing topsoil at stockpile near to Waste Rock Emplacement	53
Loading topsoil from stockpile near Waste Rock Emplacement to trucks	1
Hauling topsoil to Waste Rock Emplacement	11
Tipping/respreading topsoil at Waste Rock Emplacement	1
Waste Rock Management	
Loading rock from Waste Rock Emplacement to trucks	21
Hauling from Waste Rock Emplacement to underground	696
Ore Management	
Hauling to ROM pad	5,940
Unloading ROM to stockpile	453
Wheeled loader rehandle ore to ROM bin	453
Primary crushing	66,000
Ball milling	-
Screening	26,400
Unloading of crushed / processed ore (concentrate) to stockpile	6
Wheeled loader loading from concentrate stockpile to vehicles	12
Hauling concentrate off-site	5,360
Stockpile Management	
Wind erosion from the Waste Rock Emplacement and ROM pad	3,154
Wind erosion from soil stockpile areas	17,170
Wind erosion from concentrate stockpile	876
Other	
Grading roads	43,132
Total	**169,969**
Source: PAEH (2010) – Table 7.1	

4.10.5.2 Greenhouse Gas Emissions

The primary source of greenhouse gas emissions from the Project would be from the combustion of fuel by diesel-powered equipment and vehicles within the Project Site and along the transportation route. The use of purchased electricity within the Project Site would also be a source of greenhouse gas emissions. In order to assess greenhouse gas emissions, the various greenhouse gas emitting activities were identified and, through the use of established National Greenhouse Accounts (NGA) Factors, published by the DCC (DCC, 2009b), annual CO_2-equivalent emissions were calculated.

The DCC defines the following three 'scopes' (or emission categories) of greenhouse gas emitting sources.

- **Scope 1 Emissions**

  These are the direct emissions from sources within the boundary of the Project Site such as the combustion of fuel by diesel-powered equipment and vehicles.

- **Scope 2 Emissions**

  These are the indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation.

- **Scope 3 Emissions**

  These emissions are defined as all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned, or controlled, by the organisation. In the case of the Project, this includes:

  – the emissions which arise as a result of the procession and production of the diesel and transport to the Project Site; and

  – the emissions arising from electricity lost through the transmission of purchased electricity.

4.10.6 Management and Mitigation Measures

4.10.6.1 Dust Management and Mitigation Measures

The Proponent has committed to implementing "best practice" management for pollution control. "Best practice" management for the control of particulate emissions is defined by Environment Australia (1998) as follows.

> *"Best Practice can be defined as the most practical and effective methodology that is currently in use or otherwise available. Best practice dust management can be achieved by appropriate planning in the case of new or expanding mining operations and by identifying and controlling dust sources during the active phases of all mining operations."*

Table 4.41 identify the mine design, wind-blown and mining-generated dust sources and proposed controls. These have been incorporated in the analysis, where relevant.

4.10.6.2 Energy Reduction Measures

The Proponent has and would continue to would implement the following measures to minimise the emisions of greenhouse gases during the life of the Project.

- Optimise the underground mine design to minimise:
  – development metres;
  – travel distances for mining equipment; and
  – rehandle of waste and ore material.
- Use mining equipment which is regularly maintained and serviced to maximise efficiency.
- Use Euro 4 compliant engines wherever practicable.
- Minimise the mine footprint to reduce land disturbance and travel distances for mobile plant.
- Optimise the design Process Plant to:
  – maximise the use of gravity to move material through the Process Plant reducing the need for pumping; and
  – maximise the use of energy efficient motors in major pieces of plant

Table 4.41
Proposed Dust Management Controls

Source	Control Procedures
Mine Design	
Transportation of ore	• Operate the largest practical truck size to reduce the number of movements necessary to transport the ore. • Use the shortest route possible. • Use conveyors within the processing plant. • Establish and use water sprays on key transfer points within the processing plant.
Waste Rock Emplacement	• Orient the Waste Rock Emplacement to minimise profile exposure to receptors. • Profile all surfaces to reduce velocity of overland winds. • Contour the final landform shape to avoid strong wind flows and smooth gradients to reduce turbulence at surface.
Revegetation	• Apply vegetative cover to non-operational exposed surfaces, eg. tailings storage facility Wall, ROM pad batters, as soon as practical after disturbance. • Apply vegetation as widely as practical.
Wind-blown Dust	
Areas Disturbed by Mining	• Limit disturbance to the minimum area necessary for mining and associated activities. • Reshape, topsoil and rehabilitate completed waste rock emplacement areas as soon as practicable after the completion of waste rock tipping. (As the Waste Rock Emplacement of the Project is to be a temporary structure, reshaping, topsoiling and rehabilitation activities of the remaining structure (ROM pad batter) would be undertaken as soon as practical after the excavation and haulage of the waste rock is complete.)
Ore Handling Areas/Stockpiles	• Maintain ore handling areas / stockpiles in a moist condition by using water carts to water down areas affected by wind-blown and traffic-generated dust.
Stockpiles	• Water stockpiles to maintain moisture content and minimise the generation of dust.
Mine-generated Dust	
Haul Road Dust	• Apply water to all roads and trafficked areas using water trucks to minimise the generation of dust. • Clearly define all haul roads edges with marker posts or equivalent to control their locations, especially when crossing large areas of non-descript disturbance. • Close, rip and revegetate all obsolete roads.
Minor Roads	• Limit the development of minor roads and clearly define the locations of these. • Apply water to all minor roads used regularly for access. • Close, rip and revegetate all obsolete roads.
Topsoil Stripping	• Apply water to all access tracks used by topsoil stripping equipment during their loading and unloading cycle.
Topsoil Stockpiling	• Establish vegetative cover over all long term topsoil stockpiles not regularly used.
Processing	• Establish and use water sprays on key transfer points within the processing plant. • Minimise drop heights from the ROM bin to the primary crusher.

Source: PAEH (2010) After Tables 9.1 to 9.3.

- Maximise the recovery of recyclable materials where practicable, including:
  - waste hydrocarbons;
  - polyethylene; and
  - scrap metals.

- Minimise waste sent to landfill through the development of appropriate purchasing and waste management plans.
- Progressively review and implement energy efficiency measures during the life of the Project.

4.10.7 Assessment of Impacts

4.10.7.1 Particulate Matter and Deposited Dust Impacts

Table 4.42 summarises the predicted PM_{10}, TSP and deposited dust concentrations at each of the residential receptors attributable to the Project. Emission concentrations are provided both as those attributable to the Project alone, as well as cumulative emissions of the Project and other background sources (based on the background emission concentrations estimated in Section 4.9.2.2). The following compares the maximum incremental contribution for PM_{10}, TSP and deposited dust and assesses each against the Project goals identified in Section 4.10.4.1.

Annual Average PM_{10}

The most potentially affected non-project related residence (Residence R27) is predicted to experience annual average PM_{10} concentration of 1.1µg/m^3 from the Project alone and a cumulative concentration of approximately 22µg/m^3. This is below the NSW DECC goal of 30µg/m^3. **Figure 4.36** provides the predicted cumulative dispersion contours for annual average PM_{10} concentrations.

Maximum 24-hour Average PM_{10}

PAEH (2010) note that where contemporaneous and continuous monitoring data are not available in the vicinity of a Project, it is difficult to establish a reliable background for short-term PM_{10} effects. Notwithstanding the lack of a contemporaneous dataset for comparison to the Project generated PM_{10} increment, it is notable that the predicted 24-hour PM_{10} concentrations at the sensitive receptors surrounding the Project Site are very low. In fact the highest prediction from operations at the Project alone is 9µg/m^3 which represents 18% of the assessment criteria. **Figure 4.36** provides the predicted dispersion contours for Project generated PM_{10} concentrations.

As the Project Site is situated in a rural area with no major sources of air pollution, the local air quality is likely to be good and therefore on all but extreme condition days, eg. when bushfires or dust storms are occurring, cumulative emissions would comply with 50µg/m^3 criterion.

Annual Average TSP

The maximum predicted concentration at surrounding non-project related residences from the Project alone is 1.3µg/m^3 (Residence R27) and a cumulative concentration of approximately 54µg/m^3. This is below the NHMRC goal of 90µg/m^3. **Figure 4.37** provides the predicted cumulative dispersion contours for annual average TSP concentrations.

Dust Deposition

Dust deposition levels at all surrounding residences are predicted to be less than 0.2g/m^2/month. Compliance with the NSW DECC goal of 4g/m^2/month would be anticipated with the existing dust deposition of 2.4g/m^2/month. **Figure 4.37** provides the predicted cumulative dispersion contours for annual average dust deposition levels.

Table 4.42
Predicted Particulate Matter Emissions[1]

Receiver[1]	Project Only				Cumulative Emissions		
	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust Deposition (g/m^2/month)	PM_{10} ($\mu g/m^3$)	TSP ($\mu g/m^3$)	Dust Deposition (g/m^2/month)
	24-hour	Annual	Annual	Annual	Annual	Annual	Annual
	Assessment Criteria						
	50	***N/A***	***N/A***	***2***	***30***	***90***	***4***
R1	6	0.3	0.4	0.03	21	53	2.4
R2	4	0.4	0.4	0.03	21	53	2.4
R6	4	0.4	0.4	0.03	21	53	2.4
R7	4	0.4	0.4	0.03	21	53	2.4
R8	4	0.4	0.4	0.03	21	53	2.4
R9	5	0.3	0.4	0.03	21	53	2.4
R10	4	0.4	0.5	0.04	21	53	2.4
R11	5	0.4	0.4	0.03	21	53	2.4
R12	6	0.3	0.3	0.02	21	53	2.4
R13	5	0.3	0.3	0.02	21	53	2.4
R14	5	0.3	0.3	0.02	21	53	2.4
R15	2	0.2	0.2	0.02	21	53	2.4
R16	4	0.5	0.6	0.04	21	54	2.4
R17	4	0.5	0.6	0.05	21	54	2.4
R18	4	0.5	0.6	0.05	22	54	2.5
R19	4	0.5	0.6	0.05	21	54	2.4
R20	4	0.6	0.7	0.05	22	54	2.5
R21	4	0.6	0.7	0.05	22	54	2.5
R22	4	0.6	0.7	0.05	22	54	2.5
R23	4	0.6	0.7	0.06	22	54	2.5
R24	6	0.8	0.9	0.07	22	54	2.5
R25	6	0.7	0.9	0.07	22	54	2.5
R26	6	0.8	0.9	0.07	22	54	2.5
R27	**8**	**1.1**	**1.3**	**0.11**	**22**	**54**	**2.5**
R28	6	0.8	1.0	0.07	22	54	2.5
R29	8	0.7	0.9	0.07	22	54	2.5
R30	9	0.6	0.7	0.05	22	54	2.5
R31	8	0.7	0.9	0.07	22	54	2.5
R34	4	0.1	0.1	0.01	21	53	2.4
R53	4	0.5	0.6	0.04	22	54	2.4
R54	4	0.5	0.6	0.04	22	54	2.4
R55	4	0.6	0.6	0.05	22	54	2.4
R56	4	0.5	0.6	0.04	22	54	2.4
R58	5	0.6	0.7	0.05	22	54	2.5
R59	5	0.6	0.7	0.05	22	54	2.5
R60	4	0.5	0.6	0.04	21	54	2.4
R70	4	0.4	0.5	0.04	21	53	2.4
R71	4	0.6	0.7	0.05	22	54	2.5
R72	5	0.6	0.7	0.05	22	54	2.5
R93	4	0.3	0.4	0.03	21	53	2.4
R94	4	0.3	0.3	0.03	21	53	2.4
R107	4	0.3	0.3	0.02	21	53	2.4

Note 1: see **Figure 4.7** for residence locations.
Note 2: Only residences predicted to receive maximum 24-hour PM_{10} concentrations of 4$\mu g/m^3$ or more are shown. The results for all residences are shown in Table 8.1 of PEAH (2010)

Source: Modified after PAEH (2010) – Table 8.1

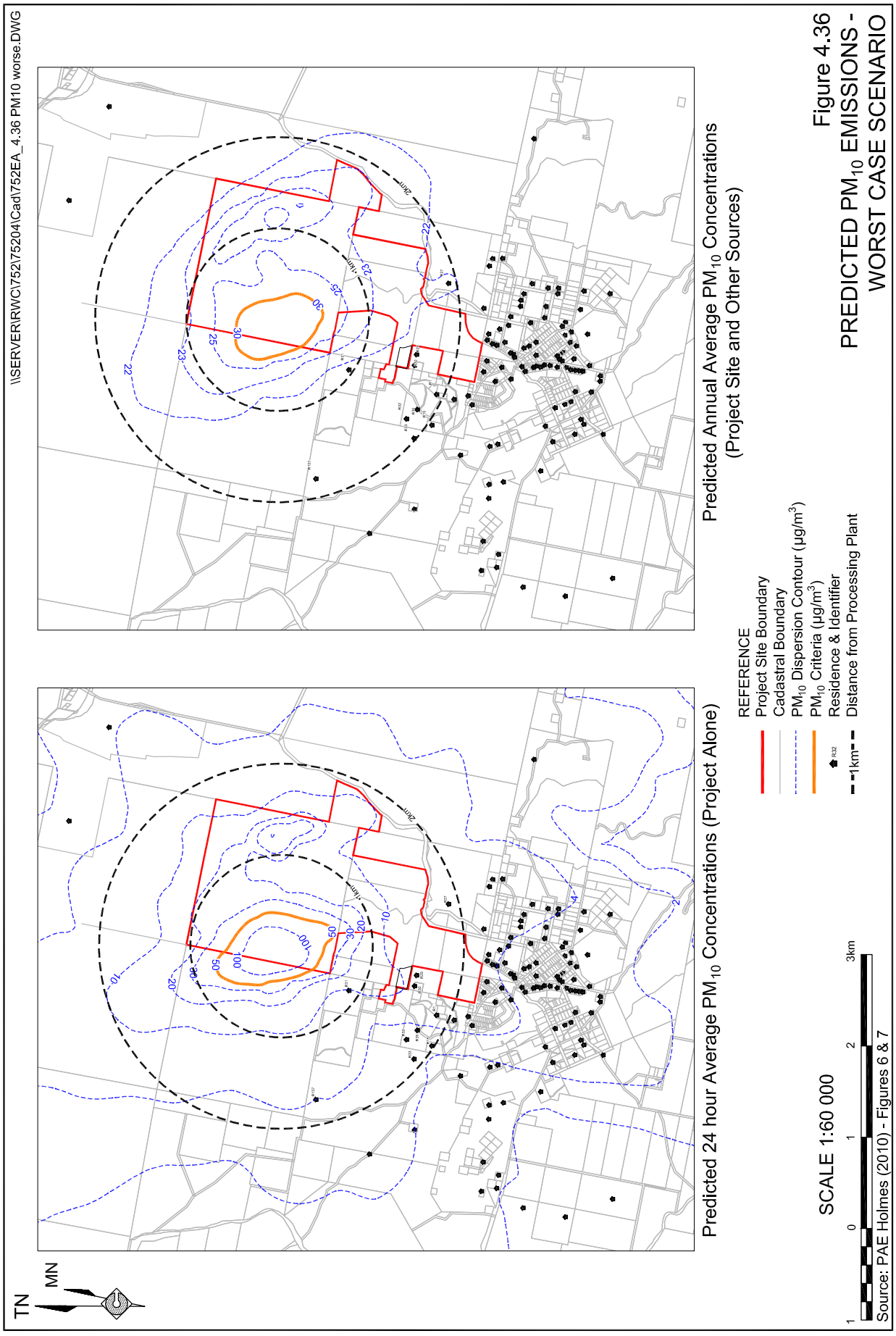


Figure 4.36
PREDICTED PM_{10} EMISSIONS - WORST CASE SCENARIO

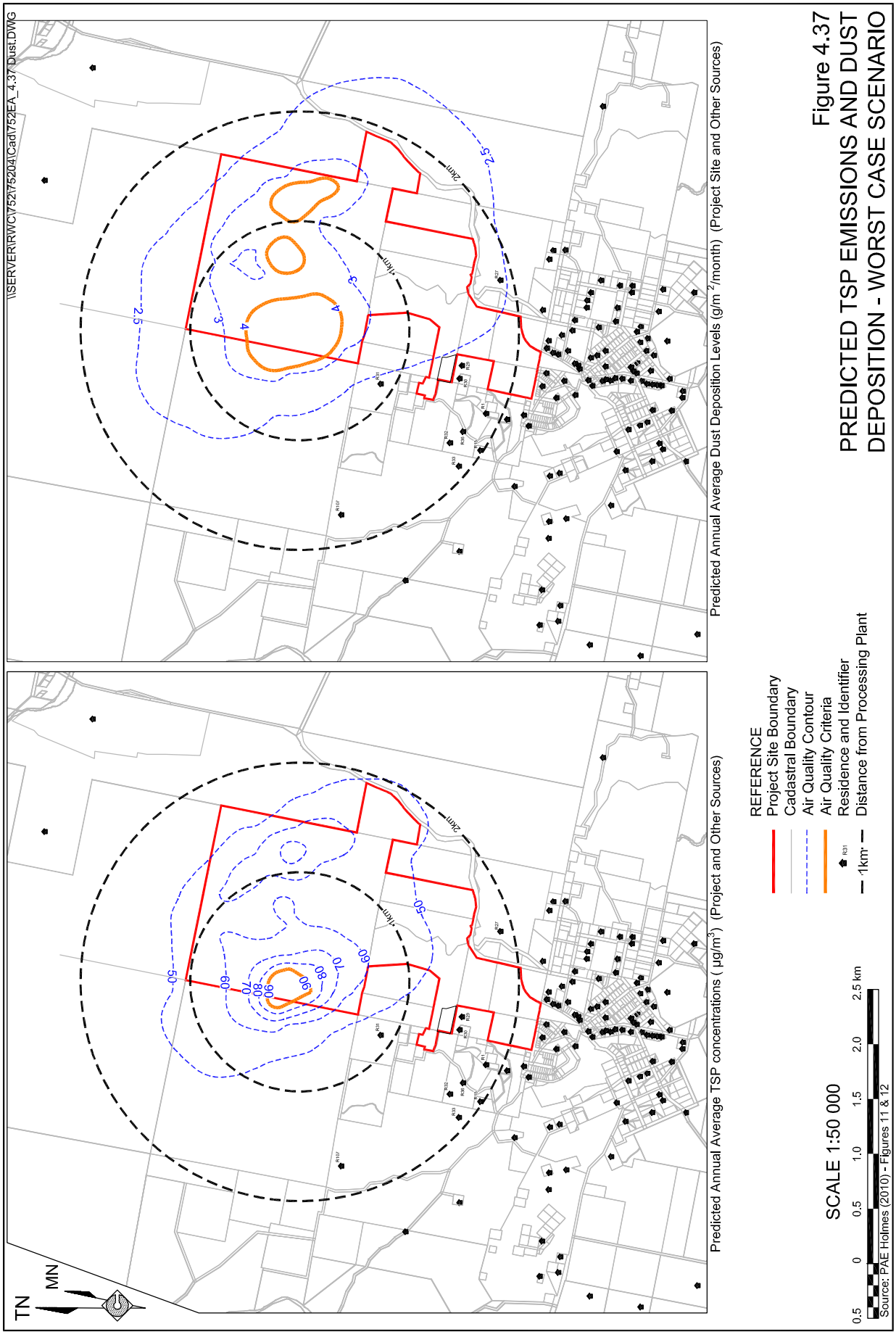


Figure 4.37
PREDICTED TSP EMISSIONS AND DUST DEPOSITION - WORST CASE SCENARIO

The minimal incremental increases in deposited dust (<0.2g/m^2/month) are considered extremely unlikely to have any influence on the growth of vegetation surrounding the Project Site, including native vegetation, pasture and nursery stock. An illustration of the tolerance of vegetation to dust accumulation is provided by Hunt (1999) who considered the accumulation of dust at a rate equivalent to 8g/m^2/day (at least 240 times the maximum predicted incremental increase to dust deposition predicted for residences surrounding the Project Site) on pasture palatability and production. Hunt (1999) concluded that the addition of the elevated rates of dust deposition had no effect on palatability or production.

4.10.7.2 Greenhouse Gas Emissions

Scope 1 Emissions (Diesel Fuel Consumption)

The following formula (DCC, 2009b) was used to estimate the Scope 1 greenhouse gas emissions from fuel usage.

$$GHG\ Emissions\ (tCO_2 - e) = \frac{Q \times EC \times EF}{1000}$$ Equation 1

Where:

EC = energy content of the fuel in GJ/kL = 38.6GJ/kL (DCC, 2009b)

EF = relevant emission factor in kg CO_2-e/GJ = 69.5kg CO_2-e/GJ (DCC, 2009b)

Q = quantity of fuel in tonnes or thousands of litres

Table 4.43 provides the estimated diesel fuel consumption per year (Q) for the Project and the associated CO_2-e Emissions.

Table 4.43
Summary of Scope 1 Emissions

Operational Year	Diesel Usage per Year (L)	CO_2-e Emissions (t CO_2-e/y)
Year 1	1 117 314	2 997
Year 2	1 473 228	3 952
Year 3	1 475 820	3 959
Year 4	955 800	2 564
Year 5	635 607	1 705
Total (L)	**5 657 769**	**15 178**
Source: Modified after PAEH (2010) – Tables 10.2 & 10.3		

Scope 2 Emissions (Purchased Electricity)

To calculate emissions from electricity usage, the following equation was used:

$$GHG\ Emissions\ (tCO_2 - e) = Q \times \frac{EF}{1000}$$ Equation 2

Where:

EF = relevant emission factor in kg CO2-e/GJ = 0.89kg CO2-e/kWh

Q = electricity consumed in kWH

Table 4.44 provides the estimated electricity consumption per year (Q) for the Project and the associated CO_2-e Emissions.

Table 4.44
Summary of consumption of Scope 2 Emissions

Operational Year	Electricity Consumption per Year (kWh)	Electricity CO_2-e Emissions (t CO_2-e/y)
Construction - 4 months	206 681	184
Year 1	36 238 204	32 252
Year 2	45 241 750	40 265
Year 3	46 567 613	41 445
Year 4	46 662 513	41 530
Year 5	34 818 947	30 989
Total	**209 735 707**	**186 665**
Source: Modified after PAEH (2010) – Tables 10.4 & 10.5		

Scope 3 Emissions - Diesel Extraction and Transport & Electricity Transmission Loss

The same formula was used to calculate Scope 3 emissions resultant from the consumption of diesel fuel as used to calculate Scope 1 emissions, however, an emission factor of 5.3kg CO_2-e/GJ was used.

Table 4.45 provides the estimated diesel fuel consumption per year (Q) for the Project and the associated CO_2-e Emissions.

Table 4.45
Summary of Scope 3 Emissions – Diesel Extraction and Transport

Operational Year	Diesel Usage per Year (L)	CO_2-e Emissions (t CO_2-e/y)
Year 1	1 117 314	229
Year 2	1 473 228	301
Year 3	1 475 820	302
Year 4	955 800	196
Year 5	635 607	130
Total (L)	**5 657 769**	**1 157**
Source: Modified after PAEH (2010) – Tables 10.2 & 10.6		

The same formula was used to calculate Scope 3 emissions resultant from the consumption of purchased electricity as used to calculate Scope 2 emissions, however, an emission factor of 0.18kg CO_2-e/kWh was used.

Table 4.46 provides the estimated electricity consumption per year (Q) for the Project and the associated CO_2-e Emissions.

Total Greenhouse Gas Emissions

A summary of the total GHG emissions associated with the Project are presented in **Table 4.47**.

Table 4.46
Summary of Scope 3 Emissions – Electricity Transmission Loss

Operational Year	Electricity Consumption per Year (kWh)	Electricity CO_2-e Emissions (t CO_2-e/y)
Construction - 4 months	206 681	37
Year 1	36 238 204	6 523
Year 2	45 241 750	8 144
Year 3	46 567 613	8 382
Year 4	46 662 513	8 399
Year 5	34 818 947	6 267
Total	**209 735 707**	**37 752**
Source: Modified after PAEH (2010) – Tables 10.4 & 10.7		

Table 4.47
Summary of estimated CO_2-e emissions (t CO_2-e/y)

Year	Scope 1	Scope 2	Scope 3	Total
Construction - 4 months	0	184	37	221
Year 1	2 997	32 252	6 751	42 000
Year 2	3 952	40 265	8 445	52 662
Year 3	3 959	41 445	8 684	54 088
Year 4	2 564	41 530	8 595	52 689
Year 5	1 705	30 989	6, 397	39091
Total	**15 178**	**186 665**	**38 910**	**240 752**
Source: Modified after PAEH (2010) – Table 10.8				

The annual greenhouse emissions in NSW for 2007 were 162.7Mt (DCC, 2009a). For the life of the Project, it has been estimated that the development would release approximately 0.24Mt/y CO_2-e. The maximum annual increase of emissions would be in Year 3 which would represent an approximate annual contribution of 0.03% to baseline 2007 NSW emissions.

The emissions rate is equivalent to approximately 1.31t CO_2-e per ounce of gold produced.

4.10.8 Monitoring

The Proponent would implement an *Air Quality Monitoring Program* in consultation with DECCW and the surrounding Community. Given the relatively low level of impact associated with the Project, it is anticipated that this would be restricted to the installation and management of several dust deposition gauges surrounding the Project Site. In addition, the existing weather station within the Project Site would continue to be operated for the life of the Project.

4.11 VISUAL AMENITY

4.11.1 Introduction

The DGRs identify "***Visual*** *– including landform and lighting impacts"* as a key issue for assessment in the *Environmental Assessment*. Based on the risk assessment undertaken for the Project (see Section 3.3), the specific visual amenity-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) and therefore require assessment include the following.

- A temporary disturbance to the landform.
- Identifiable change to the landform following final landform creation and rehabilitation.

The visual amenity assessment has been conducted by R.W. Corkery & Co. Pty Limited.

It is noted at the outset that the value placed upon visual amenity will vary from person to person and from location to location. As a result, a visual amenity assessment is, by its nature, is highly subjective. As a result, during the visual amenity assessment emphasis has been placed on providing a description of the existing visual amenity surrounding the Project Site and the measures that would be undertaken by the Proponent to minimise potential visual amenity-related impacts on surrounding residents and others. In addition, indicative descriptions of the anticipated visual landscape following completion of mining-related operations have been provided.

4.11.2 Existing Environment

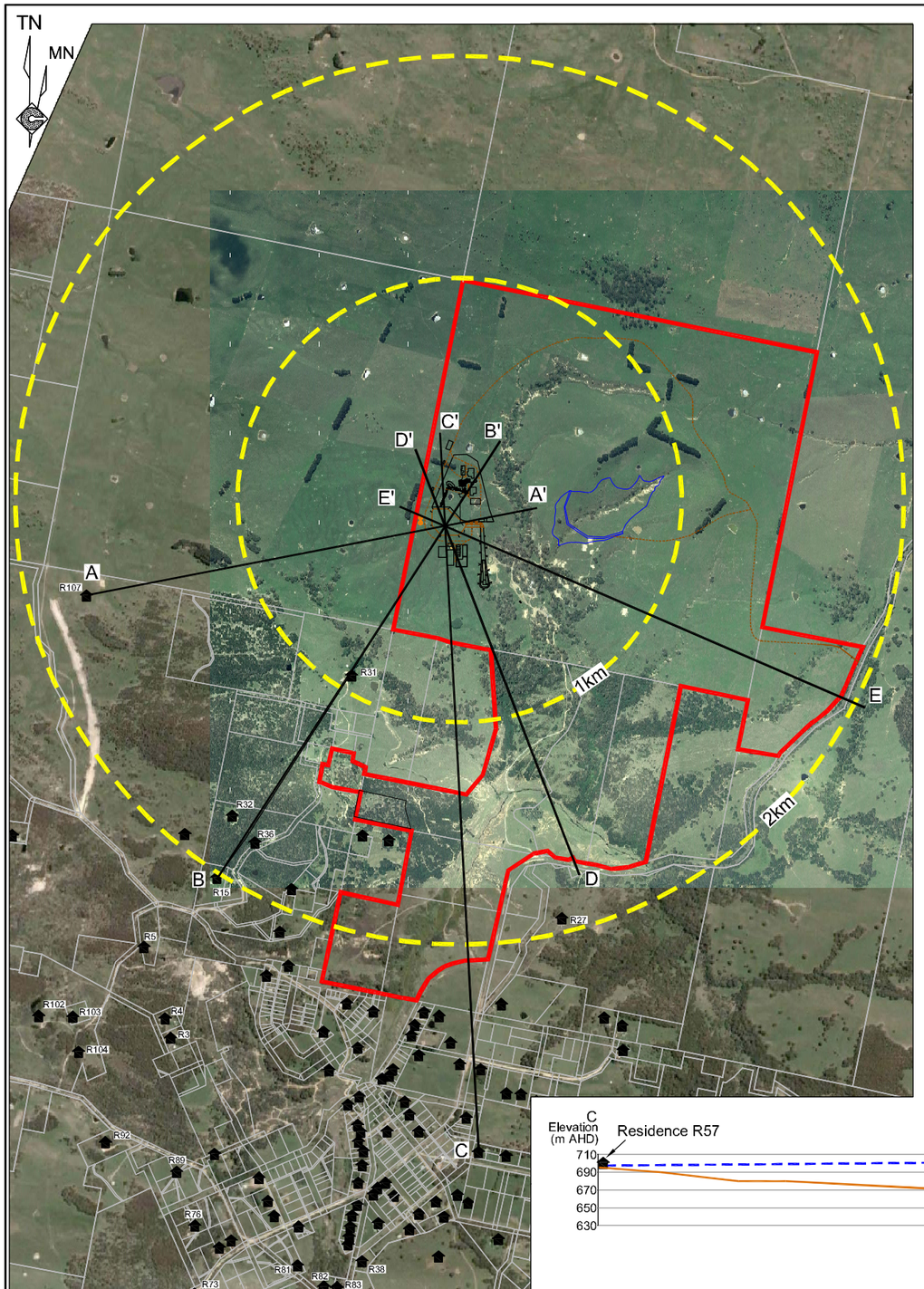
The existing visual amenity surrounding the Project Site is typical of rural areas in the southern tablelands, with the outlook from most rural residences and other vantage points including land used for agriculture, nature conservation, transportation or other infrastructure. Outlooks from residences within the village of Majors Creek include views of surrounding buildings, Majors Creek and established trees and smaller vegetation.

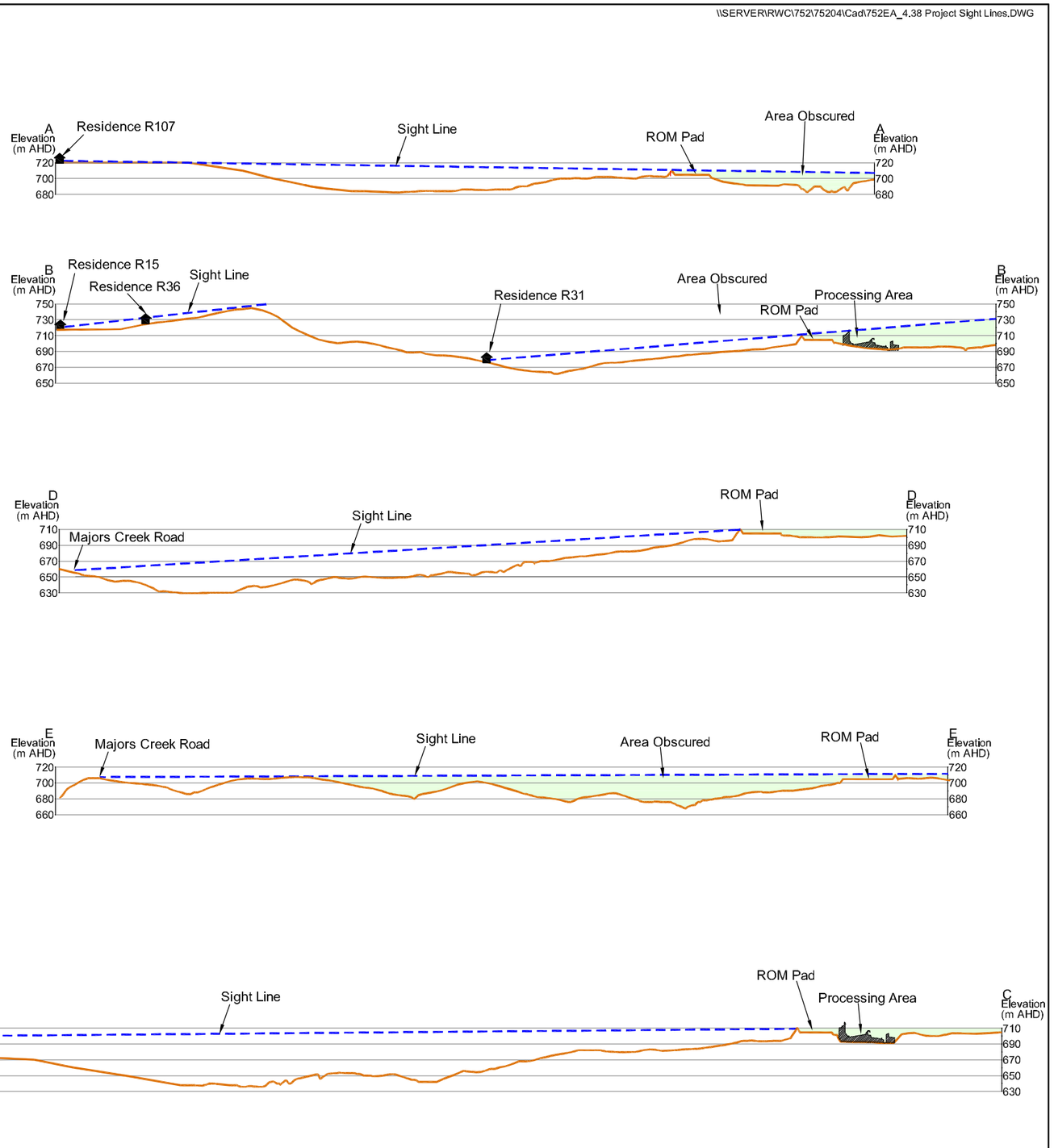
The Project Site is typically visible from the following locations.

- Residences to the southeast, south and southwest of the Project Site.
- Motorists using Majors Creek Road.

The rural landscape surrounding the Project Site is variably rolling to steeply incised. Vegetation varies from pasture to areas of remnant vegetation and regrowth, both native (wattles) and woody weeds (broom and blackberry) and wind breaks (**Figure 4.38**). As a result, elevated areas of land to the south the Project Site have, depending on the density of obscuring vegetation, good views of the Project Site. Areas of lower elevation to the south of the Project Site, particularly those areas with surrounding vegetation, have very limited views of the Project Site or views of the southern section of the Project Site only.

\\SERVER\RWC\752\75204\Cad\752EA_4.38 Project Sight Lines.DWG





SCALE 1:25 000

250 0 250 500 750 1000 1250 m

Source: Big Island Mining Pty Ltd

REFERENCE
Project Site Boundary
Cadastral Boundary
R1 Residence & Identifier
Distance from Processing Plant

Figure 4.38
PROJECT SIGHT LINES

This page has intentionally been left blank

With the exception of the Proponent's exploration activities, there is currently no industrial activity undertaken after dark in the vicinity of the Project Site. As a result, with the exception of lights associated with the Proponents exploration activities, residences and street lighting in Majors Creek, limited night time lighting is visible surrounding the Project Site.

4.11.3 Management and Mitigation Measures

Managing the visual impact of a mining operations offers a range of challenges and requires a range of solutions. The Proponent would implement the following management and mitigation measures to minimise to the greatest extent possible the impact of its activities on the visual amenity surrounding the Project Site.

- Construct and revegetate a 5m high bund on the southern and western edge of the ROM pad as soon as practicable after the commencement of mining operations. This bund, together with the southern and western faces of the ROM pad, would be temporarily covered with soil material and revegetated with appropriate species as soon as practicable after completion to ensure that the visual impact of the ROM pad and bund is minimised to the greatest extent practicable.
- Progressive reshaping and rehabilitation of areas that are no longer required for mining related purposes.
- Continuation of the existing tree planting program to limit views of the Project Site from areas to the southwest, south and southeast of the Project Site.
- Construction of the processing plant and other infrastructure within the Project Site from non-reflective, neutral-coloured material.
- Selection and placement of permanent and temporary lights such that the lights
  - do not point towards surrounding residences; or
  - minimise the 'loom' created by the lights.
- Consider any reasonable request by a potentially affected resident for assistance to create a visual screen adjacent to their residence through planting of fast growing vegetation and/or landscaping where such a screen would effectively reduce the visual impact of the Proponent's activities during the life of the Project.

4.11.4 Assessment of Impacts

The proposed final landform within the Project Site is described in detail in Section 2.14.3. In summary, however, the final landform would comprise the following.

- A shaped and rehabilitated tailings storage facility.
- An appropriately fenced and bunded box cut.
- A shaped and rehabilitated processing plant area.

The ROM pad would be removed and the footprint shaped and rehabilitated together with the processing plant footprint.

Figure 4.38 presents a series of sections from potential vantage points to the southwest, south and southeast of the Project Site during the life of the Project. The sections converge at the ROM pad which will be the most visually imposing component of the Project. The following provides an overview of the visual impacts anticipated from each of the identified vantage points. It is noted that visual impacts from areas adjacent to the identified vantage would be similar to those discussed below

- Visual Section A – A' (Residence R107)

  The ROM pad and processing plant area would indicatively not be visible from this vantage point because of a small rise to the west of the processing plant area.

- Visual Section B – B' (Residences R31, R32 and R36)

  The Project Site is not visible from Residences R15, R32 and R36 because a rise to the north of those residences obscures views to the north. In addition, Residence R31 would not have views of the ROM pad because it is located at a lower elevation and intervening topography would obscure views.

- Visual Section C – C' (Residence R57)

  This residence has distant views of the ROM pad approximately 3.0km to the north. **Plate 4.3** presents the anticipated views of the ROM pad once constructed from Residence R57.

- Visual Section D – D' (Majors Creek Road)

  Views from Majors Creek Road immediately north of Majors Creek would be limited by intervening vegetation. **Plate 4.4** presents the anticipated views of the ROM pad once constructed from this section of Majors Creek Road.

- Visual Section E – E' (Majors Creek Road)

  Views of the Project Site from Majors Creek Road north of the bridge over Majors Creek are limited by intervening topography.

In summary, the visual amenity to the south of the Project Site during the life of the Project would be altered through the addition of a shaped and revegetated ROM pad. Other section of the Project Site would be obscured. It is noted that views of the ROM pad, however, would be distant only and the Proponent contends that the impact on day time visual amenity surrounding the Project Site would not be significant.

In addition, the Proponent contends that the proposed management and mitigation measures relating to night-time impacts of lighting would be sufficient to ensure that there would be no significant adverse impacts to the night-time visual amenity surrounding the Project Site.

Finally, the Proponent would seek to address individual concerns in relation visual amenity impacts through discussions and negotiations with individual residents.

Plate 4.3 Anticipated view from Residence R57

Plate 4.4 Anticipated view from Location D on Majors Creek Road

4.12 SOIL AND LAND CAPABILITY

4.12.1 Introduction

The DGRs issued by the Department of Planning require that the *Environmental Assessment* include an assessment of "**Soil and Water**".

Based on the risk assessment undertaken for the Project (see Section 3.3), specific soil-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) include the following.

- Insufficient soil quantities for rehabilitation.
- Reduced soil quality.
- Increased erosion or erosion potential of soils.

The soil and land capability assessment was undertaken by Strategic Environmental and Engineering Consulting (SEEC). This section of the *Environmental Assessment* provides a summary of that assessment report which is presented in full as Part 8 (Volume 2) of the *Specialist Consultant Studies Compendium* and referred to hereafter as "SEEC (2010b)".

The assessment was managed by Mr Andrew Macleod BSc(Hons), CPSS, CPESC of SEEC.

4.12.2 Regional Soils Environment

The only publicly available soils mapping information available for the area surrounding the Project Site is mapping published by the Sydney Catchment Authority over the Shoalhaven Catchment. That mapping information indicated that the likely soil landscape units within the Project Site include:

- the Braidwood Soil Landscape; and
- the Brushy Hill Soil Landscape.

4.12.3 Project Site Soils Environment

4.12.3.1 Assessment Methodology

The soils assessment included extraction of 13 soil test pits within the Project Site (**Figure 4.39**). Each profile was described in the field and a representative suite of samples were collected for both physical and chemical analysis in the laboratory.

4.12.3.2 Project Site Soils

SEEC (2010B) identify two soil landscape units within the Project Site in accordance with the published soil landscape information, namely:

- the Braidwood Soil Landscape; and
- the Brushy Hill Soil Landscape.

Figure 4.39 presents the distribution of each soil landscape unit and **Table 4.48** presents a typical profile of each unit.

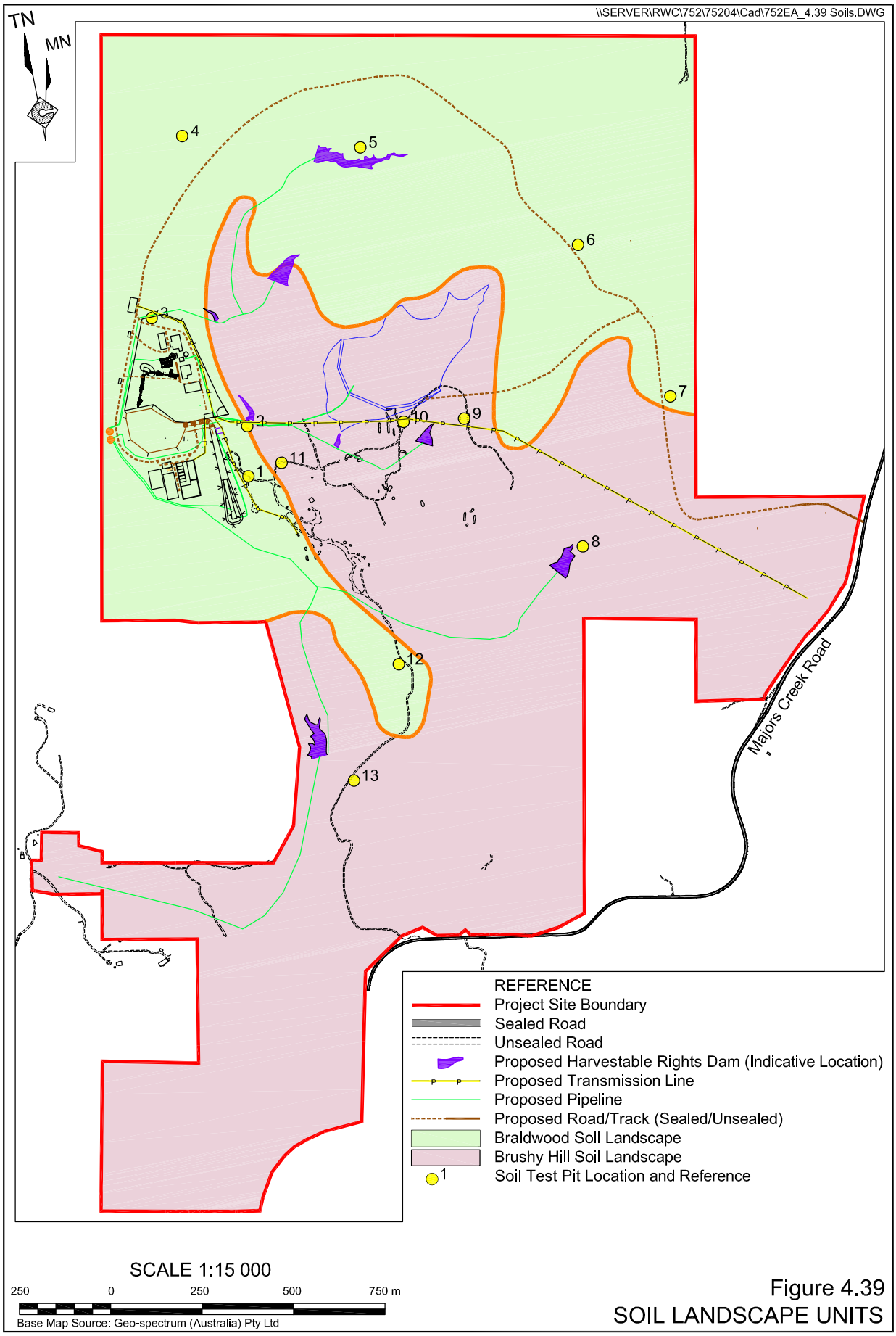


Figure 4.39
SOIL LANDSCAPE UNITS

Table 4.48
Typical Soil Profiles

Layer	Depth range	Description
Braidwood Soil Landscape		
1	0 – 150mm	Topsoil. Dark brown, weakly pedal loam. No coarse fragments.
2	150 – 350mm	Topsoil. Greyish-brown, weakly pedal sandy loam to sandy clay loam. No coarse fragments.
3	350 – 800mm	Subsoil. Yellowish-brown, moderately to strongly pedal sandy clay. No coarse fragments.
4	800 – 1,400mm+	Subsoil. Mottled yellow/grey/brown moderately to strongly pedal clayey sand. Evidence of weathering rock with increasing depth. 5 to 10% coarse fragments, increasing with depth.
Brushy Hill Soil Landscape		
1	0 – 110mm	Topsoil. Dark brown, weakly pedal loam. No coarse fragments.
2	110 – 300mm	Topsoil. Mid-brown, weakly pedal sandy loam. No coarse fragments.
3	300 – 650mm	Subsoil. Yellowish-brown, mottled, moderately pedal sandy clay. <5% coarse fragments.
4	650 – 1,100mm+	Subsoil. Greyish-yellow-brown, gritty clayey sand. Massive to weakly pedal. >5% coarse fragments as weathering granite. Layer continues to at least 1,500mm in some areas.

Source: SEEC (2010B) - Tables 1 and 2.

4.12.3.3 Physical Characteristics

Eight samples were collected for testing of their physical characteristics. The results of that test work are presented in Section 6.2 of SEEC (2010B) and are summarised below.

- K-Factor - five samples returned K-factor levels of between 0.021 and 0.039, indicating moderate erodibility.
- Wind erodibility - five samples returned results indicating low wind erodibility.
- Emerson Aggregate Tests - three topsoil samples returned results indicating slight dispersibility (Type C to D soils) while two subsoil samples returned results indicating slight to significant dispersibility (Type D to F soils).
- Soil loss (calculated using RUSLE and SOILOSS 5.3) - the Braidwood and Bushy Hill Soil Landscape Units recorded a soil loss class of 3 (low to moderate) and 5 (high) respectively. As a result, soil disturbing works within all areas of proposed disturbance will require management and mitigation measures identified in Section 4.12.4.
- Liquid Limit Test and Plasticity - two samples returned a high compressibility and high shrink/swell potential indicating that adequate compaction of areas to be used for buildings or structures.

4.12.3.4 Chemical Characteristics

Four samples were collected for testing of their chemical characteristics. The results of that test work are presented in Section 6.3 of SEEC (2010B) and are summarised below.

- Electrical conductivity and salinity - all soils tested were non-saline.
- pH - all samples tested were moderately to very strongly acidic (4.6 to 5.7).

- Cation exchange capability - topsoils returned results that indicate that they are nutrient poor and likely to leach nutrients. Subsoils, however, are likely to retain any leached nutrients and those nutrients would continue to be available for plants.
- Available phosphorus - three of the four samples analysed returned very low phosphorous results (all 3mg/kg or less), with one sample returning a very high result (28mg/kg).
- Organic matter - five samples returned extremely low to low (0.19% to 1.51%) levels of organic matter.

4.12.3.5 Summary of Soil Characteristics

In summary, SEEC (2010b) state that the soils of the Project Site are:

- weakly pedal in their upper section, grading to strongly pedal in their lower sections;
- moderately to imperfectly drained;
- potentially dispersive and prone to instability; and
- suitable for stripping and use during rehabilitation operations, provided the management and mitigation measures presented in Section 4.12.4 are implemented.

4.12.4 Management and Mitigation Measures

The Proponent would implement the following management and mitigation measures during soil stripping, stockpiling and placement operations.

- Strip soil materials to the depths identified in **Table 2.2.**
- Strip soil materials only when they are moderately moist to preserve soil structure.
- Stockpile topsoil and subsoil materials separately.
- Construct soil stockpiles as low, flat, elongated mounds on slopes of less than 1:10 (V:H). Topsoil stockpiles would be less than 2m high and subsoil stockpiles would be less than 3m high.
- Ensure that soil stockpiles achieve a 70% vegetative cover within 10 days of formation.
- Place soil material in areas to be rehabilitated in the same stratigraphic order in which they were removed. SEEC (2010b) note that topsoils of one soil landscape unit may be mixed with topsoils soils of the other landscape unit. Similarly, subsoils of one soil landscape unit may be mixed with subsoils soils of the other landscape unit.

In addition, the Proponent would implement the following management and mitigation measures to minimise the potential for erosion and sedimentation in sections of the Project Site that would be disturbed and have slopes of more than 13% or approximately 1:7.5 (V:H). It is noted that additional erosion and sedimentation controls are identified in Section 4.5.4.

- Ensure that ground disturbing activities are limited to the period from 1 March to 30 November, unless measures identified in Landcom (2004) and DECC (2008) are implemented, including ensuring that soils are not exposed during any period when the three-day weather forecast suggests rain is likely.
- Ensure that slope lengths are no longer than 80m.
- Ensure that run-on from upslope is diverted away from disturbed areas.

4.12.5 Land Capability

SEEC (2010b) identify a range of land capabilities within the Project Site. Generally, gently sloping lands identified as Braidwood Soil Landscape are Class IV, namely:

> *land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and requiring soil conservation practices such as pasture improvement, stock control, application of fertiliser and minimal cultivation for the establishment or re-establishment of permanent pasture.*

Lands identified as Brushy Hill Soil Landscape are Class V, namely:

> *land not capable of being regularly cultivated but suitable for grazing with occasional cultivation and requiring structural soil conservation works such as absorption banks, diversion banks and contour ripping, together with the practices as in Class IV."*

Steeply eroded gullies in the vicinity of Spring Creek and its tributaries are typically classified as Class VII, namely "land best protected by green timber"

SEEC (2010b) state that, presuming that the management measures identified in Section 2.14 and 4.12.4 are fully implemented, then the Land Capability of the rehabilitated land form should be similar to the existing landform.

4.12.6 Conclusion

SEEC (2010b) state that provided that the management and mitigation measures identified in Section 4.12.4 are implemented, that the Project should not result in significant adverse soil-related impacts. In addition, the land capability of the final landform should be approximately the same as the existing land capability.

4.13 SOCIO-ECONOMIC CLIMATE

4.13.1 Introduction

The DGRs identify "***Socio-economic"*** as a key issue for assessment in the *Environmental Assessment*. Based on the risk assessment undertaken for the Project (see Section 3.3), the specific socio-economic-related impacts that may result as a consequence of the Project (without the implementation of the safeguards, controls and mitigation measures presented in this section) and therefore require assessment include reduced quality of life (actual or perceived).

The socio-economic assessment has been undertaken by R.W. Corkery & Co. Pty Limited, with additional assistance provided by Marcom Communication who have undertaken extensive community consultation in relation to the Project.

This sub-section provides a description of the measures that the Proponent would implement to maximise the positive socio-economic benefits and minimise adverse socio-economic impacts, if any, associated with the Project and provides an assessment of the anticipated socio-economic impacts associated with the Project.

4.13.2 Surrounding Communities

Section 4.1.6 provides a description of the community within the "Braidwood State Suburb" census statistical division. However, it is noted that there are a number of distinct communities both within that statistical division and further afield that may be impacted by or benefit from the Project. For the purposes of this assessment, these communities have been identified as follows. A brief description of the anticipated class of potential Project-related impacts are as follows.

- Majors Creek Community – namely the community that lives within and surrounding the village of Majors Creek and Jembaicumbene. This includes all the Proponents neighbours and near neighbours.
- Araluen Community – namely the community that lives within Araluen and surrounding areas.
- Braidwood Community – namely the community that lives within Braidwood and surrounding areas or relies on services within Braidwood.
- Palerang LGA Community – namely the community that lives within the wider Palerang LGA and relies on services provided by Palerang Council.

4.13.3 Management and Mitigation Measures

A detailed description of the Project-related employment and economic contributions are presented in Sections 2.12. In addition, management and mitigation measures related to specific environmental aspects of the Project are presented previously in this Section. In addition to these measures, the Proponent would implement the following management and mitigation measures to ensure that Project-related benefits for the communities surrounding the Project Site are maximised and adverse impacts are minimised to the greatest extent practicable. Where possible these measures have been categorised to reflect the particular aspect that would be addressed by each. Finally, the following also identify where particular measures would be targeted towards particular communities. Where no particular community is identified, the proposed management and mitigation measures would be targeted to all identified communities.

Social and Community

- Engage each of the communities surrounding the Project Site in regular dialogue in relation to the proposed and ongoing operation of the Project and maintain an "open door" policy for any member of those communities who wishes to discuss any aspect of the Project.
- Proactively and regularly consult with those residents most likely to be adversely impacted by the Project, particularly those within the Majors Creek Community.
- Continue to support community organisations, groups and events, as appropriate, and review any request by a community organisation for support or assistance throughout the life of the Project. Particular emphasis would be placed on providing support to those organisations, groups or events that service the communities in Majors Creek, Araluen or Braidwood.
- Form and maintain a Community Consultative Committee (CCC), including representative members of the surrounding community and Palerang Council. It is noted that the Proponent has previously consulted with the Majors Creek Community Liaison Committee. The Proponent would continue to do so, either as part of the CCC or separately.
- Regularly brief the CCC and wider community on activities within the Project Site and seek feedback in relation to Project-related impacts whether actual or perceived. In addition, seek advice in relation to the most appropriate manner in which to provide assistance to the community in an effective, fair and equitable manner.
- Advertise and maintain a community complaints telephone line.

Employment and Training

- Give preference when engaging new employees, where practicable, to candidates who are part of the Majors Creek, Araluen or Braidwood communities over candidates with equivalent experience and qualifications based elsewhere and ensure that the mining and other contractors do so as well.
- Encourage the involvement of the local Aboriginal community in the workforce.
- Encourage and support participation of locally based employees and contractors in appropriate training or education programs that would provide skills and qualifications that may be of use to encourage and further develop economic activity within the surrounding communities following completion of the Project.

Economic Contribution and Development

- Give preference, where practicable, to suppliers of equipment, services or consumables located within the Palerang LGA.
- Assist community members and others, as appropriate, to establish complimentary businesses within the Palerang LGA where those businesses would provide a benefit to the community through increased economic activity or development.
- Assist Palerang Council to promote and encourage economic development that would continue beyond the life of the Project.

Infrastructure and Services

- Ensure that infrastructure and services installed for the Project, including the electricity transmission facilities, road improvements and water supply bores, remain available for alternative uses during and/or following completion of the Project.
- Encourage and support, in consultation with the local community, the provision of services to the community. These may include health, education, transportation and other services.

Agricultural Lands

- Prepare and implement a *Property Vegetation Plan* as described in Section 2.15, including continued management of weeds, pests and bushfire risks on land held by the Proponent in consultation with surrounding landowners.
- Ensure that the land capability of those sections of the final landform to be used for agricultural purposes is similar to the current land capability.

4.13.4 Impact Assessment

The Project would result in a range of socio-economic benefits to the community surrounding the Project. These benefits would include the following.

- Direct employment (full-time equivalent) for approximately 100 people during construction and approximately 60 people during operation of the Project. These people would be drawn preferentially from within the Palerang LGA and the Proponent envisages that they would primarily reside within and contribute to the economic development of the LGA.
- Injection of approximately $3 million to $7 million per year into the local and regional economy, excluding employee and contractor wages and salaries, a significant proportion of which would also be spent within the local and regional economy. This expenditure is likely to generate additional economic activity and flow on effects for the local and regional community, providing further employment opportunities.
- Injection of approximately $10 million to $31 million into the State and national economy. This expenditure would also generate additional economic activity and flow on effects for the wider community, providing further employment opportunities.
- Ongoing support for training and education of employees and others in the vicinity of the Project Site.
- Support to establish complimentary businesses in the vicinity of the Project Site, with the resulting benefits of increased economic activity and opportunities.
- Provision of infrastructure, including improved electrical transmission facilities and improvements to Majors Creek, Araluen and Captains Flat Roads. These improvements would remain following completion of the Project and would support the long term economic development of the local and wider economy.

- Support for the provision of services, including health, education, transportation and other services, to the community.
- Continued support for local sporting and other organisations.

It is noted that the community identified impacts on property values as an issue of concern. The Proponent notes that the factors that influence property values will depend on individual circumstances and that no assessment of overall impacts can be made. However, it is also noted that the Project would result in increased economic activity in the vicinity of the Project Site and increased demand for housing. As a result, the Project is more likely, as a whole, to result in upward pressure on property values rather than downward pressure.

It is acknowledged that the Project would also have some limited adverse impacts. However, the Proponent notes that it has taken all reasonable and feasible measures to minimise those impacts and that appropriate agreements would be negotiated with the relevant landowners who would experience direct impacts prior to or during the life of the Project.

The Proponent contends that any adverse socio-economic or environmental impacts, both actual and perceived, would be more than adequately countered by the positive effect that the Project would have on the community and economy in the vicinity of the Project Site and the wider area.