Section Four

Assessment and Management of Key Environmental Issues

The assessment and management of the key environmental issues identified in Section 3 commences with an outline of background information relevant to a number of the subsequent issues. The issues are generally addressed in the order of priority established in Section 3.5.

For each key environmental issue, the existing features are described and the constraint(s) the existing features would have on the design and operation of the project are identified. The mitigation measures and operational procedures required to manage each issue are then outlined together with the predicted changes to that component of the environment on and/or surrounding the Project Site. Residual impacts are then assessed against statutory criteria or goals or relevant guidelines and/or policies. Where appropriate, a program of monitoring and documentation is proposed to demonstrate the predictions presented in this document are being achieved and compliance criteria or goals satisfied.

The text for the bulk of this section is drawn from studies undertaken by a range of specialist consultants commissioned by the Proponent. Wherever possible, the study results have been summarised focussing only upon the key points. Readers should refer to the relevant part in the Specialist Consultant Studies Compendium in the event further detail is required.

4.1 BACKGROUND INFORMATION

4.1.1 Introduction

The descriptions of various assessments of potential environmental impacts throughout this section are reliant upon a range of background information common to many of the key environmental issues. Background information is provided on the topography, meteorology, land ownership, land uses and surrounding residences.

4.1.2 Topography

4.1.2.1 Regional Topography

The Project Site is situated on the Somersby Plateau near the southern end of the Hunter Range. The Somersby Plateau comprises wide areas of gently sloping land typically elevated at between 200m AHD and 300m AHD with steeply incised valleys of Mooney Mooney and Popran Creeks typically with elevations <30m AHD. Plateau elevations also drop off quickly to the east.

4.1.2.2 Local Topography

The Project Site is located predominantly on the eastern side of the Hunter Range where slopes are typically $<10^{o}$. The topographically highest part in the Somersby area is immediately west of the Project Site (at 304m AHD) where the "Mangrove Tower" is positioned – see **Figure 4.1**.

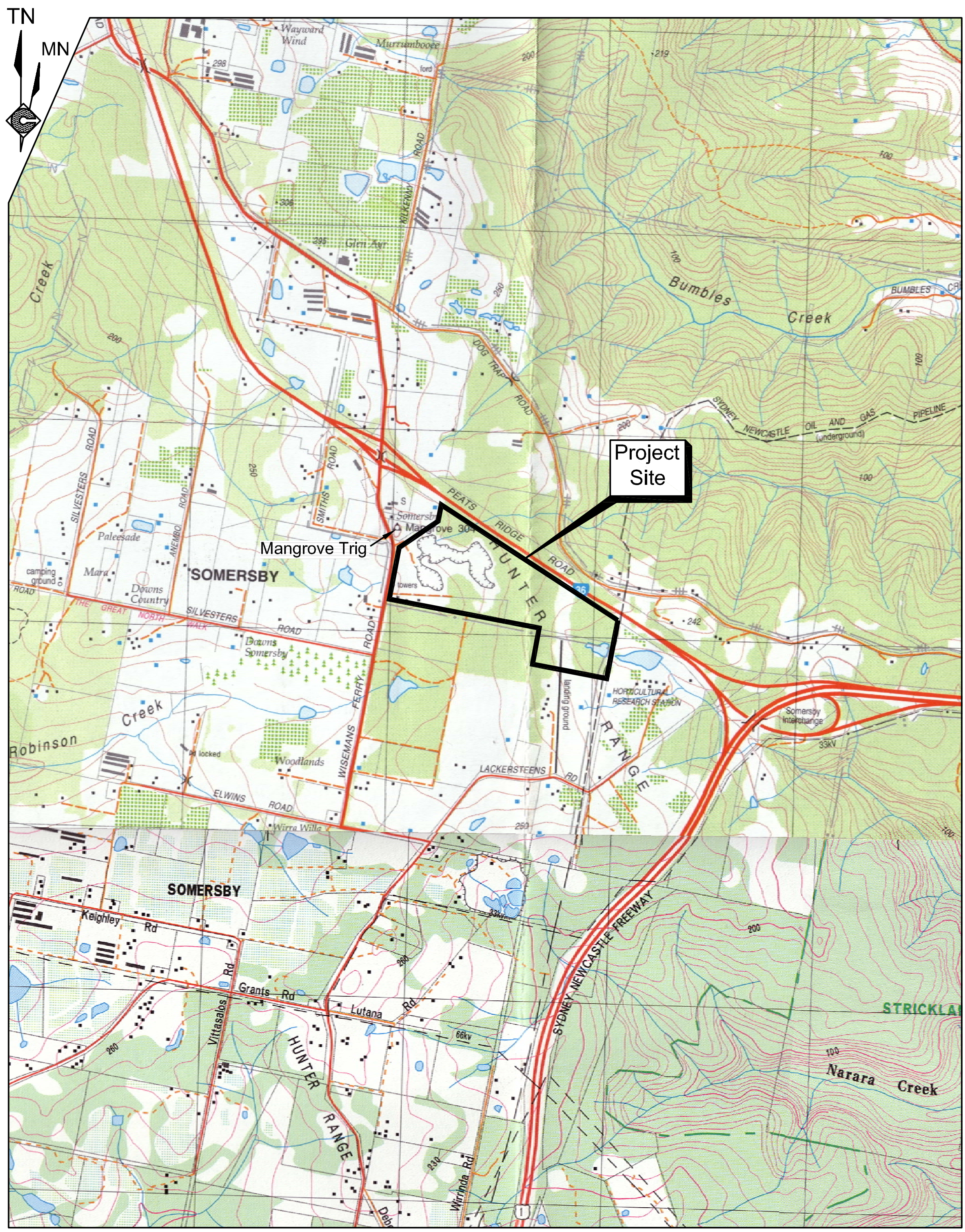
The land surrounding the Project Site invariably drops away to the north, east and south whereas it continues to rise marginally to the west towards Somersby Public School.

4.1.2.3 Project Site Topography

Figure 4.2 displays the topography within the Project Site. A ridge line occurs near the western boundary of the Project Site corresponding to the watershed between the local surface water catchments. Natural slopes on both sides of the ridgeline fall at gradients of 4^{o} to 8^{o}. It is noted that the land surface across the western section of the Project Site was substantially modified during ridge gravel extraction operations in the late 1970s, this material used in roadbase for construction of the F3. In some areas, the existing elevation is up to 3m lower than its former natural elevation. Mostly, however, the land in that section has been lowered by about 1m.

The slopes on the western side of the Project Site predominantly have a northeasterly aspect whereas the slopes on the eastern side of the Project Site invariably face east. The eastern slopes typically have gradients of 4^{o} to 8^{o} until they drop off more steeply (to 12^{o}) to the slopes surrounding Dam A.

The highest elevation on the western side of the Project Site is recorded at 298m AHD. The lowest elevation on the Project Site is approximately 232m AHD immediately east of Dam A on the eastern boundary of the Project Site.



REFERENCE
Project Site Boundary

SCALE 1:30 000

500 0 500 1000 1500 m

Base Map Source: Gosford & Wyong 1:25 000 Topographic Maps

Figure 4.1
SOMERSBY LOCAL SETTING

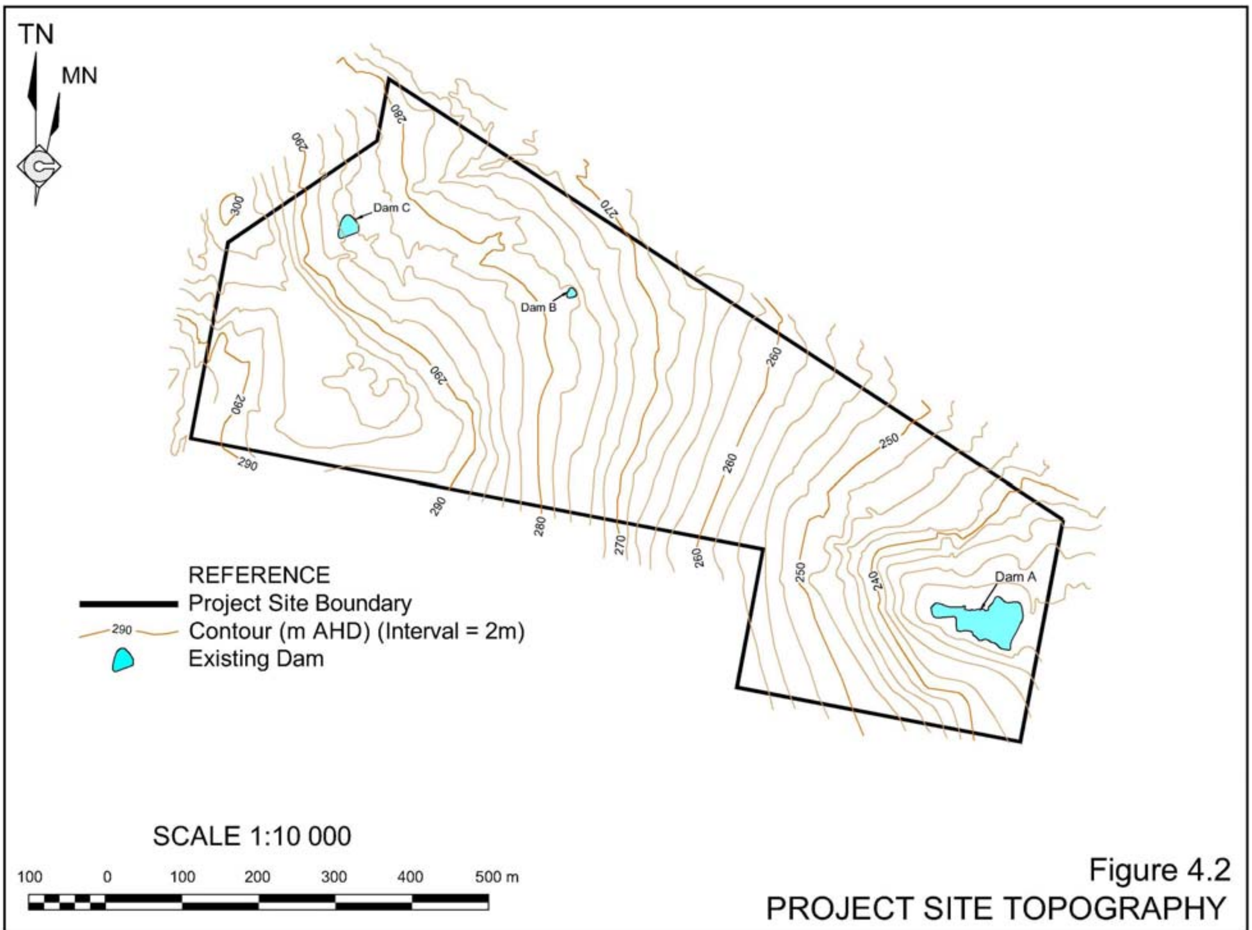


Figure 4.2
PROJECT SITE TOPOGRAPHY

4.1.3 Meteorology

4.1.3.1 Rainfall

The Bureau of Meteorology maintains a number of rainfall recording stations on the central coast. The two closest sites with a substantial period of data are at Peats Ridge (Station 61351) and Ourimbah (Station 61093). Relevant data from both of these sites are recorded in **Table 4.1**.

For the purposes of assessing the surface water resources and infiltration of rainfall to the groundwater table, the data collected during a 52 year period at the Ourimbah Station has been used. This station is slightly lower topographically than the Project Site (195mAHD) and approximately 3km from the Project Site.

Table 4.1
Monthly Meteorological Data – Somersby Area

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
RAINFALL (mm) - Ourimbah Station No. 61093													
Mean	142.2	189.6	168.7	119.1	122.2	117.4	62.4	78.4	61.2	96.9	111.7	107.1	1377.0
Highest	414.2	671.0	385.8	609.4	356.0	410.8	201.6	357.6	201.4	466.6	330.0	300.2	2164.0
Lowest	9.2	17.8	4.6	6.0	3.6	0.8	0.0	1.2	0.0	0.0	10.7	6.0	838.0
TEMPERATURE (°C) - Peats Ridge Station No. 61351													
Mean Maximum	26.9	26.3	24.5	22.1	19.0	16.4	15.8	17.5	20.4	22.8	23.9	25.9	
Mean Minimum	16.0	16.2	14.5	12.0	9.7	7.1	6.0	6.5	8.5	10.7	12.5	14.8	
Lowest	7.9	8.4	6.2	3.7	1.1	0	-0.1	-0.1	0	1.4	4.9	6.9	
Highest	42.9	40.5	38.9	34.7	26.9	23.6	23.7	28.9	33.3	38.6	40.7	40.8	
EVAPORATION - Peats Ridge Station No. 61351													
Mean	146	118	105	78	59	48	53	78	102	127	135	152	1 200

In addition to the monthly rainfall data, rainfall intensity data is also required for runoff modelling, particularly for peak flows. **Table 4.2** sets out the rainfall intensities for the 1 year, 2 year, 10 year and 100 year events for varying durations.

Table 4.2
Rainfall Intensities – Somersby Area (mm/hour)

	1 hour	12 hour	72 hour
1 year	27.2	6.7	2.3
2 year	35.0	8.7	3.0
10 year	50.6	13.1	4.4
100 year	75.5	25.3	6.7
Source: Cardno Willing (2006)			

4.1.3.2 Temperature

The average daily temperatures recorded in **Table 4.1** show that January is the warmest month and July is the coldest. Overall, temperatures are mild throughout the period April to October and warm between November and March.

4.1.3.3 Evaporation

Table 4.1 presents the average monthly evaporation data showing the highest evaporation in December and least evaporation in June. In total, annual evaporation is approximately 1 200mm, a level comparable to average annual rainfall. It is noted from **Table 4.1** that evaporation exceeds rainfall during the months of September to January. For the remaining months, monthly evaporation is exceeded by monthly rainfall.

4.1.3.4 Wind

The most appropriate wind data for use in the assessment of air quality and noise impacts of the Somersby Fields Project has been based upon data drawn from the continuous data recorded at the Mangrove Mountain Station No. 61375. **Figure 4.3** displays both the annual and seasonal wind roses for this station for the 2004 Calendar Year. The prevailing wind directions at the Project Site are from the following directions.

Spring	Summer	Autumn	Winter
NW-NE	NE-SE	NW-E	NW-N

The closest residences to the Project Site are located in three principal directions from the Project Site, namely:

(i) northeast;

(ii) northwest (including Somersby Public School); and

(iii) southwest.

A summary of the frequency of winds blowing towards these groups of residences (and Somersby Public School) is listed in **Table 4.3**. The distinction is made between the eastern and western sections of the Project Site.

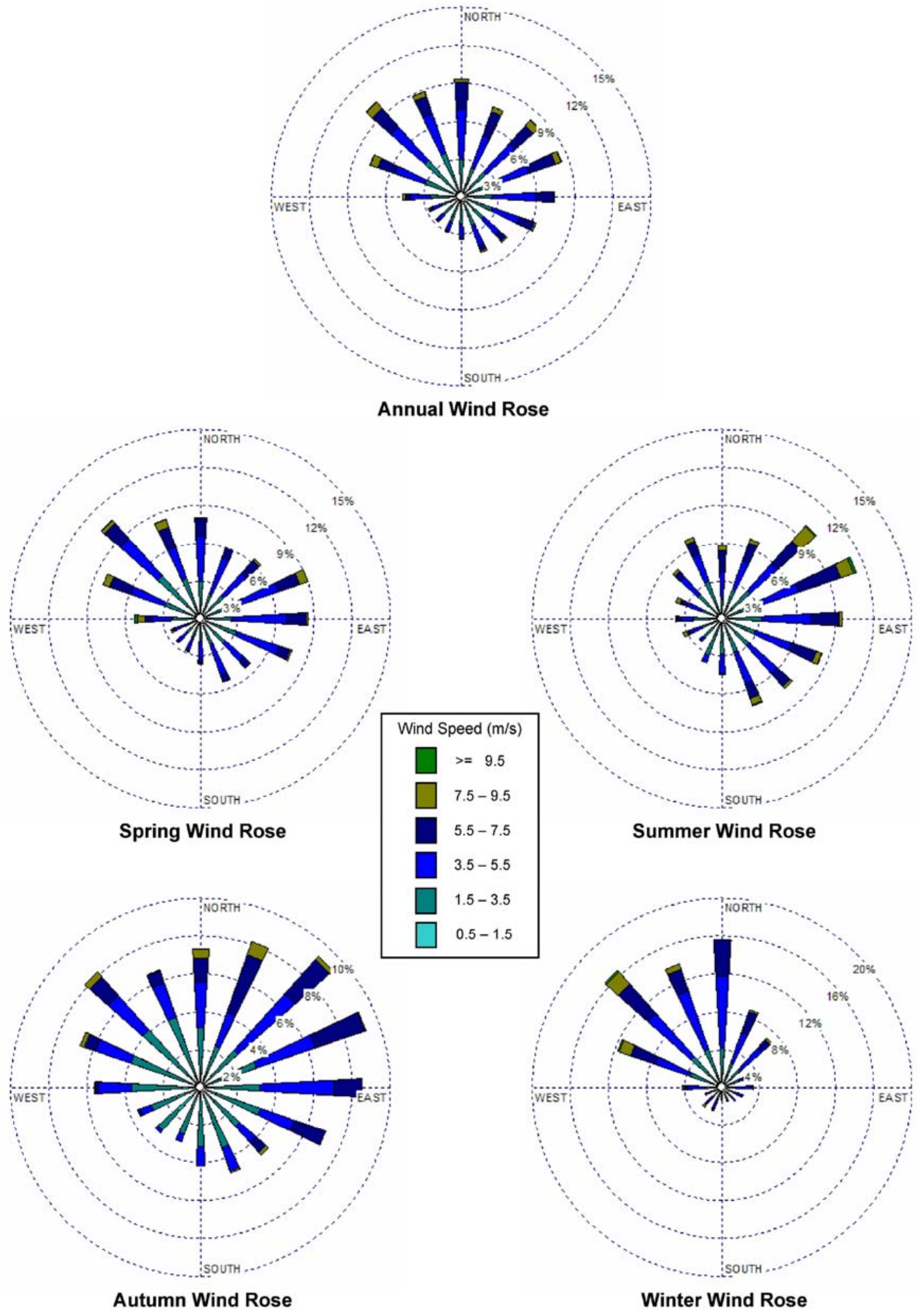
Table 4.3
Frequencies of Winds Blowing Towards Residences and Somersby Public School

Residence Group*	Operations in Eastern Sections of Project Site					Operations in Western Section of Project Site				
	Wind Direction	Wind Frequency				Wind Direction	Wind Frequency			
		Spring	Summer	Autumn	Winter		Spring	Summer	Autumn	Winter
Northeast	WSW & SW	5.0%	6.0%	6.5%	5.0%	WNW & W	13.5%	8.0%	12.5%	16.0%
Northwest	ESE & SE	13.0%	16.0%	12.0%	4.0%	SSE & SE	11.0%	14.5%	10.0%	3.5%
Southwest	ENE & E	17.5%	21.0%	17.5%	5.5%	ENE & NE	15.5%	21.0%	18.0%	9.0%
* See **Figure 4.3**										

4.1.4 Surrounding Land Ownership, Land Uses and Residences

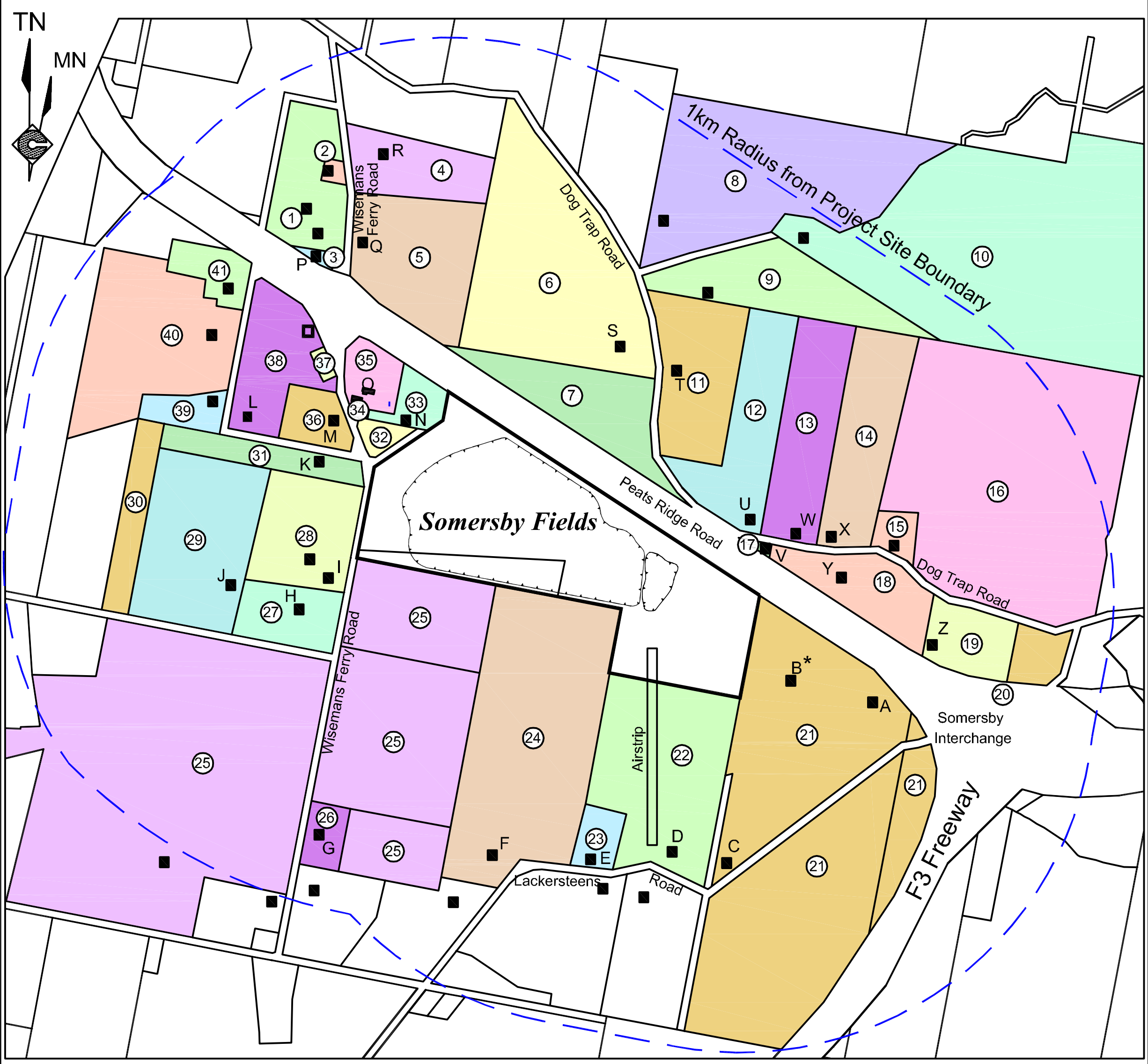
4.1.4.1 Surrounding Land Ownership

Figure 4.4 presents the ownership of land within approximately 1km of the boundary of the Project Site. This information has been sourced from the Department of Lands Land Ownership Register.



Source: Heggies Pty Ltd (2006b) - Appendix 3

Figure 4.3
ANNUAL AND SEASONAL WIND ROSES



Reference	Owner
1	P. & R. Tate
2	J. & J. O'Toole
3	P. & S. Moore
4	Coachwood Nurseries Pty Ltd
5	G. & P. Radford
6	G. & H. Rose
7	M. & N. Ozbaglar
8	J. & C. McLuckie
9	G. & T. Morris
10	E. & G. Ireland
11	R. Fischer
12	F. & V. Knutson
13	P. & S. Martin
14	S. Bromfield
15	E. Grant, S. & P. Drew
16	A. Smith & P. McLoughlin
17	L. & N. Douglass
18	C. & R. Sultana
19	T. & V. Lamb
20	C. & P. Gilbert
21	Minister of Agriculture
22	A. Gregory
23	I. Scott
24	D. Ross
25	Wytown Pty Limited
26	B. & J. Thompson

Reference	Owner
27	R. & S. Weller
28	R. Thompson, B. Thompson & S. Jarvis
29	G. Williams, T. & C. Underwood, G. & H. Taylor
30	A. & A. Korogiannis
31	K. & L. Hawker & J. Woods
32	Minister for Lands
33	B. & L. Daniel
34	H. Chivers, A. Hoipo, E. Goldswain, M. Hunter & D. Studds
35	Minister for Education
36	S. & M. Cahill
37	N. Stapleton
38	W. & I. Raddatz
39	D. & B. Lyon
40	B. & S. Arms
41	C. & M. Smith

REFERENCE
Project Site Boundary
X Residence and Identifier
Commercial
Cadastral Boundary
*Note: Location of Planned Residence

SCALE 1:20 000
200 0 200 400 600 800 1000 m
Land Ownership Source: Department of Lands

Figure 4.4
SURROUNDING LAND OWNERSHIP

4.1.4.2 Land Uses

Land uses are presented both in terms of their historical and current context.

Historical Land Uses

Figure 4.5(a) presents a sequence of aerial photographs recording the land use within and surrounding the Project Site at approximately decade intervals since 1954. The land use on and surrounding the Project Site was compiled by Anne Clements and Associates.

On the surrounding lands, there has been rectangular clearing for agriculture (paddocks, orchards and crop lands) prior to 1954, with additional agriculture clearing up to at least 1984. At the time of the construction of Peats Ridge Road, in about 1966, irregular shaped clearings appeared associated with the road construction. On the Project Site, approximately 10ha of the irregular shaped clearing was evident in 1966. Additional clearing is apparent in 1974 and 1984 during the period of construction of the F3 Freeway east of the Project Site.

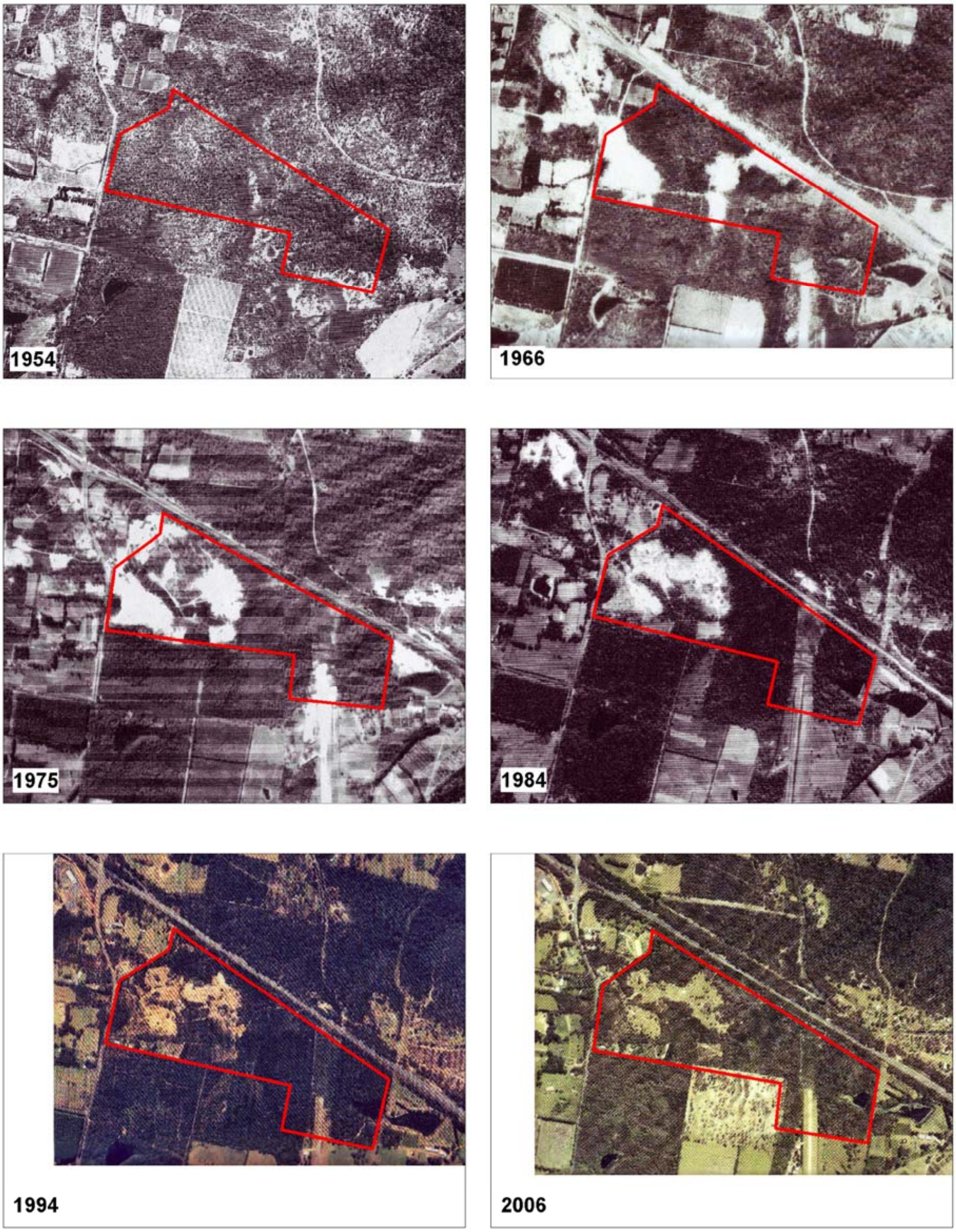
In the areas of irregular clearings on the Project Site, the surface lateritic gravel layer has been extracted, resulting in lowered landform with a number of trees left on 1m to 2m high pedestals. The gravels were used as road base for Peats Ridge Road and the F3 Freeway. Other disturbance on the Project Site included:

- a dam visible on aerial photographs from 1984 in the east (Dam A) adjoining the cleared Horticultural Station land; and
- clearing associated with the airstrip approach to the south.

The following notes present a summary of the various features within and surrounding the Project Site between 1954 and 2006.

Year	Within the Project Site	Surrounding the Project Site
1954	Vegetated with possible fire scar with south-east corner fragmented clearing	North: vegetated with fragmented clearing/fire scars; Dog Trap Road constructed; Tracks west from Dog Trap Road to cleared rectangular <1 ha patches of farming land. West: dirt road – Wisemans Ferry Road constructed adjoining the Project Site. West of Wisemans Ferry Road: fragmented bushland and orchards. South: fragmented bushland, extension of swamp, large orchard (200 m wide and more than 600 m long) with central building. Dam present. East: fragmented bushland, extension of swamp. South-east: large clearing with approximately 4ha rectangular paddock.

Year	Within the Project Site	Surrounding the Project Site
1966	Approximately 10 ha cleared in west, centre, and across part of the northern boundary on the Project Site. The clearing appears to be related to the construction of Peats Ridge Road. Tracks between the clearings and additional tracks in the southeast of the Project Site. Northern section of airstrip cleared (about 1 ha)	North: bitumenised Peats Ridge Road; Track parallel to Peats Ridge Road; Tracks as shown on 1954 aerial; Additional rectangular agricultural clearings. West: additional clearing possibly associated with Peats Ridge Road. South: Additional agricultural clearing to east of the large orchard. Airstrip present. East: dam immediately to the east. Bushland cleared, except about 1.3 ha triangle in the northern section, south of Peats Ridge Road. North of Peats Ridge Road and south of Dog Trap Road there is additional clearing. South-east: further agricultural clearing – probably the Somersby Field Station.
1975	Approximately 10 ha cleared mainly in the west, patchy clearing in the northwest and regrowth in north – different shape from 1966. Approximately 60 m longer airstrip clearing.	North: similar to 1966. West: patchy regrowth in the previously cleared areas. South: between the orchard and the Somersby Field Station most of the bushland has been cleared for agriculture or the air strip. East: recent clearing of approximately 1.3 ha triangle of bushland adjoining northern section of the eastern boundary. Patches of bushland about 1 ha regrowth adjoining the cleared agricultural land. North of Peats Ridge Road and south of Dog Trap Road: regrowth of previous clearing with some patchy clearing associated with network of tracks.
1984	Similar clearing pattern as in 1975 with some clearing extended - total clearing of about 11.5 ha. Extension of airstrip clearing north to Peats Ridge Road. Dam in the east of the Project Site, apparently associated with the Somersby Field Station.	North: similar to 1975. West: similar to 1975 with slight differences in clearing patterns and a building constructed in the main clearing south of the Peats Ridge Road intersection. South: additional agricultural clearing between the orchard and the Project Site. Airstrip appears to have been bitumenised. East: similar to 1975, with clearing for the F3 Freeway east of the Horticultural Station.



Compiled by Anne Clements & Associates.

Source: Robert Payne - Ecological Surveys & Management (2006) - Figure 4

Figure 4.5a
LAND USE HISTORY

Year	Within the Project Site	Surrounding the Project Site
1994	Similar clearing pattern as in 1984, with regrowth on edges and some islands of trees. Regrowth in the northern section of airstrip clearing. Dam in the east of the Project Site.	North: similar to 1984. West: similar clearing pattern to 1984. Bitumenised carparks (?) surrounding building south of the Peat Ridge Road intersection. North-west: buildings constructed on cleared paddocks. South: regrowth of clearing between the orchard and the Project Site; Airstrip similar to 1984. East: similar to 1984, with Freeway east of the Somersby Field Station constructed and clearing north of Peats Ridge Road and south of Dog Trap Road. North-east: scattered houses.
2006	Similar clearing pattern as in 1984. Clearing has been grassed with additional regrowth on edges. Additional tracks. Plant growth in the dam in the east of the Project Site.	North: similar 1994 with additional track. West: similar to 1994. South: clearing between the orchard and the Project Site. Airstrip similar to 1994. East: similar to 1994 with plant growth in the dam. Buildings and 'figure 8' track north of Peats Ridge Road and south of Dog Trap Road.

Current Land Uses

Land uses on the Project Site currently comprise native conservation, limited grazing (by an adjoining land owner) and a telecommunications tower. The northern end of the local airstrip and its slashed northern approach is also located on the Project Site with the agreement of the Proponent.

Figure 4.5(b) displays the range of land uses within approximately 1km of the boundary of the Project Site. The bulk of the landholdings around the Project Site are typically 5ha to 25ha in size and support mainly intensive agricultural / horticultural activities or rural-residential lifestyle dwellings / buildings. A brief overview of the surrounding land uses is provided below.

East/Northeast: Peats Ridge Road to the north of the Project Site separates the Project Site from an area currently used predominantly for nature conservation. A group of rural-residential lifestyle blocks fronting onto Dog Trap Road is located to the northeast of the Project Site.

Southeast: To the southeast of the Project Site, the Somersby Field Station is managed by the Department of Primary Industries (Agriculture) predominantly as a horticultural research station. The station is to be upgraded within the next 3 to 5 years as a number of the functions currently undertaken at the Narara Research Station are transferred to the Somersby Field Station. It is understood the focus of horticultural activities will be more upon intensive trials rather than irrigation-based studies as have been conducted in the past.

South/Southwest: The land uses south of the Project Site comprise a combination of rural-residential lifestyle landholdings, intensive flower production, grazing, a sand quarry, nature conservation and a private airstrip. The Proponent previously owned the land on which the airstrip is located and holds an agreement with the current owners to allow its ongoing use as an airstrip. Furthermore, the airstrip owners agreed, by way of the purchase contract, to concur with future land use of the proponent's property providing such use was in accordance with zoning conditions at the time. The airstrip is regularly used. Details of the sand quarry south of the Project Site are provided in Section 4.1.4.4.

West/Northwest: To the west and northwest of the Project Site, a diverse range of land uses are present including Somersby Public School, rural-residential lifestyle landholdings, a community hall, local shop, a fuel outlet and automotive workshop, intensive horticultural activities including nurseries, and communications towers. Most of these land uses have access to Wisemans Ferry Road, a collector road serving the local community.

4.1.4.3 Surrounding Residences

Figure 4.4 also presents the locations of the residences on the surrounding properties generally within 1km of the boundary of the Project Site. **Table 4.4** lists typical distances from representative residences surrounding the Project Site to the closest and most distant point of sand removal and the closest part of the processing area.

Table 4.4
Proximity of Representative Residences to Project Site Activities

Residence / Building	Distance (m) to Project Site Activities		
	Sand Removal Closest Point	Sand Removal Most Distant Point	Closest Point of Processing Area
B*	420	1 210	760
C	745	1 400	990
F	760	1 180	840
G	810	1 270	950
H	350	1 080	610
I	240	990	510
K	250	1 060	590
M	280	1 070	600
N	150	890	420
O@	260	1 020	550
P	670	1 380	920
R	870	1 500	1 060
S	390	830	490
T	420	910	510
U	240	980	510
V	250	1 030	560
Y	460	1 260	790
Z	750	1 550	1 080

* Planned residence on Somersby Field Station
@ Somersby Public School

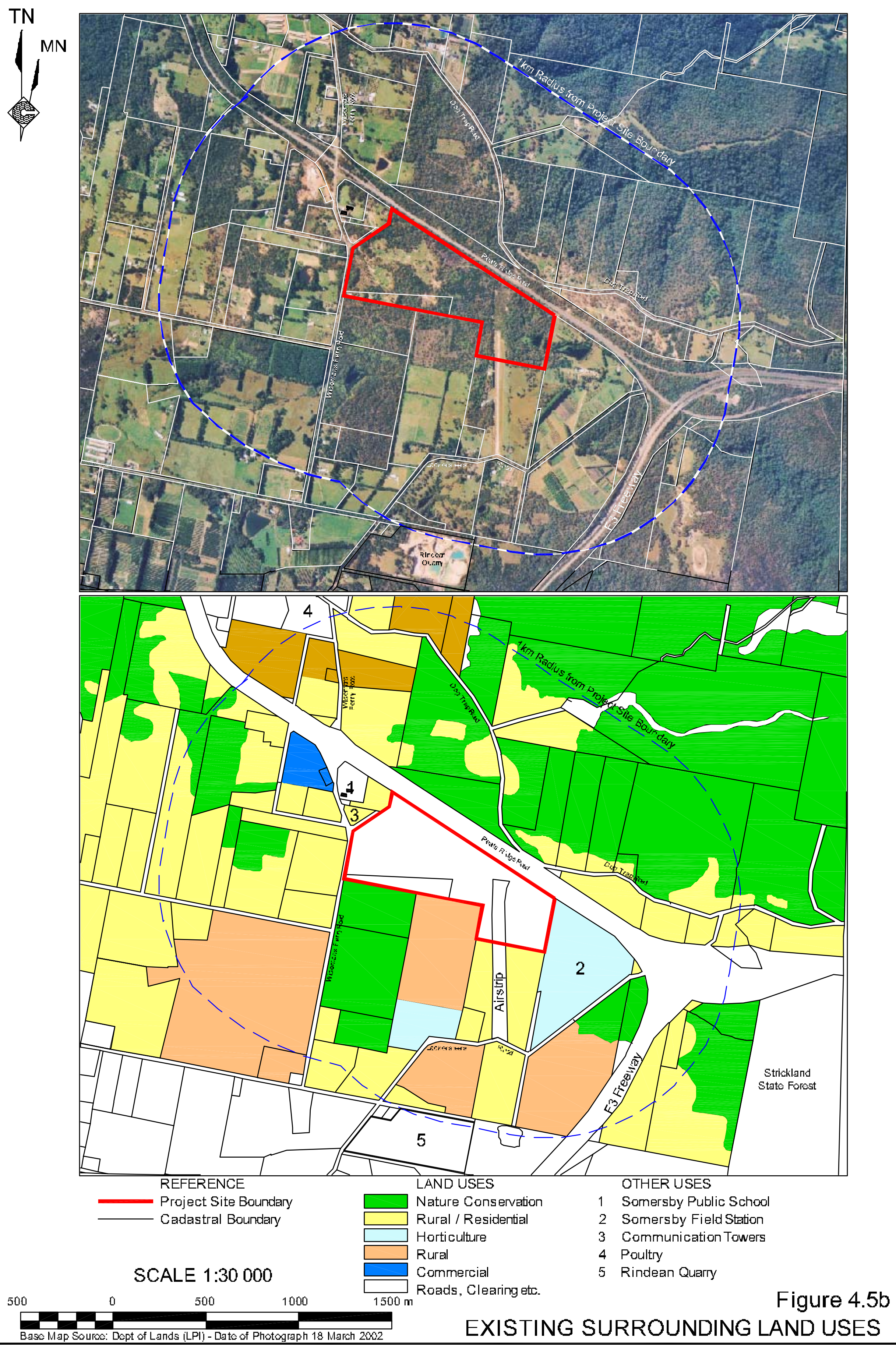


Figure 4.5b
EXISTING SURROUNDING LAND USES

4.1.4.4 Rindean Quarry

Figure 4.5(b) displays the location of a comparatively small sand quarry, referred to as the Rindean Quarry, approximately 1.2km south of the proposed area of sand removal on the Somersby Fields Project Site. The quarry was first established in 1979 and to date over half of the 15ha area has been disturbed by sand extraction operations.

The quarry is currently not operational, however, on 20 June 2006, Cleve Smith Excavations Pty Ltd received a deferred commencement approval from Gosford City Council to extract up to 150 000t of material per year from the quarry until 20 June 2022. Operations have not yet recommenced on site as the Applicant is currently seeking to modify 19 development consent conditions that would enable the viable recommencement of extraction operations on site.

Based upon information provided in the Environmental Impact Statement for the redevelopment of the Rindean Quarry (Pacrim, 2004) the principal components of the proposal redevelopment of the Rindean Quarry that are relevant to the Somersby Fields Project and the assessment of potential cumulative impacts of both quarries are as follows.

1. Resource size between 3.5 and 4 million tonnes.
2. Annual production of 150 000tpa would comprise:
   - 70 000tpa – washed and graded sand
   - 40 000tpa – mortar sand
   - 30 000tpa – unwashed sand
   - 10 000tpa – coarse reject and overburden
3. Depth of Sand Removal – Maximum 30m below surrounding land surface.
4. Hours of Operation
   - 7.00am to 6.00pm Monday to Friday
   - 7.00am to 1.00pm Saturday
5. Product Transportation
   - Average 20 loads per day (40 truck movements).
   - Average 2 loads per hour (4 truck movements).
   - All products despatched via Wisemans Ferry Road, mostly to the south (towards Sydney) with some to the north (past Somersby Public School) to Peats Ridge Road.

It is recognised that the potential would only exist for cumulative impacts to occur with the Somersby Fields Project if the Applicant for the redevelopment of the Rindean Quarry obtains a development consent from Council that enables a viable operation to be carried out on that site.

4.2 WATER RESOURCES

4.2.1 Introduction

Water resources within and surrounding the Project Site comprise both surface water and groundwater. Given the inter-relationship between the two and a number of common management issues, this section describes the occurrences and use of surface water and groundwater together with the water-related constraints that have been addressed throughout the design of the Somersby Fields Project. This section also presents the proposed mitigation measures and management procedures that would be adopted throughout the life of the project to protect and/or manage the surface water and groundwater resources on and beyond the Project Site.

The residual impacts of the project upon the water resources within and beyond the Project Site are described with the assumption that all proposed mitigation measures are adopted. The section concludes with the proposed monitoring to record the extent (or absence) of impacts the project would have on the water resources within and surrounding the Project Site.

The information presented in this section is drawn from two reports prepared by specialist consultants commissioned by the Somersby Fields Partnership, namely Cardno Willing (NSW) Pty Limited (Surface Water) and RCA Australia (Groundwater). These reports are respectively incorporated as Parts 1 and 2 in the *Specialist Consultant Studies Compendium* for the project.

4.2.2 Surface Water Occurrences and Uses

4.2.2.1 Regional Drainage Network

Figure 4.6 shows the Project Site lies on the boundary of three regional surface water catchments.

1. Narara Creek – which flows southeasterly and enters Brisbane Water near Gosford. The land uses in the upper catchment of Narara Creek comprise some agricultural enterprises and Strickland State Forest whereas the lower catchment drains through much of the residential area between Gosford and Niagara Park. The Narara Creek catchment covers approximately 4 860ha.
2. Ourimbah Creek – which flows in an easterly and northeasterly direction towards Tuggerah Lake. The bulk of the upper and middle catchment of Ourimbah Creek lies within the Ourimbah State Forest whereas the lower reaches of the catchment drain through predominantly agricultural enterprises and rural-residential areas. The Ourimbah Creek catchment covers approximately 16 580ha.
3. Mooney Mooney Creek – which flows southerly and enters the Hawkesbury River near Brooklyn. The upper catchment of Mooney Mooney Creek comprises some agricultural enterprises and heavily vegetated areas whereas the lower catchment drains predominantly through the Brisbane Water National Park. The Mooney Mooney Creek catchment upstream from the Mooney Mooney Creek Dam covers approximately 3 900ha.

Both Narara and Ourimbah Creeks flow uninterrupted towards their outlets points whereas Mooney Mooney Dam, located at the confluence of Mooney Mooney Creek and Little Mooney Mooney collects runoff from the upper reaches of the catchment for use in supplying mains water for Gosford and Wyong. It is recorded that the maximum capacity of Mooney Mooney Dam (4 600ML) is approximately 2.25% of total storage capacity of the Gosford/Wyong water supply (Wyong City Council, 2006).

Apart from the water collected in Mooney Mooney Dam, the water flowing in these catchments is used principally for stock, domestic and environmental purposes. A review of licences issued by the Department of Natural Resources for pumping from these catchments revealed the following.

- Narara Creek – 0 licences, 0ML entitlements
- Ourimbah Creek – 29 licences, 820ML entitlements
- Little Mooney Mooney Creek – 8 licences, 372ML entitlements

4.2.2.2 Local Drainage Network

Figure 4.7 displays the local drainage network in the Somersby Area. An un-named tributary of Narara Creek commences immediately east of the DPI Somersby Field Station and flows in a southeasterly direction beneath the F3 Freeway and through Strickland State Forest towards Gosford.

An un-named tributary of Ourimbah Creek south of Bumbles Creek originates on the Project Site near its northwestern boundary. This creek flows in an easterly direction and joins Ourimbah Creek approximately 3.5km east-northeast of the Project Site.

Small sections of the catchment boundaries of both Robinson Creek and Little Mooney Creek cross the southwestern corner of the Project Site. Robinson Creek trends in a west-southwesterly direction and flows into Mooney Mooney Dam approximately 3km from the Project Site. An un-named tributary of Little Mooney Mooney Creek flows west and then northwest from the Project Site towards Little Mooney Mooney Creek which in turn flows into Mooney Mooney Reservoir. The distance from the Project Site to the Mooney Mooney Dam via Little Mooney Mooney Creek is approximately 5.5km.

4.2.2.3 Project Site Drainage

Figure 4.8 displays the Project Site drainage which has the following features.

Only one defined drainage line is located on the Project Site, namely at the northwestern corner of the Project Site within the headwaters of Ourimbah Creek. This drainage line has defined comparatively steep banks typically 5m to 10m apart and only flows following rainfall.

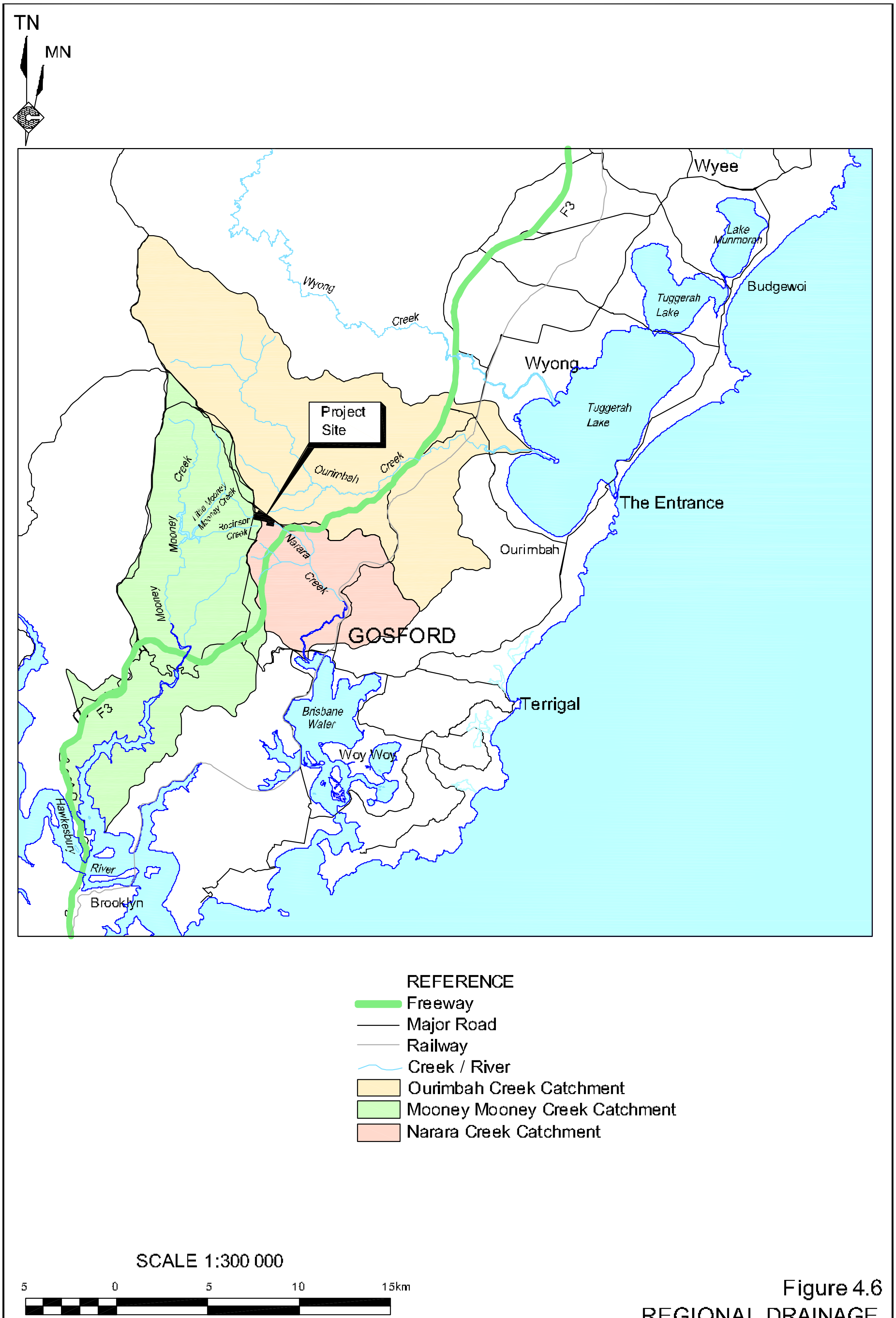


Figure 4.6
REGIONAL DRAINAGE

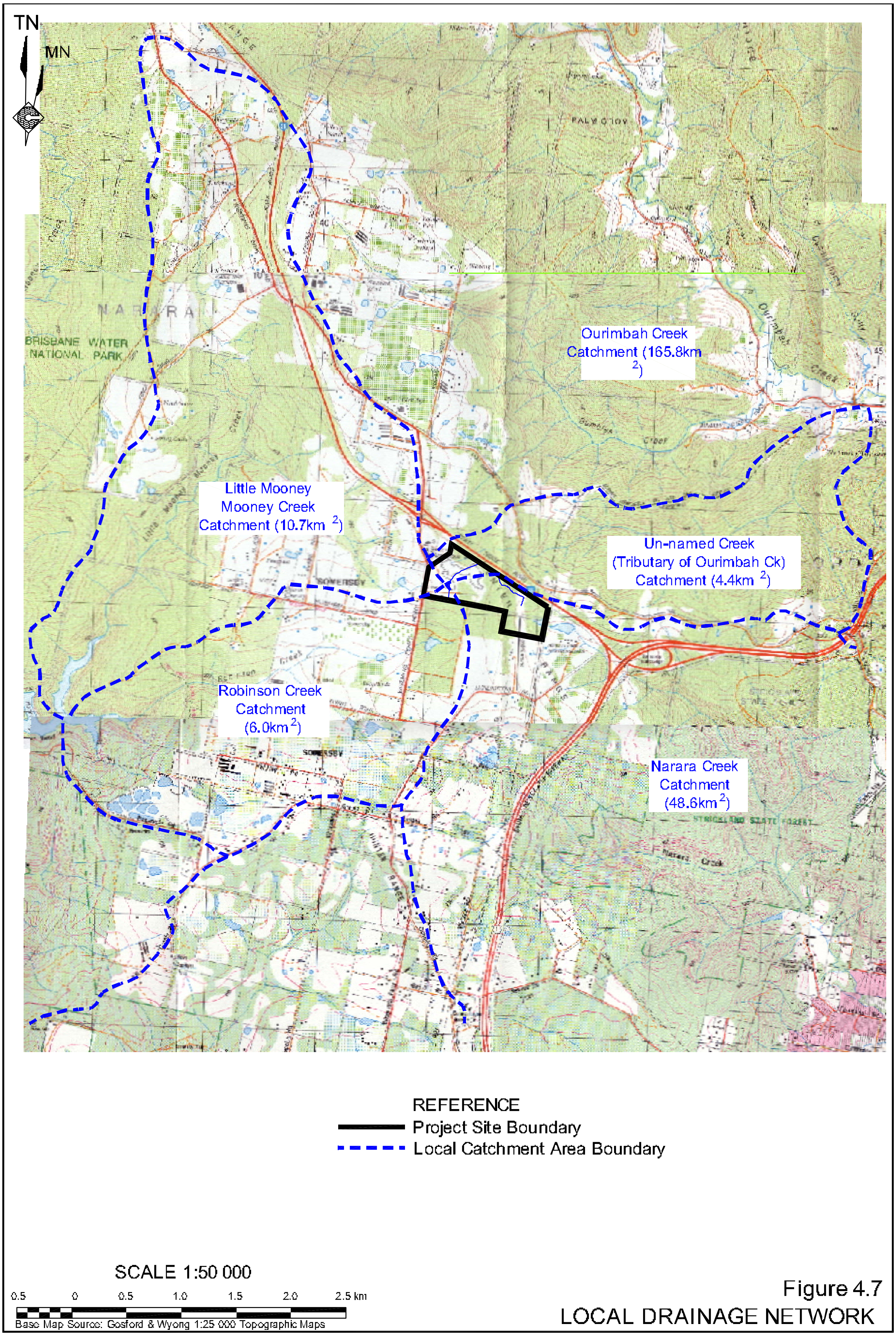


Figure 4.7
LOCAL DRAINAGE NETWORK

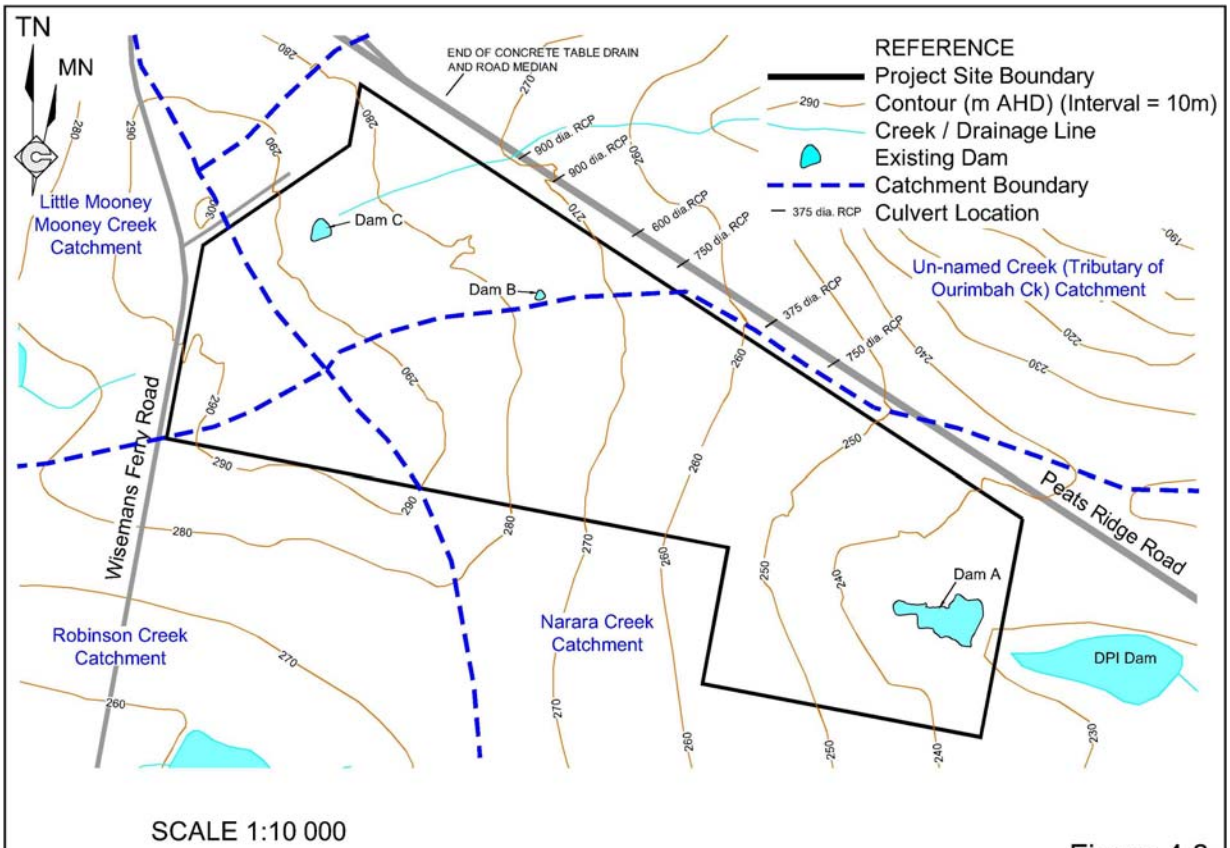


Figure 4.8
PROJECT SITE - EXISTING DRAINAGE

For the bulk of the remainder of the Project Site, runoff is typically cross-land flow over the existing landform. Near the eastern side of the Project Site, three poorly defined channels are located. These channels convey both local surface water runoff and seepage all of which reports to Dam A.

Dam A is a conventional farm dam with an earth wall and a southern (low flow) and northern (high flow) spillway. Dam A is currently licenced by the Department of Natural Resources as a source of water for stock and domestic purposes (Licence No. 10SL040975). Dam A has an estimated capacity of approximately 5.04ML (Cardno Willing, 2006), comparable to the 5.5ML capacity recorded on Licence No 105L040975, and a total catchment of 53.4ha, 23ha of which occurs within the Project Site. A pump is located within a pumphouse on the southern side of the dam. This pump has been used for irrigation in the past, however, it has not been used for some time.

Two further dams (Dams B and C) are located on the Project Site (see **Figure 4.8**). These are small dams (0.3ML and 0.6ML respectively) pushed up to contain local runoff. Both of these dams were dry during the recent drought.

Subcatchments

Four subcatchments have been defined within the Project Site feeding to the local drainage discussed in Section 4.2.2.2. **Table 4.5** lists each subcatchment and records its area and proportion of the Project Site.

Table 4.5
Subcatchments within the Project Site and Creek Catchments

Catchment*	Subcatchment Area within Project Site (ha)	Total Catchment Area (ha)	Subcatchment Proportion of Project Site	Subcatchment Proportion of Total Catchment Area
Narara Creek	23.1	4 860	54.6%	0.47%
Ourimbah Creek	14.2	16 580	33.6%	0.09%
Robinson Creek	1.6	3 900	3.8%	0.04%
Little Mooney Mooney Creek	3.4		8.0%	0.09%
Source: Modified after Cardno Willing (2006) – Table 1			* See **Figure 4.8**	

Annual and Peak Runoff

A detailed study calculating both annual and peak runoff has been conducted for each catchment on the Project Site. A knowledge of annual runoff is required to understand both what surface water (and seepage) could be harvested and what water could continue to flow off site to maintain flows in the surrounding creeks. A knowledge of peak runoff is required to understand the rate at which the on-site dams would fill and the contribution runoff from the Project Site catchment would have upon the surrounding catchments.

Table 4.6 lists the estimated annual average runoff and peak runoff from the Project Site. A further breakdown is provided of estimated annual runoff for the Narara Creek catchment. Dam A is located within this catchment and some reliance would be placed upon recovery of water from this dam until Dams D and E are well established.

Table 4.6
Estimated Annual and Peak Runoff from the Project Site

Catchment	Annual Runoff (ML)	Peak Runoff (m^3/s)			
		100yr ARI	10yr ARI	2yr ARI	1yr ARI
Narara Creek (Dam A)		10.6	6.4	3.7	2.6
Driest Year (879mm)	2.0				
Average Year (1 381mm)	58.5				
Wettest Year (2164mm)	178.1				
Average over period	67.2				
Spring Water Average Year	31.6				
Ourimbah Creek (Av)	41.4	3.8	2.2	1.3	0.83
Robinson Creek (Av)	4.7	0.54	0.31	0.17	0.12
Little Mooney Mooney Creek (Av)	9.8	0.72	0.45	0.24	0.17
Total Average	**142.3**				
Source: Modified after Cardno Willing (2006) – Tables 5 and 6					

It is noted from **Table 4.6** that the estimated average annual spring water flow into Dam A is 31.6ML/year. This has been calculated based upon an estimated continuous flow rate of 1L/s over 1 year based on observations reported in Cardno Willing (2006).

4.2.3 Groundwater Occurrences and Uses

4.2.3.1 Regional Setting

The groundwater resources in the Central Coast are located within two principal geological units, namely the Hawkesbury Sandstone and the underlying Terrigal Formation. Both of these geological units, which are widespread throughout the Central Coast, have been the subject of various investigations to supply good quality water for use throughout the Gosford City Local Government Area. The most recent study undertaken by Lee and Cook (2005) established that when defining groundwater resources, the Hawkesbury Sandstone could be divided into three units. Details of these units, their thicknesses and aquifer characteristics are provided in **Table 4.7**.

Table 4.7
Groundwater Units within the Hawkesbury Sandstone

Unit	Thickness*	Aquifers	Comments
A	>80m	<1L/sec Dominantly in lower part	• Eroded lateritised, deeply weathered at top. • “Clean” sandstone dominant. • Aquifers within porous and permeable sandstones enhanced by secondary fractures. • Sharp contact at base. • Excellent water quality.
B	~35m	Generally poor groundwater potential	• Dominated by clayey sandstone, siltstone and shale. • Occasional thin “clean” sandstones. • Shaley at base and top. • Commonly confused with basement. • Widespread correlation of this unit reflects an eustatic sea level rise, followed by a transgressive event.
C	~30m	“Fair” potential, poor in Calga region (limited information available)	• Excellent aquifers in the southern part of the basin, fairing the central region, marginal in the study area (poor in the Calga regions – limited information available). • Improved aquifers can be expected in the main source channels. • Excellent water quality expected.
* In the Somersby Area			
Source: Modified after RCA Australia (2006) – Table 1 – Originally drawn from Lee and Cook (2005)			

The underlying Terrigal Formation is understood to be approximately 120m thick and estimated to be at depths of approximately 120m below the ground surface in the Somersby area. Its aquifers are high yielding (>40L/s) and dominantly fracture-controlled, ie. probably sub-vertical fractures.

A review of DNR Groundwater Works Summary records found that groundwater bores within 1.5km of the Project Site were generally utilised for rural purposes with bore depths ranging between approximately 10m and 140m in consolidated sandstone.

4.2.3.2 Local Setting

The groundwater resources within the Somersby area are located principally within Unit A of the Hawkesbury Sandstone discussed in Section 4.2.3.1. It is recognised that within Unit A there are various layers that are more permeable than others, however, insufficient detail is available to accurately describe the number of individual aquifers and their continuity throughout the Somersby area. It is, however, noted that the bases of most groundwater bores are typically between 100m AHD and 270m AHD.

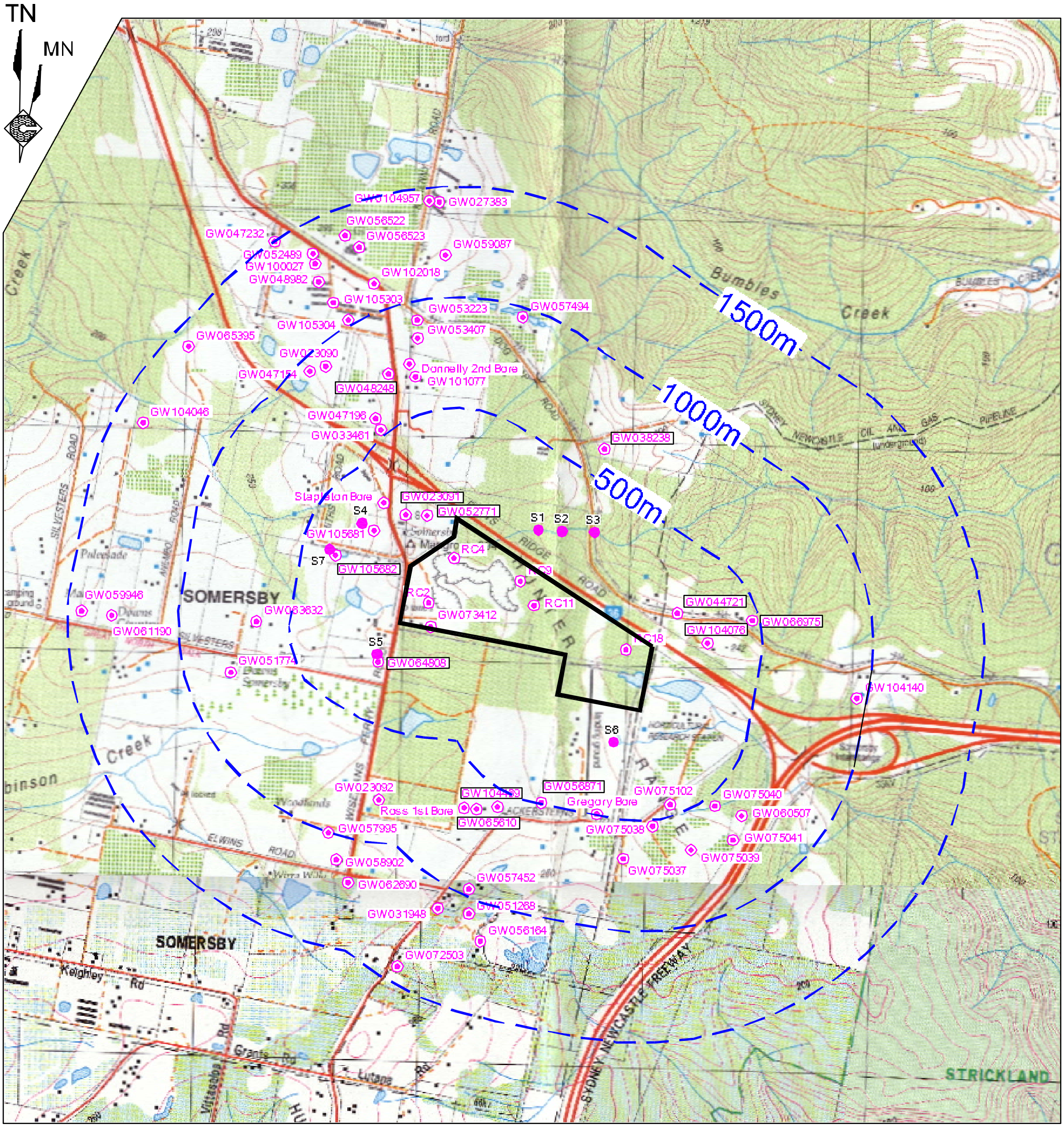
Table 4.8 lists the groundwater bores within 1.5km of the boundary of the Project Site together with details of the bore depth, standing water level and saturated thickness. The locations of the various groundwater bores are shown on **Figure 4.9**. In summary, the numbers of groundwater bores surrounding the Project Site are as follows.

12	–	within 500m of the Project Site boundary
27	–	500m to 1 000m from the Project Site boundary
23	–	1 000m to 1 500m from the Project Site boundary

The groundwater bores vary in depth between 10m and 140m with standing water levels varying from 5m to 70m below ground surface. It is noted that six of the listed bores are not registered with the Department of Natural Resources.

An important attribute of each groundwater bore, particularly when assessing potential residual impacts, is the variation in saturated thickness. Monitoring of groundwater bores by the Department of Natural Resources within the grounds of the Somersby Field Station over the period from 1 October 1999 and 5 May 2005 established that the measured variations in saturated thickness for bores drawing water from 32m to 84m depth varied, due to natural fluctuations, by between 3.5% and 9.0%. A greater natural variation in saturated thickness was, however, recorded in one bore where groundwater was present at depths of 6m to 10m below the surface.

The yields within the bores surrounding the Project Site are typically up to 1.2L/s. The bulk of the water pumped from groundwater bores in the Somersby area is used for horticultural and domestic uses. The quantity of groundwater harvested annually in the Somersby area is not well recorded.



REFERENCE
Project Site Boundary
Registered Groundwater Bore (within 1500m of Project Site Boundary)
Groundwater Bore Recorded in Bore Census
S1 Spring

SPRING	LAND OWNER
S1	M. & N. Ozbaglar
S2	M. & N. Ozbagler
S3	R. Fischer
S4	S. & M. Cahill
S5	R. & S. Weller
S6	A. Gregory
S7	K. & L. Hawker

SCALE 1:30 000

500 0 500 1000 1500 m

Base Map Source: Gosford & Wyong 1:25 000 Topographic Maps
Groundwater Bore Source: Department of Natural Resources Database
Modified After RCA Australia (2006) - Figure 5

Figure 4.9
GROUNDWATER BORES AND SPRINGS SURROUNDING THE PROJECT SITE

Table 4.8
Existing Bores within 1.5km of the Project Site Boundary @

Page 1 of 2

Bore Ref No. *	Land Owner*	Collar Height (m AHD)#	Total Depth (m)	SWL (m)	Saturated Thickness⌖ (m)
Distance to Project Site Boundary <500m					
GW023091	Minister for Education	288	53.9	7.9	46
GW052771	B & L Daniel	288	46.0	14.9	31.1
GW105681	S & M Cahill	280	65	21.9	43.1
GW105682	K & L Hawker and J Woods	270	70.0	20.4	49.6
GW064808	R & S Weller	272	70.0	10.9	59.1
GW066975	S & P Drew, E Grant	225	26.6	11.0	15.6
GW044721	P & S Martin	235	53.3	9.0	44.3
GW104076	C & R Sultana	240	138.0	24.0	114
GW056871	I Scott	270	34.0	14.0	20
Stapleton Bore ◆	N Stapleton	285	70.0	16.6	53.4
Gregory Bore ◆	A Gregory	260	90.0	17.7	72.3
GW075012	Minister of Agriculture	240	85	14.3	70.7
Distance to Project Site Boundary 500m to 1 000m					
GW033461	P & S Moore	282	45.6	7.6	38.0
GW038238	G & T Morris	235	71.6	18.2	53.4
Ross 1st Bore ◆	D Ross	275	90.0	NK	NK
GW065610	D Ross	275	40.0	17.0	23.0
GW104469	D Ross	273	120.0	20.0	100
GW023092	Kiboh Investments	265	19.8	6.7	13.1
GW057995	Schneider	255	46	5	41
GW057452	Minister of Agriculture	260	28	9	19
GW075037	Minister of Agriculture	260	38	23.05	14.95
GW075038	Minister of Agriculture	242	37	3.46	33.54
GW075039	Minister of Agriculture	240	29	17.6	11.4
GW075041	Minister of Agriculture	232	22	2.04	19.96
GW060507	Minister of Agriculture	222	21.1	14	7.1
GW075040	Minister of Agriculture	225	22	10.4	11.6
GW104140		205	84	12	72
GW047196	P&R Tate	280	31	10.3	20.7
GW048248	J&J O'Toole	285	45.8	NK	NK
GW101077	Coachwood Nurseries	278	48	8	40
Donnelly 2nd Bore ◆	Coachwood Nurseries	280	NK	7.75	NK
GW047154		268	46	5.4	40.6
GW023090		273	30.4	NK	NK
GW053407		278	55	10	45
GW053223		276	45	7.2	37.8
GW057494		240	114	6.2	107.8
GW051774		240	42	4	38
GW063632		255	85.4	18.3	67.1
Taylor Bore ◆	Taylor	NK	NK	NK	NK
Distance to Project Site Boundary 1 000m to 1 500m					
GW072503		265	48	26	22
GW056164		240	30	6	24
GW051268		250	30	5.1	24.9
GW031948		260	30.4	6.7	23.7

NK: Not Known # Collar height estimated from topographic map. * Recorded on bore licence
@ Data drawn from DNR Database ◆ Bore unregistered
⌖ In all cases the saturated thickness, which is the available volume of water within the bore, approximated "available drawdown" which is the volume/height of water within the bore above the pump, as each pump was noted at the base of the bore.

Table 4.8 (Cont'd)
Existing Bores within 1.5km of the Project Site Boundary @

Page 2 of 2

Bore Ref No. *	Land Owner*	Collar Height (m AHD)#	Total Depth (m)	SWL (m)	Saturated Thickness⌖ (m)
Distance to Project Site Boundary 1 000m to 1 500m (Cont'd)					
GW062690	Collins	253	25	4	21
GW058902		255	30	20	10
GW059946		260	42	1	41
GW061190		265	31	8	23
GW104046	Lee	230	84	12	72
GW065395		248	76	30	46
GW105304	King	282	20	NK	NK
GW105303	King	285	20	NK	NK
GW048982	Johnston	288	45.8	NK	NK
GW100027	Johnston	292	97.5	11	86.5
GW052489	Johnston	293	60	15	45
GW047232		290	31	4.9	26.1
GW102018		291	30	NK	NK
GW056523		294	46	7	39
GW056522		295	45	8	37
GW059087		275	44	12.1	31.9
GW104957	Brain	282	79	12	67
GW027383		280	42.7	5.4	37.3
Sewell Bore ◆	R Sewell	NK	NK	NK	NK

NK: Not Known # Collar height estimated from topographic map. * Recorded on bore licence
@ Data drawn from DNR Database ◆ Bore unregistered
⌖ In all cases the saturated thickness, which is the available volume of water within the bore, approximated "available drawdown" which is the volume/height of water within the bore above the pump, as each pump was noted at the base of the bore.

In addition to the deeper groundwater aquifers, it has been established that there are some local springs where rainfall percolates through the upper layers of the Hawkesbury Sandstone and is directed sideways by localised harder rock units or shaley units. Groundwater seepages have been identified on six properties around the Project Site (see **Figure 4.9**).

4.2.3.3 Project Site

Groundwater beneath the Project Site, and throughout the Somersby area, is largely derived from rainfall infiltrating the friable sandstone exposed at or near the ground surface.

An understanding of the groundwater resources beneath the Project Site has been established through the placement of a range of deep and shallow bores. The deeper bores were installed to monitor the regional groundwater table whereas the shallow bores were installed to identify the presence or absence of a perched water table in the area occupied by the main population of *Prostanthera junonis* (Somersby Mintbush).

Figure 4.10 presents the locations of the deep and shallow groundwater bores and springs within the Project Site.

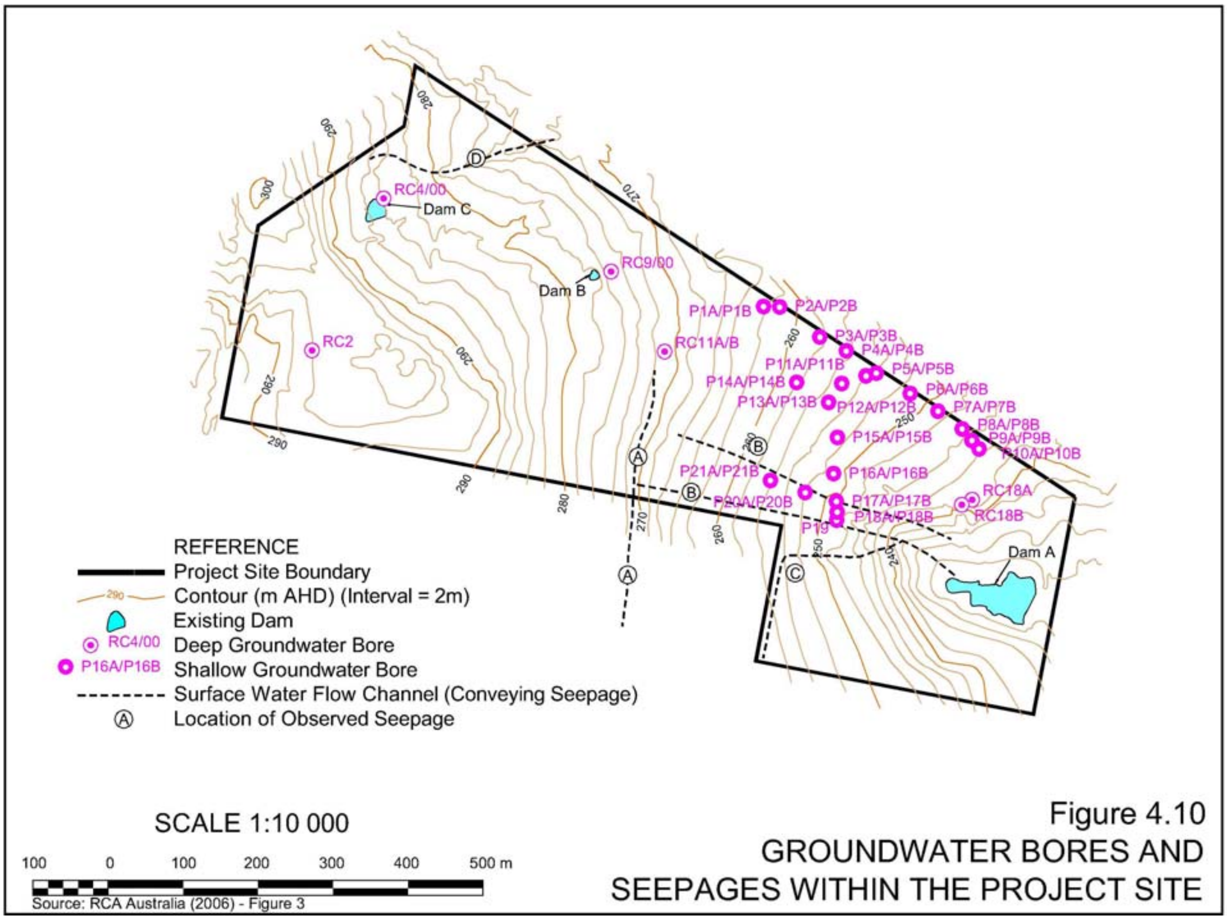


Figure 4.10
GROUNDWATER BORES AND SEEPAGES WITHIN THE PROJECT SITE

Regional Groundwater Table

The levels of the regional groundwater table beneath the Project Site typically vary between 2m below ground surface near the eastern end of the Project Site and about 10m near the western and more elevated end of the Project Site. Invariably, the direction of groundwater flow mimics the surface water flows, ie. perpendicular to ground contours.

The first groundwater monitoring bores were established on the Project Site in 1995. During the intervening 10 years to 2005, the groundwater levels in bores unaffected by nearby farm dams have fluctuated by up to 2.4m within the western and central sections of the Project Site and 0.7m at the eastern, lower section of the Project Site. The lowest groundwater levels correspond with the periods of least rainfall given the levels fluctuate with variation in rainfall.

Tests conducted in 1996 established that the permeability of the aquifer beneath the Project Site is in the order of 1×10^{-7}m/s, which is typical of Hawkesbury Sandstone aquifers.

Perched Groundwater

An investigation of potential perched groundwater near the eastern section of the Project Site near the main population of the *P. junonis* established the following.

- Perched water occurs at depths of <1.5m within localised areas near the eastern end of the Project Site.
- The presence of perched water was found to be dependent on infiltration and associated surface drainage.

Springs

Figure 4.10 shows an alignment of observed seepage in a north-south direction through Location A near the southern central section of the Project Site. The seepage from this area extends well into the property to the south. It is understood that the seepage from this feature is perennial and contributes to the base flow within the three small channels upslope of Dam A.

4.2.4 Water Quality

Given the relationship between surface water and groundwater, it is not surprising to observe that the quality of surface water and groundwater is similar. **Table 4.9** lists the results of a range of chemical tests of both surface water and groundwater, including springs.

Table 4.9
Surface Water and Groundwater Quality

Page 1 of 2

Parameter	**Groundwater Samples**					
	RC2	**RC11**	**RC18**	**GW064808 Bore**	**Gregory Pump**	**GW105681 Bore**
pH	5.5	5.4	5.1	4.28	4.62	5.88
Electrical Conductivity @ 25^{o}C (µS/cm)	82	100	170	159	118	91
Total Dissolved Solids @ 180^{o}C	52	65	110	74	51	55
Hydroxide Alkalinity as $CaCO_3$	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	8	<1	9	<1	1	2
Total Alkalinity as $CaCO_3$	8	<1	9	<1	1	2
Sulphate as SO_4^{2-}	6	3	12	10	2	<1
Chloride	14	22	31	29.1	28.2	21
Calcium	1.4	0.8	4.2	<1	<1	<1
Magnesium	0.7	1.4	2.6	2	2	<1
Sodium	12	12	19	18	14	10
Potassium	0.4	0.2	0.9	<1	<1	<1
Nitrate as N (mg/L)	0.29	0.71	0.06			
Total Hardness as $CaCO_3$ (mg/L)	6.2	7.8	21			
Arsenic	<0.001	<0.001	<0.001			
Cadmium	0.0001	0.0001	<0.00001			
Cobalt	<0.001	<0.001	0.003			
Chromium (total)	<0.001	<0.001	<0.001			
Copper	0.002	0.002	<0.001			
Nickel	0.002	nd	0.004			
Lead	0.011	0.01	0.002			
Zinc	0.014	0.017	0.005			
Source: Modified after RCA (2006) – Table 7		nd = not detected				

Table 4.9 (Cont'd)
Surface Water and Groundwater Quality

Page 2 of 2

Parameter	Spring Samples		
	GW064808 Spring	Gregory Spring	Fischer Spring
pH	5.74	4.61	6.04
Electrical Conductivity @ 25°C (µS/cm)	91	122	114
Total Dissolved Solids @ 180°C	64	51	67
Hydroxide Alkalinity as $CaCO_3$	<1	<1	<1
Carbonate Alkalinity as $CaCO_3$	<1	<1	<1
Bicarbonate Alkalinity as $CaCO_3$	13	1	2
Total Alkalinity as $CaCO_3$	13	1	2
Sulphate as SO_4^{2-}	8	8	<1
Chloride	11.9	26.9	30.9
Calcium	4	1	<1
Magnesium	1	2	2
Sodium	8	14	14
Potassium	<1	<1	<1

Source: Modified after RCA (2006) – Table 7 nd = not detected

The results presented in **Table 4.9** established that the water sampled from the groundwater bores, springs and surface water is fresh, sodium chloride-type water with an acidic pH. With the exception of lead, which was found to be marginally above the NHMRC & NHMMC (2004) drinking water guidelines in one sample, heavy metal concentrations were identified to be very low in all samples. Nitrate concentrations were also found to be low and, with a maximum recorded level at 0.71mg/L, well below the NHMRC & NHMMC (2004) guideline level.

It is noted from the analyses of groundwater and spring water at the locations where the bore is close to a spring, that the chemistry of both types of water were very similar.

4.2.5 Mitigation Measures and Management Procedures

4.2.5.1 Surface Water

The mitigation measures and management procedures to be adopted with respect to surface water would focus upon the diversion of clean water around active operational areas and the containment of sediment-laden water. This would be undertaken in conjunction with the management of water on site to meet operational requirements.

Site Establishment

During site establishment, the following mitigation measures and management procedures would be adopted.

1. Sediment Dam 1 would be one of the first structures constructed, principally to provide a sump for the collection of any coarse sediment generated during the early stages of construction.
2. A diversion bank would be constructed on the upslope side of Dams D and E to divert any clean water to the south to effectively bypass Sediment Dam 1. This diversion bank would be retained until upslope runoff becomes sediment-laden following the clearing of Stage 1/3.

3. The earth mound on the western side of the processing area would divert upslope runoff around the processing area into existing Dam B from where it would be directed via a grassed channel to a culvert beneath the site access road and towards Dams D and E (as cross-land flow). The upslope drain would be extended beyond the southern boundary of the processing area to also divert runoff from the initial raw feed stockpile area.
4. To mitigate against the loss of very low (environmental) flows within the Narara Creek catchment (from Project Site spring flows), a small diversion channel or pipe would be constructed around Dam A to divert very low flows (<0.2ML/day) to the Narara Creek catchment (via the DPI Dam).
5. Silt-stop fencing would be erected downslope of all operational / construction areas to collect the bulk of the sandy sediments washed from the disturbed areas during construction. This would include the initial raw feed stockpile area.
6. Dam D would be excavated prior to Dam E to provide an additional collection point (in addition to Sediment Dam 1) for sediment-laden runoff during the early stages of construction. Excavation in Dam D would be undertaken in such a manner that a sump would be retained during the first day's activities. A sump would be retained throughout the life of construction of Dam D.
7. The internal haul road between the processing area and Dam D would be constructed with mitre drains positioned every 40m to divert runoff from the road onto the nearby vegetation.
8. The far-western earth mound would be constructed with silt-stop fencing positioned at the base of the mound following topsoil placement. This would be retained until the mound is adequately vegetated.
9. All disturbed areas no longer required for project-related operations during the first year of operations would be stabilised with a pasture grass mix.
10. All efforts would be made during the site establishment period to minimise the number of tracks used on site. Management would define and mark the nominated tracks for earthmoving equipment and other vehicles to use.
11. All earthmoving equipment would be fuelled with the use of a mobile spill tray. Any substantial spillages would be collected and disposed off site at an approved remediation facility or remediated on site.
12. The on-site fuel tank would be contained within an impermeable bund designed to hold >110% of fuel tank volume.

Sand Removal Operations

1. During the staged sand removal operations, the Proponent would ensure that an internal sump is present within each operational area so that all sediment-laden runoff can be contained within the operational area.
2. All sediment-laden runoff would be allowed to settle within the active sump before being pumped / siphoned to Dam E.

3. **Figure 4.11** presents the proposed layout of Dams D and E. The dams have a capacity of 11 200m^3 and 20 700m^3 respectively. Throughout the sand removal operation, Dam D would be preferentially used for the supply of water for dust suppression and process water to maximise the storage capacity to contain runoff from most rainfall events.
4. In order to retain the existing level of peak runoff from the final landform during a 100yr ARI peak runoff event and avoid increasing flood flows in Narara Creek in and around Gosford, it is proposed to construct Dam F with a storage capacity of at least 14.3ML.
5. All runoff from the processing area would be directed to Sediment Dam 2 to be constructed near the northeastern corner of the processing area (see **Figure 4.11**). The overflow from this dam would be directed into a defined drainage line constructed across Stages 1/5, 1/4 and 1/3 towards Dam E. However, once sand removal is underway in those stages, the water would report to the active sump in those stages from where it would be pumped to Dam E.
6. Each active section of the dewatered clay fines backfill area would be isolated from run-on water to minimise the generation of sediment-laden water. Wherever practical, the dewatered clay fines would be covered periodically with coarse oversize material to also limit sediment-laden runoff from these areas.
7. All fuel stored on site would be kept in either double-skin tanks or bunded tanks. All refuelling would either take place on a bunded refuelling area close to the fuel storage tank(s) or in the active operational area with the use of a mobile spill tray.
8. The surface water assessment has established that during most years, it would be necessary to discharge water from the Project Site. All discharges would occur via Dam D to Dam A, and then overflow via one or both of the spillways on Dam A to the DPI Dam on the adjoining property.
9. In the event it is necessary during a dry year to discharge water from Dam A, this would occur through pumping from Dam D (subject to satisfactory quality tests) via a pipeline to the northern spillway of Dam A to ensure the water leaves the Project Site and enters the DPI Dam.
10. An important component of the ongoing surface water management would involve the compilation of the following documentation to enable a periodic review of the water balance.
    (i) Site rainfall.
    (ii) As-built capacities of all sumps, dams etc.
    (iii) Storage record boards in all dams (to record storage volumes on a monthly basis).
    (iv) Quantities of water used for dust suppression / washing.
    (v) Confirmation checks of the moisture content of the sand products and dewatered clay fines.
    (vi) Quality of water flowing from the Project Site.

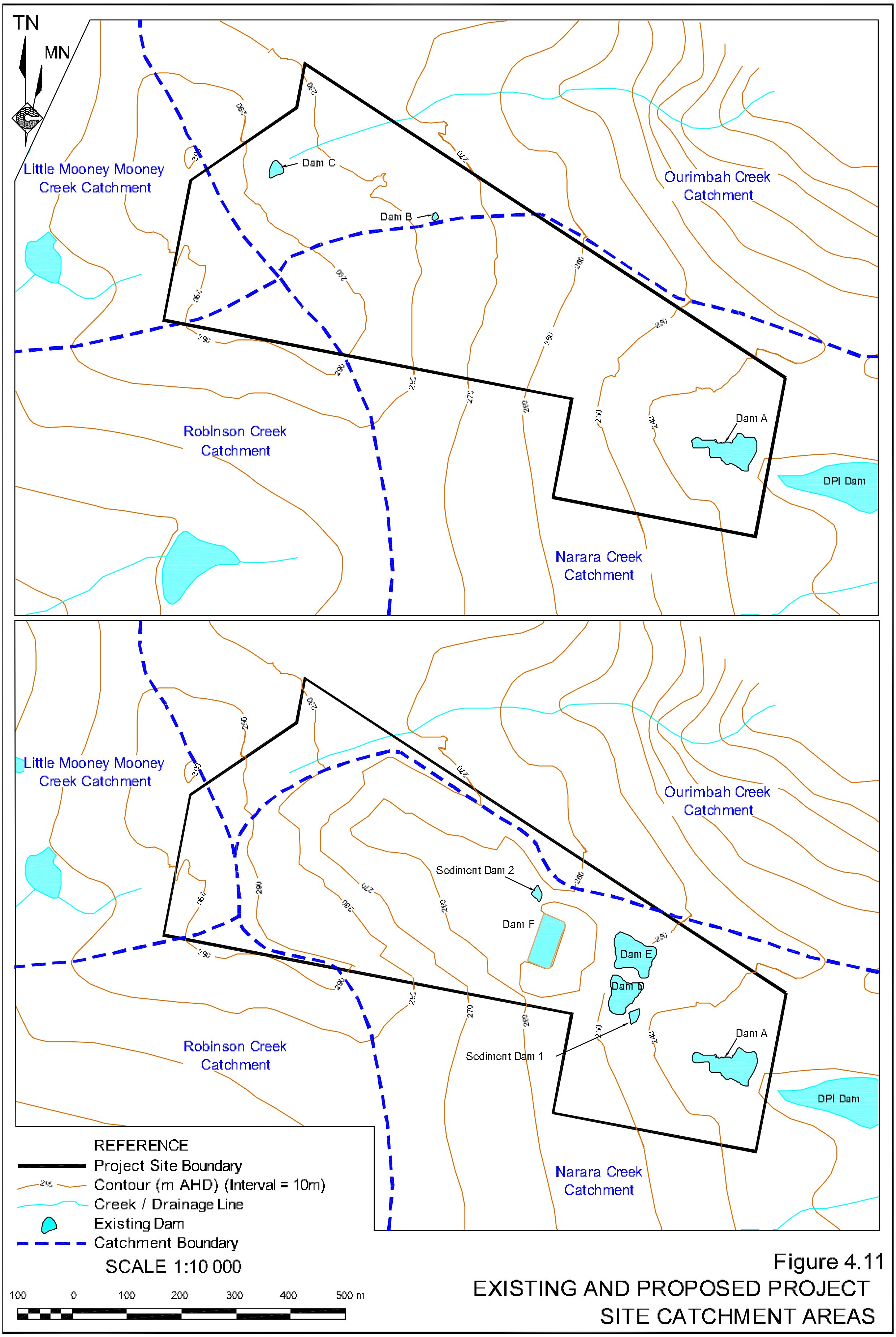


Figure 4.11
EXISTING AND PROPOSED PROJECT
SITE CATCHMENT AREAS

4.2.5.2 Groundwater

There are a few direct mitigation measures that can be adopted to minimise and/or avoid impacts associated with the reduction of groundwater levels. The controls in Section 4.2.5.1 relating to avoidance of hydrocarbon spillages would equally apply to protect groundwater resources.

The most critical management control relating to groundwater would involve monitoring of a range of groundwater parameters to ensure the predictions discussed in Section 4.2.7.2 are being achieved. The monitoring would also confirm to the extent to which (if any), the sand removal operations on the Project Site and the Rindean Quarry (see Section 4.1.4.4) are having on groundwater levels in surrounding bores. Details of the proposed groundwater monitoring program are presented in Section 4.2.11.2.

The most effective mitigation measure that the Proponent would be able to implement to replace any reductions in available groundwater supplies (from either bores or springs) would be to offer to affected land owners to either re-establish water yields on any property where the bore or water spring is affected by the sand removal operation or offer some other form of offset with the owners of properties. Details of the Proponent's approach to this mitigation measure for the potentially affected land owners, ie. individual undertakings, are provided in Section 4.2.8.2.

4.2.6 Objectives and Criteria for Assessing Residual Impacts

Surface Water

The reconfiguration of the landform within 22ha of the Project Site could cause localised changes to existing catchment boundaries, slopes, runoff coefficients, on-site storage capacities, water quality, peak runoff rates. Each of these components has been reviewed and the following objectives or criteria nominated.

Existing Catchment Boundaries:	It is an acceptable objective that the change in any catchment does not substantially change the total catchment of the subject creek (to the next main confluence).
Landform Slopes:	It is an acceptable objective that slopes are not steeper than 14^{o} to substantially increase the velocity of runoff from the final landform.
Runoff Coefficient:	It is an acceptable objective that the runoff coefficient(s) are not substantially changed for the final landform.

On-site Storage Capacities:	It is an acceptable objective that the storage capacities of dams during the life of the operation and within the final landform do not retain quantities of water required for downstream use and/or environmental flows.
Peak Runoff Rates:	It is an acceptable objective that peak runoff rates from the final landform do not exceed those from the existing landform.
Water Quality:	It would be a requirement of the DEC (EPA) that any water flowing or being discharged from the Project Site into the Narara Creek catchment satisfies the following water quality criteria. – Total suspended solids - <50mg/L. – pH - ± 1 pH unit from background levels. – Oil and Grease - <10mg/L.
Maximum Harvestable Right Dam Capacity:	It is a requirement under the *Water Management Act 2000* that the quantity of clean water stored in an off-line dam on the Project Site should not exceed 10% of the runoff from the property – otherwise, a licence is required under Part 2 of the *Water Act 1912*. The maximum harvestable right dam capacity for the Project Site has been calculated as 4.24ML.

Groundwater

The project would intersect the local groundwater table and would therefore have the potential to impact on the water level, quantity, availability and quality of the local groundwater. Objectives and criteria for each of these components is nominated as follows.

Saturated Thickness:	A reduction in saturated thickness of <10% is adopted by RCA Australia (2006) as an acceptable criterion given the natural variation in the saturated thickness in bores in the Somersby area is typically of this magnitude also.
Water Quality:	It is an acceptable objective for groundwater quality at surrounding bores to remain comparable to the existing quality.
Annual Extraction:	It is a requirement under Clause 4 of the Water Sharing Plan for the Kulnara Mangrove Mountain Groundwater Sources for total annual extraction of groundwater not to exceed 200ML/km^2. This would equate to a criterion of 84.6ML/year for the Project Site.

Water Availability:	It is an acceptable objective for water availability that the yield obtained from all surrounding bores remains comparable to the existing yield.
Water Use:	It is a requirement that groundwater accessed by the project, including any incidental water make as a result of groundwater seepage, be licensed under a Water Access Licence (WAL) and use restricted to the licensed quantity. The Proponent holds WAL 11271 for 37MLpa.

It is noted that the following documents make specific reference to the Kulnura Mangrove Mountain Groundwater Sources Water Sharing Plan, hence these three documents are addressed through that water sharing plan.

- The NSW State Groundwater Policy Framework Document
- The NSW Groundwater Quality Protection Policy.
- The NSW State Groundwater Dependent Ecosystem Policy.

The relevant aims, objectives and principles from these documents that need to be addressed for the Somersby Fields Project, as presented in the water sharing plan, are as follows.

36 – Extraction interference between neighbours

To minimise interference between extraction under different access licenses in each groundwater source, the following rules will apply to extraction authorised by an access license:

(a) *extraction from a new or replacement water supply work (bore) for the extraction of basic landholder rights will not be permitted within:*

(i) 50m of the property boundary or,

(ii) 100m of an approved water supply work (bore) from which basic landholder rights may be extracted.

(b) *extraction from a new or replacement water supply work (bore) nominated by an access licence will not be permitted within:*

(i) 400m of an approved water supply (bore) nominated by an access license, (ii) 200m of an approved water supply (bore) from which basic landholder rights water may be extracted, or

(ii) 50m of the property boundary.

39 Protection of Groundwater Dependent Ecosystems

1. *Extraction of groundwater from a new or replacement water supply work (bore) for any purpose, is excluded within 100m of:*
   (a) *high priority groundwater dependent ecosystems listed in schedule 5 and shown in Appendix 4;*
   (b) *culturally significant sites, being areas of high conservation value for cultural reasons, as contained in the National Parks and Wildlife Service's or Cultural Site Register; or*
   (c) *any river*
2. *Where an applicant can demonstrate to the Minister that the distance conditions in subclause (1) cannot be met, the minister may consider the application providing the following construction criteria can be met:*
   (a) *the water supply work (bore) must only draw water from an aquifer at depths greater than 40m from the land surface;*
   (b) *the water supply work (bore) must have an impermeable seal, as specified by the minister, constructed within the bore to isolate aquifers above 40m depth and to prevent water ingress and*
   (c) *the water supply work (bore) must comply with any access licence and water supply work approval conditions established to mitigate any risk to groundwater dependent ecosystems*
3. *Pursuant to section 45(1) (b) of the Act, the Minister may amend the exclusion of distance in subclause (1) and (2), based on further studies of groundwater ecosystems dependency undertaken by the Minister.*

Section 4.2.11 (**Table 4.17**) presents a summary of how each of these aims, objectives and principles are addressed by the Proponent and their consultants.

4.2.7 Outcomes from Computer Modelling

4.2.7.1 Introduction

A range of industry-recognised computer models were used to calculate various surface water parameters and groundwater quality variations for the project.

4.2.7.2 Surface Water

4.2.7.2.1 Surface Water Catchments

The Somersby Fields Project would result in minor changes to the existing boundaries between the various catchments on the Project Site (see **Figure 4.11**). **Table 4.10** lists the existing and proposed catchments and their respective areas.

Table 4.10
Catchment Areas – Existing and Proposed

Catchment	Existing	Catchment Area (ha)				
		Year 3	Year 6	Year 9	Year 12	Final Landform
Narara Creek	23.1	23.3	26.5	30.4	34.0	34.8
Ourimbah Creek	14.5	14.3	11.8	7.9	5.6	4.7
Robinson Creek	1.6	1.6	0.9	0.9	0.3	0.3
Little Mooney Mooney Creek tributary	3.4	3.4	3.4	3.4	2.7	2.7
Source: Cardno Willing (2006) – Table 11						

The catchment of Narara Creek on the Project Site would increase by up to approximately 11.7ha, whereas the Ourimbah Creek catchment would decrease by 9.8ha.

4.2.7.2.2 Peak Runoff

It is proposed with the design capacities of Dams D, E and F, the peak runoff both during the life of the project and at the end of the project life, that there would be no increases in peak flows above existing peak flows. This would avoid any adverse impacts on flooding in the lower reaches of Narara Creek.

4.2.7.2.3 On-site Water Storage

It is proposed that surface water (with minor groundwater seepage) would be stored on site in the following structures.

- Dam A – 4.0ML[1]
- Dam D – 11.2ML
- Dam E – 20.7ML
- Active Sumps – Typically 5ML to 10ML

Of these structures, only Dam A would contain clean water, however, given its capacity would be less than the 10% Maximum Harvestable Right Storage Capacity, it would not be a requirement for Dam A to be licenced.

4.2.7.2.4 Surface Water Runoff

The estimated volume of runoff to Dam A in the Narara Creek catchment is listed in **Table 4.11**, ie. for existing conditions, Years 3 to 15 and long term post sand removal. This volume comprises the runoff from the Project Site and from the remainder of the Dam A catchment beyond the Project Site.

[1] The existing capacity of this dam has been estimated at 5.04ML (Cardno Willing, 2006), however, to ensure compliance with the maximum harvestable right of the Project Site, a low flow bypass pipe would be constructed during the site establishment phase to reduce the dam's capacity to approximately 4.0ML.

Table 4.11
Estimated Average Annual Runoff to Dam A
During and After the Somersby Fields Project

Stage	ML/Year
Existing	187
Year 3	132
Year 6	130
Year 9	133
Year 12	145
Year 15	145
Post Operation	226
Source: Cardno Willing (2006) – Table 17	

The increased volume of runoff post operation (39ML/year) would be as a result of the proposed final landform which diverts areas currently part of Ourimbah Creek, Robinson Creek and the tributary of Little Mooney Mooney Creek into Narara Creek, and the cessation of surface runoff harvesting. Cardno Willing (2006) note that notwithstanding the potential for increased runoff, the environmental low flow regime would be virtually unchanged beyond 1km from the Project Site. Cardno Willing (2006) also note that the minor change in the low flow regime would have no noticeable impact on stream hydrology, creek geomorphology or water quality.

Based on the modelled runoff, Cardno Willing (2006) has determined that it would be possible to meet water demands at the various stages of the project from water stored in Dams D, E and F (after it is constructed) without the need to draw water from Dam A in all except the site establishment period and low rainfall years. The analysis showed that Years 7 to 9 would be the most critical period during which there would be a 20% chance that up to a maximum of 7ML of water would need to be drawn from Dam A in any one year. 7ML of water would represent approximately 4.5% of the annual 156ML that would flow into this dam during an average year.

4.2.7.2.5 Surface Water Quality

The quality of water likely to flow from Dam A off the Project Site and into the Narara Creek catchment has been established through the MUSIC model. This model is the "industry standard" used to predict water quality. The main water quality parameters considered were total suspended solids, nitrogen and phosphorus. **Table 4.12** lists the predicted quality of each of these discharged at three yearly intervals throughout the life of the project.

Table 4.12
Predicted Water Quality Discharged from Project Site

	TSS (kg/yr)	TP (kg/yr)	TN (kg/yr)
Existing	15 600	33.2	302
End Year 3	11 700	23.1	231
End Year 6	11 500	23.3	231
End Year 9	12 300	24.2	229
End Year 12	12 700	25.0	254
End Year 15	12 100	25.2	240
Source: Modified after Cardno Willing (2006) – Table 18			

Based upon the predictions listed in **Table 4.12**, the concentrations of total suspended solids, total phosphorus and total nitrogen would all reduce, principally because of the effectiveness of the dams on site.

4.2.7.3 Groundwater

4.2.7.3.1 Introduction

In order to assess the residual impacts of the project on the groundwater resources beneath and surrounding the Project Site, it is necessary for a computer model to be developed that simulates the existing groundwater regime and then predicts the changes that would occur as a result of the project.

The modelling conducted by RCA Australia for the Somersby Fields Project was undertaken using MODFLOW which is an internationally recognised groundwater flow simulation program together with Visual Modflow, a commercially available finite difference modelling computer package. The three-dimensional model constructed assumed two layers of homogenous sandstone, the upper layer extending from 295m AHD to 235m AHD and the lower layer extending from 235m AHD to 30m AHD. The model covered an area of approximately 36km^2 with the Project Site positioned near the centre of the model. Details of the model and its calibration and validation, of which a peer review was undertaken by Kalf & Associates Pty Ltd, are presented in Part 2 of the *Specialist Consultant Studies Compendium*. Suffice it to say that the model was calibrated using site specific data collected from a number of groundwater bores within and surrounding the Project Site.

Acknowledging that the predictions arising from a groundwater model will only be as accurate as the data input into these, RCA (2006) undertook a sensitivity analysis of the model to determine the impact of chosen parameters on model behaviour. Recharge, permeability and specific yield are the main parameters that can impact on model predictions. The sensitivity of the model to recharge and permeability was addressed in the calibration process of the groundwater model and so the sensitivity analysis, post model calibration and validation, was restricted to the specific yield of the aquifer (or "storativity").

Part 2 of the *Specialist Consultant Studies Compendium* presents greater detail on the sensitivity analysis.

4.2.7.3.2 Predicted Groundwater Changes

Predicted Groundwater Seepage to Operational Areas

During the first month of sand removal operations, groundwater seepage into the sand removal area (Dam D) would be in the order of 250m^3/day. This rate of seepage would steadily decrease to 85m^3/day by the end of Year 3 before increasing again to 107m^3/day as the area of sand removal increases. **Table 4.13** lists daily seepage rates into the sand removal area for each 3 year period modelled.

Table 4.13
Predicted Daily Seepage into the Sand Removal Area

Time Period	Year 3	Year 6	Year 9	Year 12	Year 15*	Year 16#
Groundwater Inflow (m^3/day)	85	93	96	104	107	33
* Assumes sand removal completed by Year 15	# Steady state inflow predicted within 1 year of project completion					
Source: Modified after RCA Australia (2006) – Table 13						

Based upon the above seepage rates, it is predicted the maximum groundwater inflow would vary from approximately 30ML to 40ML per year during the life of the sand removal operation.

Predicted Drawdown on the Regional Groundwater Table

Using the calibrated model, the drawdown on the regional groundwater table was predicted at the end of Years 3, 6, 9, 12, 15 and long term based upon the proposed sequence of activities on the Project Site throughout the life of the project. **Figures 4.12a, b** and **c** display the predicted drawdown for the six modelled periods with the drawdown contours commencing at 3m and decreasing to 1m. **Figure 4.12d** provides a conceptual interpretation of the groundwater drawdown at the end of Years 3, 9, 15 and long term following groundwater resaturation. It is noted that the drawdown contour lines presented are those from the lower layer of the model (235m AHD to 30m AHD), ie. from the layer within which all identified groundwater bores draw water. Drawdown from the upper layer (295m AHD to 235m AHD) was also identified by the model and considered in the assessment of impact on spring flows on, and surrounding, the Project Site.

Key outcomes arising from the modelling presented in **Figures 4.12** and **4.13** are as follows.

- At the end of Year 3, the 1m drawdown contour would be confined to within approximately 150m of the northern Project Site boundary and 100m of the southern boundary. There would be negligible drawdown to the east and west (see **Figure 4.12a**).
- By the end of Year 6, the 1m drawdown contour would extend up to 450m beyond the northern, western and southern Project Site boundaries (see **Figure 4.12a**).
- By the end of Year 9 this distance would increase to approximately 800m beyond the northern Project Site boundary, 600m beyond the western Project Site boundary and 450m beyond the southern Project Site boundary (see **Figure 4.12b**).
- Beyond the end of Year 9, the rate of drawdown would decrease with the 1m drawdown contour confined to similar distances from the Project Site boundary as in Year 9 (see **Figure 4.12c**).

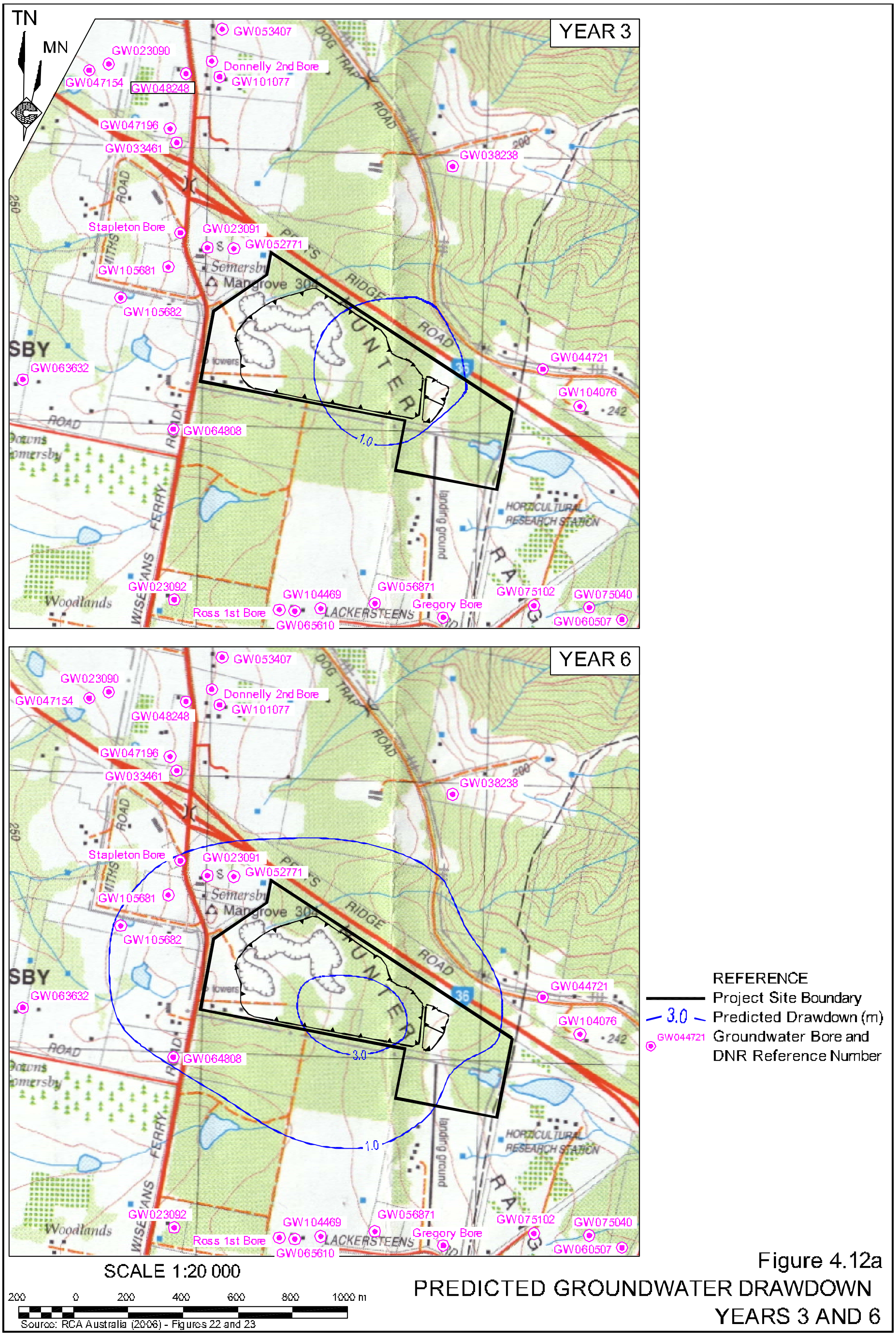
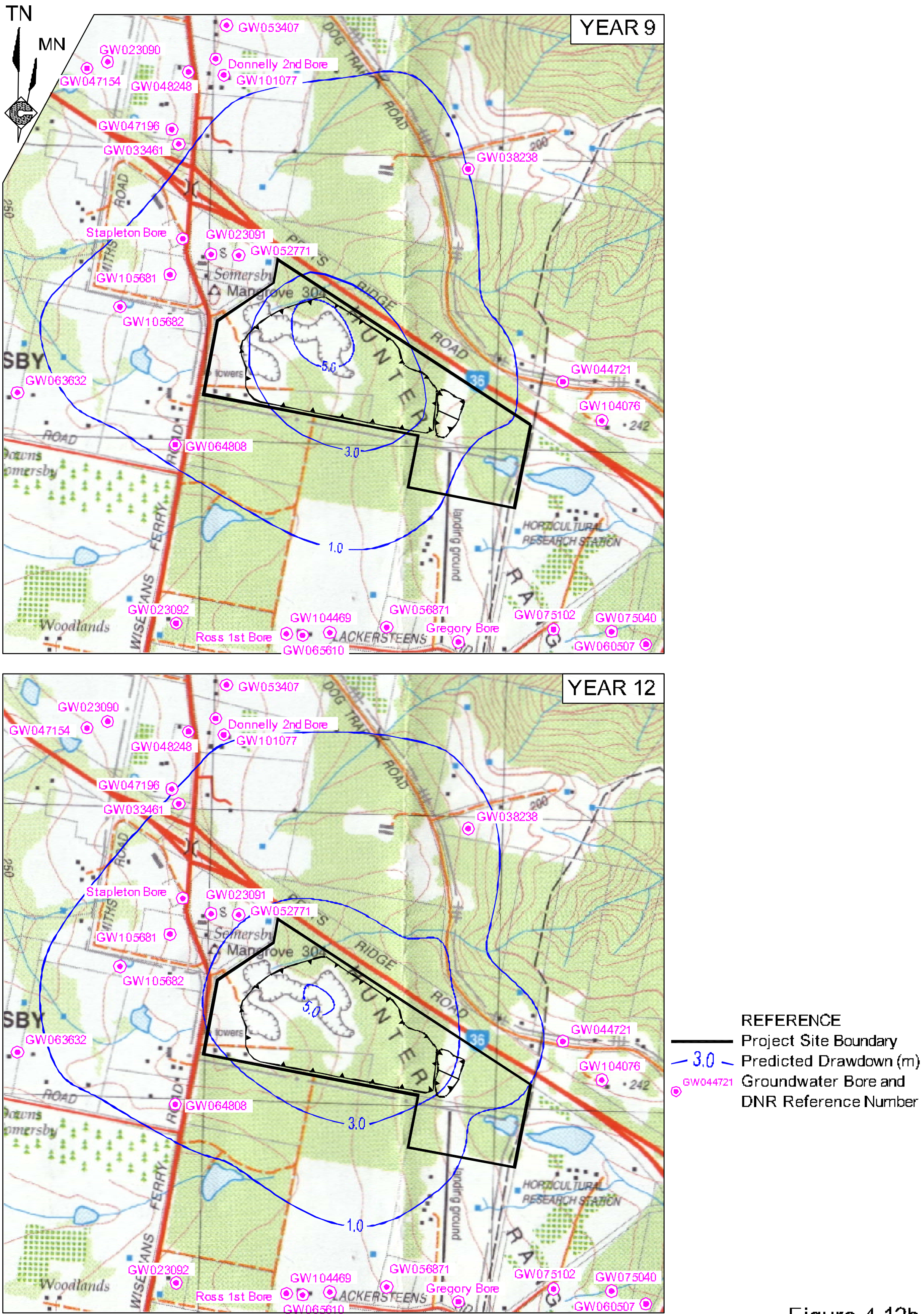


Figure 4.12a
PREDICTED GROUNDWATER DRAWDOWN
YEARS 3 AND 6



SCALE 1:20 000

200 0 200 400 600 800 1000 m

Source: RCA Australia (2006) - Figures 24 and 25

Figure 4.12b
PREDICTED GROUNDWATER DRAWDOWN
YEARS 9 AND 12

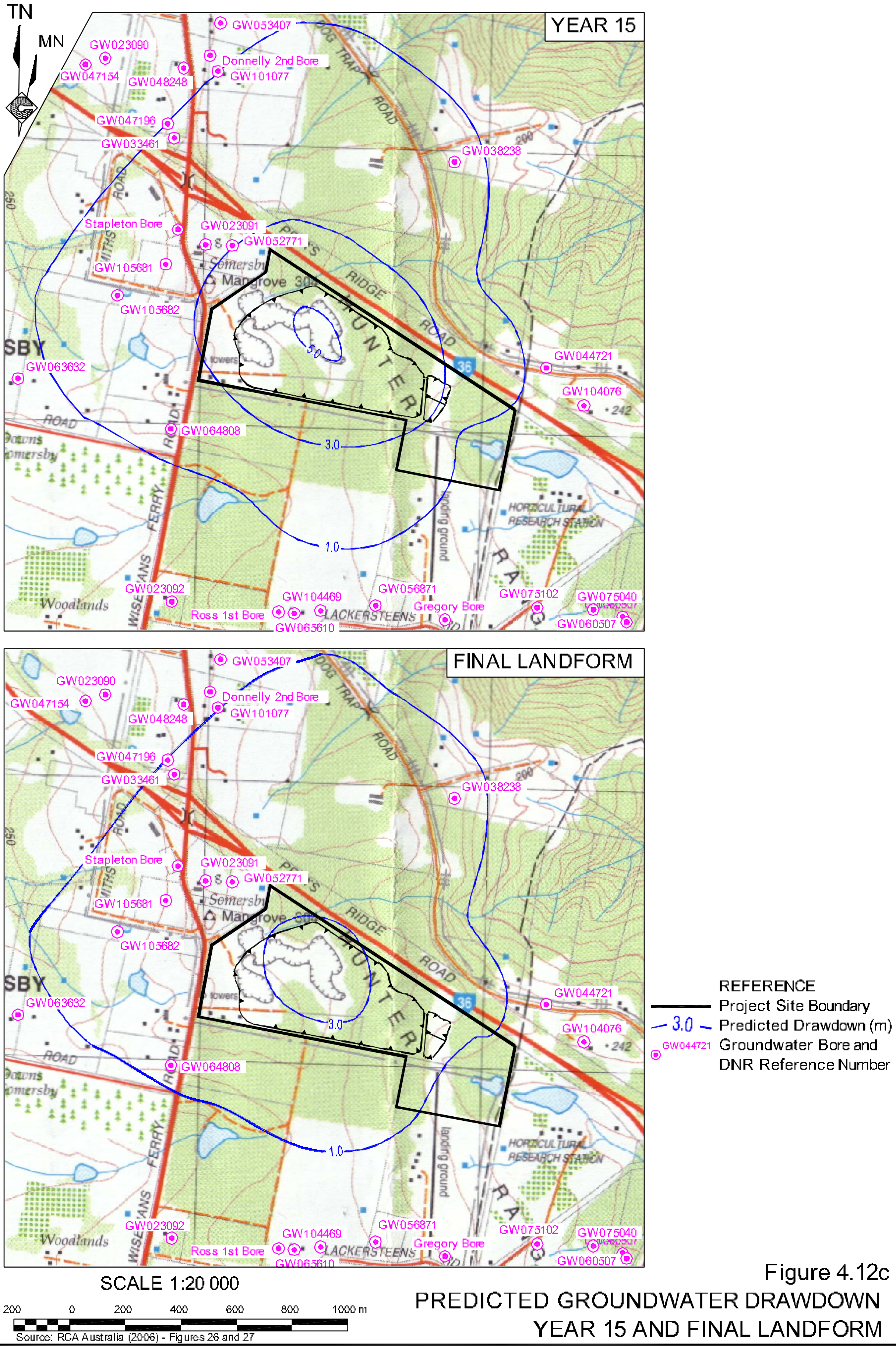


Figure 4.12c
PREDICTED GROUNDWATER DRAWDOWN
YEAR 15 AND FINAL LANDFORM

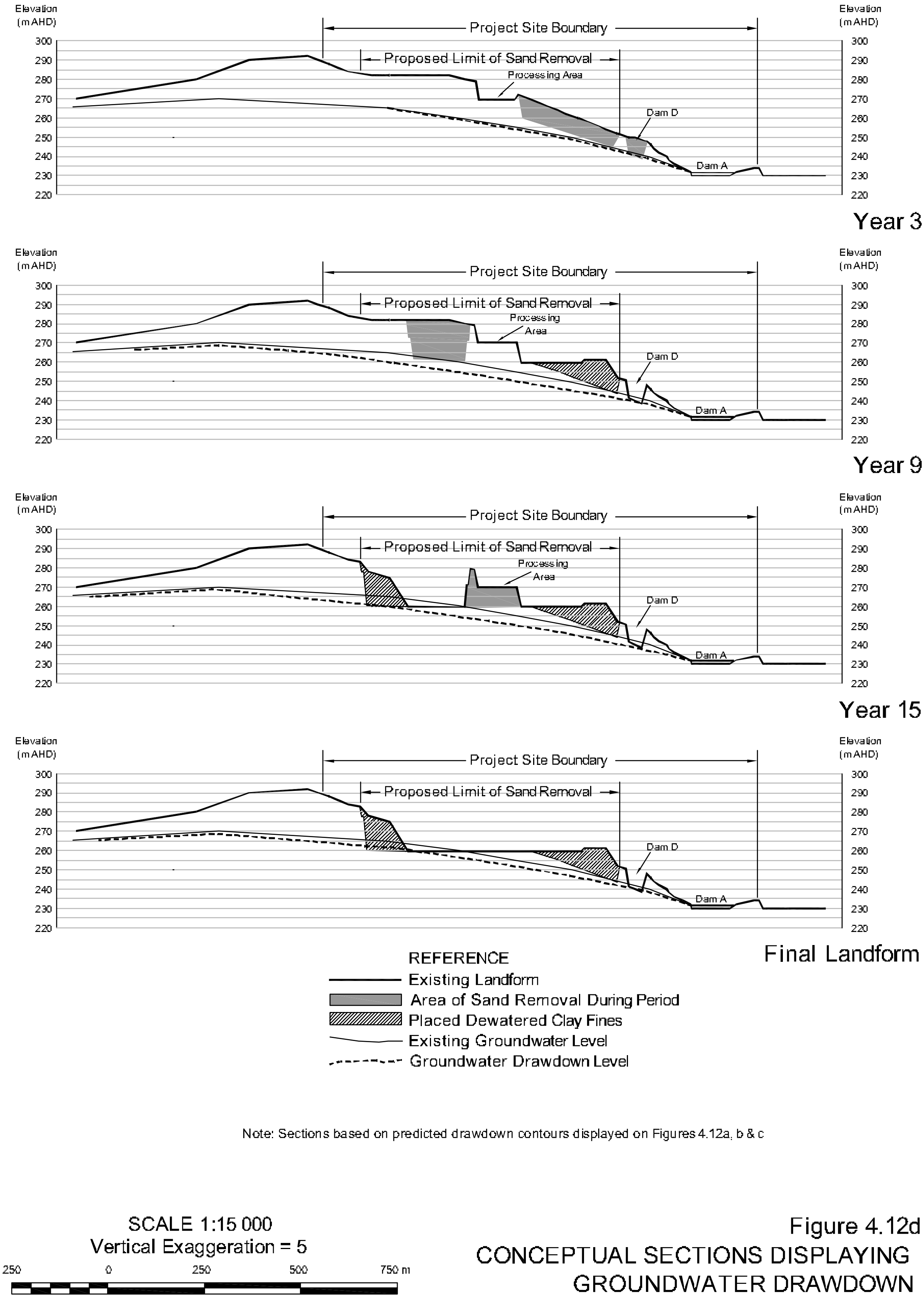


Figure 4.12d
CONCEPTUAL SECTIONS DISPLAYING
GROUNDWATER DRAWDOWN

Figure 4.13
CUMULATIVE GROUNDWATER DRAWDOWN

The placement of dewatered clay fines around the edges of the sand removal area and on parts of the floor of the final landform would result in the partial recovery of the water table. Modelling indicates that maximum resaturation would occur within less than 1year following the cessation of the project. It is noted, however, the effect of the placement of dewatered clay fines to reduce groundwater inflows would commence earlier than the end of the project life, hence, the predicted drawdown contours shown on **Figures 4.12a, b** and **c** are considered conservative.

Predicted Drawdown on Surrounding Bores (Considering Operation of Somersby Fields Project Only)

Based on the groundwater model simulation, **Table 4.14** lists the predicted drawdown and percentage reduction in available drawdown for the 62 groundwater bores within 1.5km of the Project Site. This prediction considers the scenario in which the project is the only sand removal / extractive industry operation active in the local area.

Key outcomes arising from **Table 4.14** are as follows.

- Two bores would experience a reduction in available drawdown of approximately 10% or greater, ie. Bore GW023091 on the Somersby Public School grounds (13%) and GW052771 on the Daniel's property (9.6%).
- Bore GW105681 on the Cahill's property would experience a reduction in available drawdown of approximately 5%.
- These three bores referred to above are located within 250m of a Project Site boundary, and the remaining six bores with a predicted drawdown of ≥1m are located within approximately 700m of a Project Site boundary.
- It is noted that it was not possible to calculate the exact proportional reduction in bores where the predicted drawdown was <1m.

Predicted Drawdown on Surrounding Bores (Considering Cumulative Impact of Rindean Quarry Expansion)

RCA Australia (2006) considered the potential for cumulative impacts on groundwater as a result of concurrent operations of the Somersby Fields Project and the redevelopment of the Rindean Quarry (as approved – see Section 4.1.4.4). **Figures 4.13a** and **4.13b** present the predicted maximum and long-term drawdown resultant from the concurrent operation of the Somersby Fields Project and Rindean Quarry. **Table 4.15** presents a summary of the predicted maximum cumulative drawdown for those bores where the increased drawdown exceeds 1m.

Table 4.14
Predicted Drawdown and Reduction in Saturated Thickness at Bores within 1.5km of the Project Site Boundary (Somersby Fields Project Only)

Bore Ref No. *	Land Owner*	Saturated Thickness (m)	Distance to Closest Sand Removal	Predicted Drawdown (m)	% Reduction in Saturated Thickness ⌖ / Available Drawdown
Bores with Predicted Drawdown >1.0m					
GW023091	Minister for Education	46.0	300	2.7	13.2
GW052771	B & L Daniel	46.0	240	3.0	9.6
GW105681	S & M Cahill	65.0	330	2.2	5.1
GW105682	K & L Hawker and J Woods	70.0	345	2.0	4.0
GW064808	R & S Weller	70.0	300	1.6	2.7
GW044721	P & S Martin	53.3	330	1.0	2.2
GW033461	P. & S. Moore	45.6	680	1.3	3.4
GW038238	G. & T. Morris	71.6	655	1.5	2.8
Stapleton Bore ◆	N Stapleton	70.0	400	2.1	3.9
Bores with Predicted Drawdown ≤1.0m					
GW066975	S. & P. Drew, E. Grant	26.6	660	<1	<6
GW104076	C. & R. Sultana	138.0	450	<1	<1.0
GW056871	I. Scott	34.0	690	<1	<5
Gregory Bore	A. Gregory	90.0	720	<1	<1.4
GW075012	Minister of Agriculture	85	765	<1	<1.4
Ross 1st Bore	D. Ross	NK	780	<1	NK
GW065610	D. Ross	40.0	765	<1	<4.3
GW104469	D. Ross	120.0	750	<1	<1.5
GW023092	KIBOH Investments	19.8	825	<1	<8
GW057995	Schneider*	46	1030	<1	<3
GW057452	Minister of Agriculture	28	1125	<1	<5
GW075037	Minister of Agriculture	38	930	<1	<7
GW075038	Minister of Agriculture	37	825	<1	<3
GW075039	Minister of Agriculture	29	975	<1	<9
GW075041	Minister of Agriculture	22	1050	<1	<5
GW060507	Minister of Agriculture	21.1	1000	<1	<14
GW075040	Minister of Agriculture	22	900	<1	<9
GW104140		84	1150	<1	<2
GW047196	P. & R. Tate	31	740	1	5
GW047154	J. & J. O'Toole	NK	900	<1	NK
GW023090		48	850	1	3
GW053407	Coachwood Nurseries	NK	900	<1	NK
GW053223	Coachwood Nurseries	46	1070	<1	<3
GW057494		30.4	1050	<1	<3
GW051774		55	1000	<1	<2
GW063632		45	1080	<1	<3
UNREG	Taylor	NK	1035	<1	NK

NK: Not Known
* Recorded on bore licence
⌖ In all cases the saturated thickness, which is the available volume of water within the bore, approximated "available drawdown" which is the volume/height of water within the bore above the pump, as each pump was noted at the base of the bore.
◆ Bore unregistered

Source: Modified after RCA (2006) – Table 11

Table 4.14 (Cont'd)
Predicted Drawdown and Reduction in Saturated Thickness at Bores within 1.5km of the Project Site Boundary

Page 2 of 2

Bore Ref No. *	Land Owner*	Saturated Thickness (m)	Distance to Closest Sand Removal	Predicted Drawdown (m)	% Reduction in Saturated Thickness ⌖ / Available Drawdown
Bores with Predicted Drawdown <1.0m					
GW072503		48	1530	<1	<5
GW056164		30	1350	<1	<5
GW051268		30	1230	<1	<5
GW031948		30.4	1245	<1	<5
GW062690	Collins	25	1200	<1	<5
GW058902		30	1125	<1	<10
GW059946		42	1550	<1	<2
GW061190		31	1400	<1	<5
GW104046	Lee	84	1470	<1	<2
GW065395		76	1500	<1	<2
GW105304	King	NK	1170	<1	NK
GW105303	King	NK	1275	<1	NK
GW048982	Johnston	NK	1400	<1	NK
GW100027	Johnston	97.5	1460	<1	<1
GW052489	Johnston	60	1500	<1	<2
GW047232		31	1635	<1	<4
GW102018		NK	1290	<1	NK
GW056523		46	1450	<1	<3
GW056522		45	1530	<1	<3
GW059087		44	1350	<1	<3
GW104957	Brain	79	1600	<1	<2
GW027383		42.7	1600	<1	<3
UNREG	R Sewell	NK	NK	NK	NK

NK: Not Known
* Recorded on bore licence
⌖ In all cases the saturated thickness, which is the available volume of water within the bore, approximated "available drawdown" which is the volume/height of water within the bore above the pump, as each pump was noted at the base of the bore.
◆ Bore unregistered

Source: Modified after RCA (2006) – Table 11

The level of drawdown predicted around the Rindean Quarry would be substantially greater than the drawdown predicted around the Somersby Fields Project Site, (as a consequence of its closer proximity and the greater depth of extraction within the Rindean Quarry). As a result of the combined impact of both operations, the maximum cumulative drawdown would be greater than for each operation in its own right, ie. for bores up to 3km from the Rindean Quarry. RCA Australia (2006) predicts that the greatest level of impact would occur at bores located on the Ross property. However, it is noted that of the 4.9m to 5m maximum drawdown at the bores on the Ross property, <1m is attributed to the Somersby Fields Project with the bulk of the drawdown attributed to the Rindean Quarry.

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Table 4.15
Predicted Maximum Cumulative Drawdown in Impacted Bores Attributable to the Somersby Fields and Rindean Operations
(increased drawdown >1m)

Bore Ref No.	Land Title (Lot/DP)	Land Owner	Distance to Project Site Boundary (m)	Collar Height (m AHD) #	Total Depth (m)	SWL (m)	Saturated Thickness (m)	Distance to Closest Extraction at Somersby Fields (m)	Predicted Drawdown from Somersby Fields (m)	Maximum cumulative drawdown (m)
GW056871	1/548869	I Scott	500	270	34	14	20	690	<1	4
Gregory Bore	42/1046841	A Gregory	500	260	90	17.7	72.3	720	<1	3
GW104469	211/708275	D Ross	585	273	120	20	100	750	<1	4.9
GW065610	211/708275	D Ross	630	275	40	17	23	765	<1	5
GW075012	6/261870	Minister of Ag	450	240	85	14.3	70.7	765	<1	1.8
Ross 1st Bore	211/708275	D Ross	660	275	90	NK	NK	780	<1	5
GW023092	A/409546	Kiboh Investments	795	265	19.8	6.7	13.1	825	<1	3.4
GW075038	6/261870	Minister of Ag	520	242	37	3.46	33.54	825	<1	2.1
GW075037	6/261870	Minister of Ag	660	260	38	23.05	14.95	930	<1	3.2
GW075039	6/261870	Minister of Ag	660	240	29	17.6	11.4	975	<1	1.2
GW057995	1/620696	Schneider	1000	255	46	5	41	1030	<1	3.1
GW057452	2/524053	Minister of Ag	970	260	28	9	19	1125	<1	15
GW058902	1/620696	NK	1110	255	30	20	10	1125	<1	4.9
GW062690	1/1027884	Collins	1185	253	25	4	21	1200	<1	6.2
GW051268	2/362339	NK	1065	250	30	5.1	24.9	1230	<1	21
GW031948	UNC	NK	1095	260	30.4	6.7	23.7	1245	<1	19
GW056164	2/362339	NK	1155	240	30	6	24	1350	<1	20
GW072503	1/515352	NK	1425	265	48	26	22		<1	16

NK: Not Known, UNC – Not Confirmed
Collar height estimated from topographic map.
Source: RCA Australia (2006) – Table 12

Predicted Changes to Spring Flow to Dam A

The predicted loss of spring flow to Dam A on the Project Site is as follows.

		During Operations	Completion of operations (maximum long term loss)
Northern B	:	100%	100%
Southern B	:	100%	50%
Channel C	:	<10%	<10%

Key outcomes arising from the evaluation of spring flows on the Project Site are as follows.

- Of three main spring channels conveying spring flows on the Project Site, the "Northern B Channel" (see **Figure 4.10**) is most likely sourced from on the Project Site and water identified in the Southern B Channel is likely sourced from the bedrock outcrop located both on the Project Site and the Ross property to the south. The source of spring contribution for Channel C is located predominantly on the Ross property, to the south of the Project Site, and is likely to be transient and rainfall dependent.
- On the Project Site, spring flow in the Northern B Channel would be likely to decrease and ultimately cease during the life of the project as the groundwater table, on which the spring flow is dependent, is predicted to be reduced by between 8m and 13m.
- Spring flow in the Southern B Channel would also reduce and cease during operations as a consequence of the predicted groundwater drawdown, although it is predicted to re-commence as the water table recovers following the completion of operations. However, as the long term water table is predicted to be 1.0m lower than the previous water table, a reduction in spring flow to the Southern B Channel of 50% is predicted.
- As Channel C appears to rely predominantly on surface water runoff and perched water flow which will remain unchanged, only a minor reduction in flow is predicted (~10%) resulting from a loss of contributions from within the Project Site.

Predicted Changes to Springs Surrounding the Project Site (Considering Operation of the Somersby Fields Project Only)

Each of the seven springs identified on surrounding properties was evaluated using the results of the groundwater modelling. **Table 4.16** presents the predicted drawdown from each spring on the properties surrounding the Project Site both at Year 15 and following the comparatively short period of resaturation.

Table 4.16
Evaluation of Spring Flows

Property Owner	Ref. No.*	Approx. Elevation (m AHD)[1]	Site Observations	Source of Spring	Initial Water Table Level in Vicinity of Spring (m AHD)[3]	Predicted Drawdown		Loss Prediction and Comment
						Year 15 (m)[3]	Steady state conditions at completion of operations (m)[3]	
Ozbaglar	S1	272	Dry during drought periods	Perched water based on transience	245	-3	-1	Moderate loss occurring from loss of surface water recharge catchment. Long term recovery is not expected.
	S2	260	Perennial, clear water, sample collected for analysis, transient. Water used by neighbour and is preferred future water supply.	Perched water based on transience and depth to water table	230	-2.2	-0.5	Moderate loss expected during operations. Some long term recovery is expected.
Fischer	S3	230[2]	Perennial, clear water, sample collected for analysis. Used for domestic purpose, flow rate 0.2L/s. Platypus reported to be sighted in area.	True groundwater spring based on clarity, permanence and low elevation	220	-1	0	Minor loss may be observed, no significant change in catchment predicted, long term recovery is expected.
Cahill	S4	272	Permanent seep to dam created by 2m excavation to bedrock contact, clear water, perennial.	True groundwater spring based on clarity, permanence.	270	-2	-2	Significant loss predicted during operations. Long term recovery is not expected.
Weller	S5	272	Two perennial saturated areas, one area discharges to a dam. Water sufficient to sample.	Perched water reliant on rainfall based on surface elevations. Subsurface storage is considered sufficient to provide a perennial water source	267	-2	-1.5	Minor loss occurring from loss of surface water recharge catchment, long term recovery is not expected.
Gregory	S6	248	One perennial saturated area discharging to dam. Water sufficient to sample.	Uncertain of source. Low elevation and shallow depth to water table suggests true spring water.	245	-0.8	-0.7	Minor loss may be observed, long term recovery is not expected.
Hawker	S7	280[2]	Located beneath dam, spring could not be observed. Dam permanently full, does not overtop, does not require filling. Perennial.	True groundwater spring based permanence	265	-2	-2	Significant loss predicted during operations. Long term recovery is not expected.

Source: RCA Australia (2006) – Table 15

* Refer to **Figure 4.9**

[1] Approximate from Wyong and Gosford topographical maps
[2] Approximate from Wyong and Gosford topographical maps and site observation of a change in elevation noted in this vicinity and not identified on the topographical map.
[3] Taken from groundwater model.

Key outcomes arising from the evaluation of spring flows on properties surrounding the Project Site.

- Of the seven springs, three were identified by RCA (2006) as true groundwater springs (on the Fischer, Cahill and Hawker properties), three were considered to be sourced from perched water and reliant on rainfall (on the Ozbaglar and Weller properties) and the source of an additional spring on the Gregory property was not defined but suggested to be a true groundwater spring.
- A significant loss of flow was predicted in the springs on the Cahill and Hawker properties. Long term recovery of spring flow would not be expected given the expected lowering of the groundwater table on which the spring is dependent.
- A moderate loss was predicted in the two springs on the Ozbaglar property. Long-term recovery of spring flow would not be expected.
- A minor loss was predicted in the spring on the Fischer, Weller and Gregory properties.

Predicted Changes to Springs Surrounding the Project Site (Considering Cumulative Impact of Rindean Quarry Expansion)

An evaluation of the cumulative drawdown from the combined effects of both the Rindean and Somersby Fields Proposals indicates an area of drawdown overlap between the two sites. Springs on the Weller Property (S5) and Gregory Property (S6) lie within this area of overlap.

A cumulative drawdown in the shallow water table of 2.5m was predicted at the Weller property. The spring on this property was identified as a perched water source that is largely rainfall reliant. The additional loss in water table resulting from the combined extraction operations was therefore not expected to further impact on the Weller Spring.

A cumulative drawdown in the shallow water table of 2.8m was predicted for the Gregory Property. This spring appeared to be a true groundwater spring and reliant on the groundwater table. The cumulative reduction in the water table was predicted to have a major impact on the spring performance and long term recovery was not expected. RCA Australia (2006) records that the bulk of the reduction in spring flow would be attributed to the Rindean Quarry as the drawdown attributable to the Somersby Fields Project would be minor.

4.2.8 Undertakings to Surrounding Land Owners

4.2.8.1 Surface Water

Results of the surface water predictions, indicate no impacts. As such, there will be no need for any undertakings with surrounding land owners relating to surface water, although the Proponent has provided an assurance to the Department of Primary Industries (Agriculture) that the base flow of water from Dam A would continue.

4.2.8.2 Groundwater

In light of predicted drawdown on surrounding bores and evaluation of spring flows, the Proponent and hydrogeological consultants, RCA Australia, has consulted with each of the likely affected land owners detailing the time frame and drawdown predicted by RCA (2006) and presented in **Table 4.14** and **Table 4.16**.

The Proponent and RCA Australia obtained information on current bore / spring condition and operation, water use and primary concerns of the land owner or licence holder. The potential impact on bore yield was explained, based on the current yield, current use and predicted decrease in available drawdown.

Through review of existing use and predicted impacts, RCA Australia has provided recommendations regarding the most appropriate mitigation or compensation measures that should be undertaken or committed to by the Proponent in the event that impacts are identified that are equal to, or greater than those predicted (RCA, 2006). The Proponent has accepted the recommendations of RCA (2006) and provided written undertakings to each potentially affected land owner or licence holder to mitigate against, or compensate for, any significant project-related impact. Copies of the written undertakings are held by the Proponent and provide for one, a combination, or all of the following.

- The bore yield at the commencement of operations is measured for future comparison.
- A program to monitor changes in SWL, available drawdown and bore yield would be initiated as described in Section 4.2.11.2.
- Based on the monitoring results, and the impact assessment objectives criteria defined in Section 4.2.6, project-related impacts would be identified and quantified.
- In cases where a decrease in yield is identified as being attributable to the project, ie. not a result of natural variation or altered pumping regimes, the Proponent would "make good" these losses in yield by:
  - deepening the existing bore or installing a replacement bore; or
  - paying a cash compensation equal to the assessed cost of deepening the bore; or
  - providing a 50 000L rainwater tank to enhance property water storage.
- For those land owners where spring flows are predicted to diminish, the Proponent proposes to deepen (through excavation) the landform (eg. Dam) to again intersect the water table beneath. Where this is not possible, the construction of a bore would be offered.

RCA (2006) notes that significant aquifers exist at depths of up to 80m and between approximately 110m and 140m within the Hawkesbury Sandstone. As such, deepening existing bores or installing replacement bores would provide a similar yield and water of a comparable quality to that which may be lost as a result of the project.

4.2.9 Assessment of Residual Impacts

4.2.9.1 Introduction

The residual impacts attributable to the Somersby Fields Project are presented in this subsection in the event:

(a) the project proceeds in the absence of extraction at the Rindean Quarry, and

(b) the project proceeds with extraction occurring as proposed at the Rindean Quarry, ie. creating cumulative impacts between the two operations.

4.2.9.2 Surface Water

The Proponent proposes that based on the modelling of water availability performed, the average annual 32.3ML of water required for consumptive purposes would be obtained from:

(a) groundwater seepage (30ML), collected in Dams E and F, access to which is licensed under WAL 11271 held by the Proponent (in accordance with the Kulnura – Mangrove Mountain Water Sharing Plan); and

(b) the remaining 2.3ML from clean surface water runoff collected in the site dams.

This ensures compliance with the harvestable right and groundwater access criterion nominated in Section 4.2.6.

An assessment of water demands and availability has identified that the most critical period is during Years 7 to 9 when there would be a 20% chance that up to a maximum of 7ML of water would need to be drawn from Dam A in any one average rainfall year. This quantity does, however, represent less than 5% of the average annual runoff that flows through that dam annually.

The greatest impact on very low flows (< 0.2ML/day (≈2.5L/s)) is the estimated reduction in spring runoff over the life of the project and the only partial recovery after the cessation of the operation. By constructing a diversion channel or pipeline to convey very low flows (<0.2ML/day) around Dam A, it would be ensured that water leaves the Project Site and enters the DPI Dam.

The adjustments to local catchments on the Project Site would influence local runoff, however, increased storage capacity on the Project Site would ensure there is no change to peak flows downstream in the Narara Creek catchment from the Project Site during storm events.

The project has been predicted by modelling to lower sediment and nutrient load entering Dam A and subsequently leaving the Project Site. The improvement is due to the natural sedimentation and nutrient decay processes that would occur in the dams and Sediment Dam 1. The reduction in nutrients (phosphorus and nitrogen) is also partly due to a reduction in the vegetative cover across the Project Site.

Given the Rindean Quarry is located within a different subcatchment of Narara Creek than the Somersby Fields Project Site, noticeable cumulative impacts are unlikely.

4.2.9.3 Groundwater

It is recognised that the Somersby Fields Project would cause a localised reduction in groundwater levels and a reduction in available drawdown within a number of bores, typically within approximately 700m of the Project Site. Such reductions would be unavoidable, however, the residual impacts are based upon the level of impact following the consideration of the commitments made by the Somersby Fields Partnership to the groundwater users surrounding the Project Site (se Section 4.2.8.2). In light of this approach, the following residual impacts are identified.

- At the completion of operations, a maximum drawdown of up to 4m is predicted to occur within 100m of the Project Site. Drawdowns of up to 1m are predicted within approximately 800m of the Project Site.
- The predicted loss in saturated thickness was calculated for bores surrounding the Project Site. A loss in saturated thickness of 10% or greater was predicted for Bores GW023091 and GW052771, namely 13% and 10% respectively. At all other bores, the predicted loss in saturated thickness was less than 10%, and generally less than 4%.
- Steady state water table conditions are likely to be achieved within a year of the completion of the project. This would include a long term reduction of the water table of 1m, up to approximately 800m from the Project Site Boundary, ie. a slight recovery from the Year 15 predicted groundwater condition. It is noted that this recovery may improve should the dewatered clay fines placed in the final landform provide a lower permeability layer than modelled, ie. reduce groundwater seepage.
- The flow of various springs on properties surrounding the Project Site would be reduced, some significantly. However, the opportunity would exist to replenish spring flows through deepening the excavations where the springs are present.

An assessment of the cumulative impacts has determined that the Somersby Fields Project would not significantly increase groundwater drawdown at the bores most affected by the Rindean Quarry. Similarly, there was no significant additional drawdown resultant from the Rindean Quarry operations at those bores predicted to be most impacted by the Somersby Fields Project.

The spring on the Gregory property was predicted to be significantly affected as a consequence of the concurrent operation of the project and Rindean Quarry. Notably, however, the affects are predominantly related to the Rindean Quarry with spring flow predicted to cease as a result of the Rindean Quarry operation above (RCA, 2004). The Somersby Fields Project has been predicted to have only a minor impact on spring performance (RCA, 2006).

4.2.10 Assessment of DNR Plans and Policies

Annual Drawdown

The predicted 30ML of groundwater inflow into the sand removal area on an annual basis would be well within the 84.6ML annual criteria nominated in the Water Sharing Plan. Hence, there would still remain a quantity of water for other users to recover from the Somersby area. In the longer term, ie. beyond the end of the operational life of the Somersby Fields Project, the amount of annual drawdown would be approximately 12ML/year.

The predicted groundwater seepage of 30ML/year is well within the allocation provided by WAL 11271 (37ML/year).

Table 4.17 sets out the status of the project with respect to the aims, objectives and principles of the various State Government Groundwater Plans and Policies previously discussed in Section 4.2.6.

4.2.11 Monitoring and Documentation

4.2.11.1 Surface Water

All surplus water is intended to flow from the Project Site through (or around) Dam A. It is therefore proposed that the following program of surface water monitoring is undertaken.

(i) Monthly monitoring of pH and electrical conductivity is proposed within Dams A and D together with event-related measurements of total suspended solids, ie. when water is flowing from Dam A.

(ii) In addition to the collection of data from Dam A, the Proponent would collect samples opportunistically from elsewhere on the Project Site to assist to better understand the rate of settlement of the various clays on the Project Site.

4.2.11.2 Groundwater

As discussed in Section 4.2.5.2, an important component of the ongoing management of the groundwater resources would be the monitoring of both groundwater levels and water quality. The Proponent is committed to a monitoring program which would involve the following.

(i) Baseline measurement of available drawdown and yield at representative groundwater pumping bores located within 800m of the Project Site Boundary. The number and location of these baseline measurements would be determined following approval of the project and include considerations such as permissibility of access, predicted impact, proximity of other bores at similar pump heights etc.

(ii) Installation of four monitoring bores around the perimeter of the Project Site (see **Figure 4.14**) and installation of data loggers in four permanent monitoring wells. Data loggers would be downloaded every month to allow for evaluation of water table trends.

Table 4.17
Assessment of Proposal in Accordance with State Government Groundwater Plans and Policies

Page 1 of 2

Clause from Water Sharing Plan	**Comments**
36 – Extraction interference between neighbours	
36(1) To minimise interference between extraction under different access licenses in each groundwater source, the following rules will apply to extraction authorised by an access license: *(a) extraction from a new or replacement water supply work (bore) for the extraction of basic landholder rights will not be permitted within: (i) 50m of the property boundary or, (ii) 100m of an approved water supply work (bore) from which basic landholder rights may be extracted. (b) extraction from a new or replacement water supply work (bore) nominated by an access licence will not be permitted within: (i) 400m of an approved water supply (bore) nominated by an access license, (ii) 200m of an approved water supply (bore) from which basic landholder rights water may be extracted or (iii) 50m of the property boundary.*	The proposed operational area is located within 50m of the property boundary and therefore does not satisfy the requirements of parts (a) and (b) of clause 36(1). A hydrogeological study was undertaken to assess the potential for adverse impact in accordance with clause 36 (2).
(2) Not withstanding the provisions of subclause (1), the Minister may, upon application by an access licence holder, vary the distance restrictions specified in subclause (1) if:	
(a) a hydrogeological study undertaken by the licence holder, and assessed as adequate by the Minister, demonstrates minimal potential for adverse impact on existing licensed extraction,	A hydrogeological study has been completed. The impact assessment is presented in RCA Australia (2006) Section 8.
(b) the applicant has sought written comment from the potentially affected licence holders, and submits these comments to the Minister for consideration, ***and*** *(c) there is a process for remediation in the event that any local impact occurs in the future, specified as conditions in the licence.*	Discussions have been held with potentially impacted land and licence holders regarding the potential drawdown of their bore or spring. The Proponent has provided written undertakings to each land owner/licence holder to mitigate any reduction in the availability of groundwater. A Water Management Plan has been developed for use during operations (Cardno Willing (2006) – Section 7).
(3) Subclause(1) does not apply to extraction under existing access licences until such time as the relevance water supply work (bore) is replaced.	This subclause is not applicable to this project.
(4) The maximum authorised extraction resulting from extraction authorised by a new access licence nominating a water supply work (bore) at a particular location, on the operation of Part 11 of this Plan, is not to exceed 200ML/yr per sqkm	No dedicated groundwater extraction is proposed. The predicted inflow to the groundwater operations is only 35% of the maximum permitted under the WSP.

Table 4.17 (Cont'd)
Assessment of Proposal in Accordance with State Government Groundwater Plans and Policies

Page 2 of 2

Clause from Water Sharing Plan	Comments
36 – Extraction interference between neighbours	
(5) Pursuant to Section 45(1) (b) of the Act, the Minister may amend the maximum extraction density established in subclause(4) if change is required as a result of further studies undertaken by the minister.	Not required
(6) Any change to the maximum extraction density result from subclause (5) is to be within the range of 12ML/year per sqkm to 200 ML/year per sqkm	Not required
39 Protection of Groundwater Dependent Ecosystems	
(1) Extraction of groundwater from a new or replacement water supply work (bore) for any purpose, is excluded within 100m of:	An evaluation of Groundwater Dependent Ecosystems has been undertaken by Robert Payne – Ecological Surveys and Management (2006).
(a) high priority groundwater dependent ecosystems listed in schedule 5 and shown in Appendix 4	An evaluation of Groundwater Dependent Ecosystems has been undertaken by Robert Payne – Ecological Surveys and Management (2006)
(b) culturally significant sites, being areas of high conservation value for cultural reasons, as contained in the National Parks and Wildlife Service's or Cultural Site Register, or	No sites within 1.5km of the Project Site.
(c) any river	There are no rivers in close proximity to the Project Site.
(2) Where an applicant can demonstrate to the Minister that the distance conditions in subclause (1) cannot be met, the minister may consider the application providing the following construction criteria can be met:	
(a) the water supply work (bore) must only draw water from an aquifer at depths greater than 40m from the land surface;	This clause is not relevant
(b) the water supply work (bore) must have an impermeable seal, as specified by the minister, constructed within the bore to isolate aquifers above 40m depth and to prevent water ingress and	This clause is not relevant
(c) the water supply work (bore) must comply with any access licence and water supply work approval conditions established to mitigate any risk to groundwater dependent ecosystems	An evaluation of groundwater dependent ecosystems is presented in Robert Payne – Ecological Surveys and Management (2006).
(3) Pursuant to section 45(1) (b) of the Act, the Minister may amend the exclusion of distance in subclause (1) and (2), based on further studies of groundwater ecosystems dependency undertaken by the Minister.	An evaluation of groundwater dependent ecosystems is presented in Robert Payne – Ecological Surveys and Management (2006).
Source: Modified after RCA Australia (2006) – Table 17	

(iii) Establish baseline spring yields and zones at all springs identified within 800m of the Project Site (see **Figure 4.9**).

(iv) Quarterly monitoring of available drawdown in representative bores located within 800m of the Project Site boundary, including bores with identified impact, GW052771 and GW023091 (see **Figure 4.9**).

(v) Quarterly water quality monitoring of pH and electrical conductivity is also recommended in all four permanent monitoring bores (see **Figure 4.14**).

(vi) Annual monitoring of water quality including pH, Electrical Conductivity (EC), Ion Balance, Total Petroleum Hydrocarbons (TPH), Benzene, Toluene, Ethylbenzene, Xylenes (BTEX), Polycyclic Aromatic Hydrocarbons (PAH), Heavy Metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn).

(vii) Evaluation and monitoring of any additional bores that are identified to be impact and make good any proven deleterious impacts on available drawdown and yield in both groundwater bores and springs.

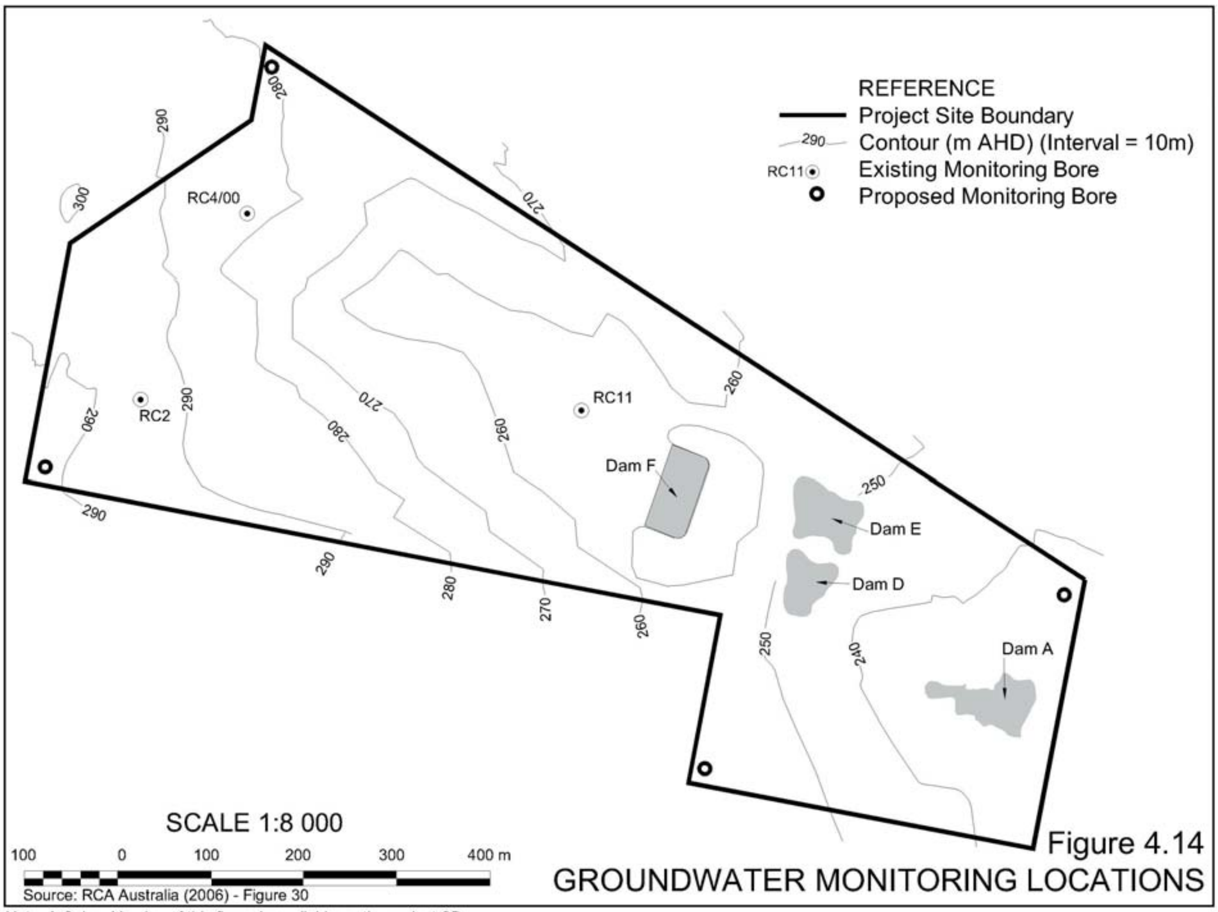


Figure 4.14
GROUNDWATER MONITORING LOCATIONS

Note: A Colour Version of this figure is available on the project CD

All monitoring data would be assembled and reviewed on a quarterly basis. A quarterly summary of data relevant to each bore would be provided to the respective land owners. All results would be presented (and evaluated) in each annual environmental management report.

The frequency of monitoring would be periodically reviewed throughout the life of the project to ensure only meaningful data is being collected.

4.3 NOISE

4.3.1 Introduction

The following section presents a summary of the noise assessment conducted for the Somersby Fields Project by Heggies Pty Ltd (Heggies, 2006a). The objectives of the assessment were to describe the existing noise climate surrounding the Project Site, identify the potential impacts of noise from the proposed project activities and to identify a range of design and operational safeguards to limit the noise impacts of the project.

The noise assessment conducted by Heggies (2006a) was undertaken with reliance placed upon the following documents.

- On-site Construction Noise Emissions: in accordance with the EPA's *Environmental Noise Control Manual* (ENCM), (EPA, 1994), Chapter 171 Noise Control Guideline – Construction Site Noise.
- On-site Operational Noise Emissions: in accordance with the NSW EPA's *Industrial Noise Policy* (INP), (EPA, 2000) for setting acceptable $L_{Aeq(15minute)}$ intrusive and $L_{Aeq(period)}$ amenity noise levels for various receiver categories as well as guidelines for assessing noise impacts from on-site noise sources.
- Off-site Road Traffic Noise Emissions: in accordance with the NSW DEC's *Environmental Criteria for Road Traffic Noise* (ECRTN), (DEC, 1999).
- Cumulative Noise Emissions: in accordance with the INP.
- Sleep Disturbance: in accordance with the DEC's most recent policy, as the emergence of the $L_{A1(60second)}$ level above the $L_{A90(15minute)}$ level at the time.

The full assessment report of Heggies (2006a) is presented as Part 7 in Volume 2 of the *Specialist Consultant Studies Compendium*.

4.3.2 Environmental Noise Control General Objectives

The responsibility for the control of noise emissions in New South Wales is vested in local government and the Department of Environment and Conservation (DEC). The DEC (as the former Environment Protection Authority) released the Industrial Noise Policy (INP) in January 2000. The INP provides a framework and process for deriving noise criteria for projects and licences that would enable the DEC to regulate premises that are scheduled under the *Protection of the Environment Operations Act 1997* (POEO Act). The project would be scheduled under the POEO Act.

The policy objectives of the INP relevant to the Somersby Fields Project are to:

(i) establish noise criteria that would protect the community from excessive intrusive noise and preserve amenity for specific land uses;

(ii) use the criteria as the basis for deriving project-specific noise levels;

(iii) promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;

(iv) outline a range of mitigation measures that could be used to minimise noise impacts;

(v) provide a formal process to guide the determination of feasible and reasonable noise limits for approvals or licences that reconcile noise impacts with the economic, social and environmental considerations of industrial development; and

(vi) carry out functions relating to the prevention, minimisation and control of noise from premises scheduled under the POEO Act.

The DEC also relies upon relevant sections of the ENCM to assess the acceptability of projects, particularly with respect to construction noise.

4.3.3 Existing Noise Climate

4.3.3.1 Surrounding the Project Site

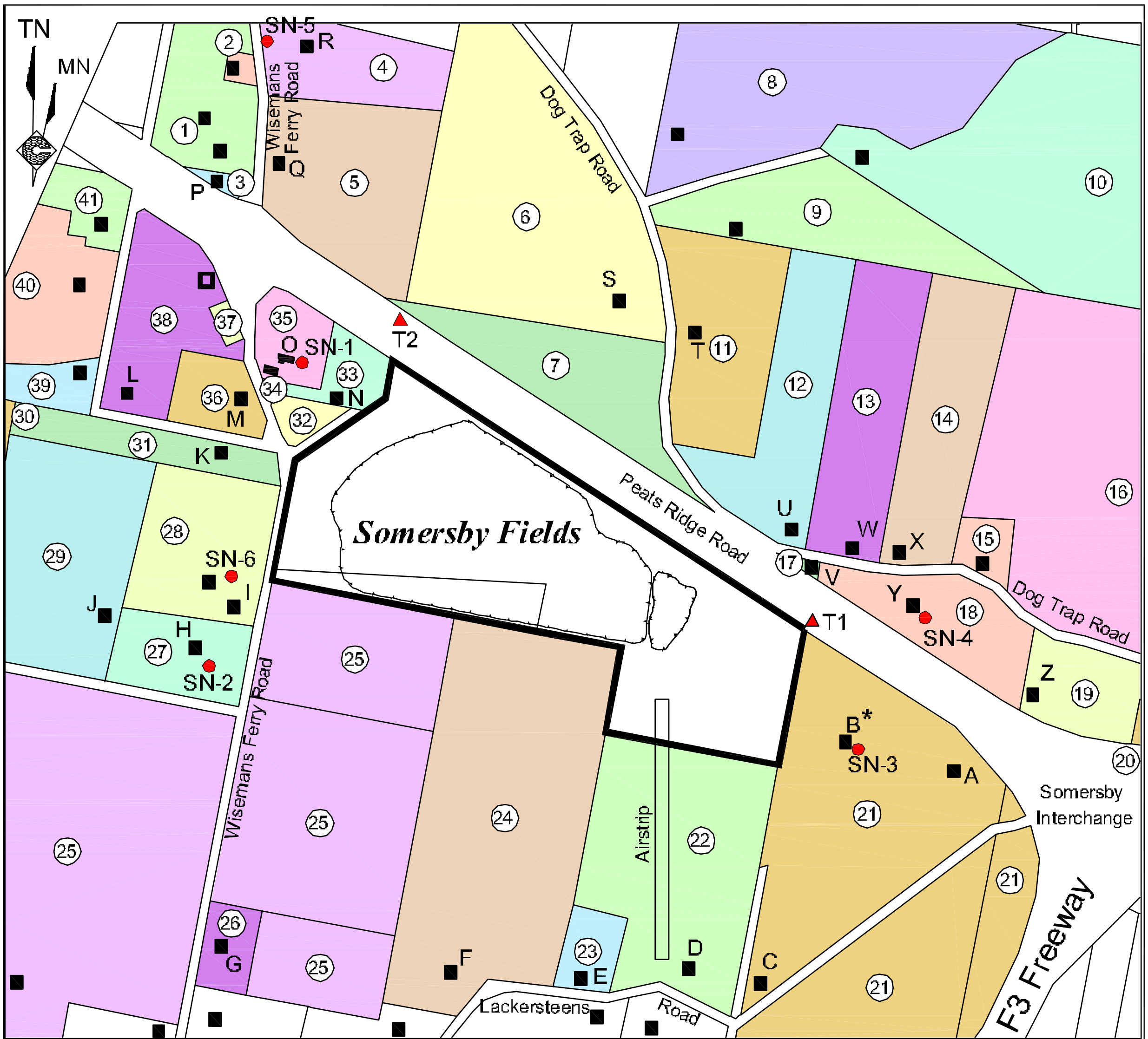
Heggies (2006a) conducted background noise surveys in August/September 2005 in order to characterise and quantify the acoustical environment in the area surrounding the Project Site. Unattended monitoring was undertaken at five representative locations surrounding the Project Site (SN-1, SN-2, SN-3, SN-4 and SN-6 – see **Figure 4.15**) for up to 19 days with operator-attended monitoring performed at these and an additional location (SN-5) during this period. Operator-attended monitoring was also conducted at two locations near the eastern and western boundaries of the Project Site adjacent to Peats Ridge Road (Sites T1 and T2 on **Figure 4.15**) on Friday, 16 September 2005 to determine the existing traffic noise levels from the road.

Table 4.18 presents the noise data processed in accordance with the requirements of the INP in order to derive the background and industrial amenity noise environment at the representative locations.

Table 4.18
Background and Industrial Amenity Noise Environment
(dB(A) re 20 μPa)

Location*	Rating Background Level[1,2,3] All Noise Sources dB(A)			$L_{Aeq(Period)}$[3] All Noise Sources dB(A)			Estimate $L_{Aeq(Period)}$[3] Industrial Noise Amenity dB(A)		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
O – SN1	41[4]	NA	NA	55[4]	NA	NA	<39[4]	NA	NA
	40	33	30	67	48	46	<44	<39	<34
H – SN2	34	34	30	47	44	41	<44	<39	<34
B – SN3	41	45	43	52	51	50	<44	<39	<34
Y – SN4	38	37	32	52	51	51	<44	<39	<34
I - SN6	36	41	37	54	48	47	<44	<39	<34

Note 1: Measured noise levels less than 31dB(A) may have a signal to noise ratio less than 5dB(A)
Note 2: In accordance with the NSW INP (if the RBL is below 30dB(A), then 30dB(A) is the assumed RBL)
Note 3: Daytime: 7:00am to 6:00pm, Evening: 6:00pm to 10:00pm and Night-time: 10pm to 7am
Note 4: Indices for learning periods only (ie. 9:00am to 3:00pm Monday to Friday excluding breaks)
NA = Not Applicable
Source: Heggies (2006a) – Table 6 * See **Figure 4.15**



Reference	Owner
1	P. & R. Tate
2	J. & J. O'Toole
3	P. & S. Moore
4	Coachwood Nurseries Pty Ltd
5	G. & P. Radford
6	G. & H. Rose
7	M. & N. Ozbaglar
8	J. & C. McLuckie
9	G. & T. Morris
10	E. & G. Ireland
11	R. Fischer
12	F. & V. Knutson
13	P. & S. Martin
14	S. Bromfield
15	E. Grant, S. & P. Drew
16	A. Smith & P. McLoughlin
17	L. & N. Douglass
18	C. & R. Sultana
19	T. & V. Lamb
20	C. & P. Gilbert
21	Minister of Agriculture & Rural Affairs
22	A. Gregory
23	I. Scott
24	D. Ross
25	Wytown Pty Limited
26	B. & J. Thompson

Reference	Owner
27	R. & S. Weller
28	R. Thompson, B. Thompson & S. Jarvis
29	G. Williams, T. & C. Underwood, G. & H. Taylor
30	A. & A. Korogiannis
31	K. & L. Hawker & J. Woods
32	Minister for Lands
33	B. & L. Daniel
34	H. Chivers, A. Hoipo, E. Goldswain, M. Hunter & D. Studds
35	Minister for Education
36	S. & M. Cahill
37	N. Stapleton
38	W. & I. Raddatz
39	D. & B. Lyon
40	B. & S. Arms
41	C. & M. Smith

REFERENCE
Project Site Boundary
Residence
Commercial
SN-4 Background Noise Monitoring Site
T1 Traffic Noise Monitoring Site
Cadastral Boundary
*Note: Location of Planned Residence

SCALE 1:15 000
250 0 250 500 750 m

Figure 4.15
BACKGROUND NOISE MONITORING

A summary of the operator-attended noise monitoring is provided in Table 5 of Heggies (2006a).

4.3.3.2 Traffic Noise

Based on the attended noise monitoring undertaken, together with the traffic counts recorded during the surveys, Heggies (2006a) predicted the existing traffic noise levels at Locations B, V and Y (ie. residences adjacent to Peats Ridge Road) (see **Table 4.19**).

Table 4.19
Predicted Existing Traffic Noise Levels from Peats Ridge Road

Time	Predicted Existing $L_{Aeq(1hour)}$ – dB(A)		
	B – Somersby Field Station Proposed Residence 200m from Peats Ridge Road	Residence V L. & N. Douglass 70m from Peats Ridge Road	Residence Y C. & R. Sultana 120m from Peats Ridge Road
Early Morning – 5:00am to 6:00am	46.9	53.8	50.3
Early Morning – 6:00am to 7:00am	49.7	56.6	53.0
Morning Peak – 8:00am to 9:00am	51.2	58.2	54.6
Afternoon Peak – 3:00pm to 4:00pm	52.2	59.1	55.6
Evening – 6:00pm to 7:00pm	48.3	55.2	51.6
Evening – 7:00pm to 8:00pm	46.0	52.9	49.4
Evening – 8:00pm to 9:00pm	44.0	50.9	47.3
Evening – 9:00pm to 10:00pm	43.1	50.1	46.5

Note: Shaded cells are higher than the relevant daytime (7:00am to 10:00pm) or night-time (10:00pm to 7:00am) criteria nominated in ECRTN
Source: Heggies (2006a) – Table 9

4.3.4 Environmental Noise Criteria

4.3.4.1 Introduction

The assessment of impacts of the proposed Somersby Fields Project upon the local noise climate has been undertaken by calculating likely noise levels under a range of construction and operational scenarios and comparing those noise levels against the noise criteria established through reference to:

(i) the INP – for site operational noise;

(ii) relevant sections of the ENCM – for site construction activities; and

(iii) the existing noise climate established at a number of surrounding assessment locations, namely the potentially most affected residences (see **Figure 4.15**).

4.3.4.2 Construction Noise Criteria

The proposed Somersby Fields Project would require construction works including tree clearing, topsoil removal, road construction, construction of the sand processing plants, construction of acoustic earth mounds and bund walls, construction of sediment dams and water storages and installation of offices, amenities and services to the Project Site. It is anticipated that this construction activity would occur within the initial 6 months of the life of the project and as such the following criteria, as outlined in the ENCM, apply.

(i) $L_{A10\ (15\ minute)}$ restricted to RBL + 10dB(A) during daytime period only.

Table 4.20 presents the construction noise criteria at nine representative residences and Somersby Public School ("assessment locations") surrounding the Project Site.

Table 4.20
INP Project Specific Noise Assessment Criteria

Assessment Location*	Project Specific Assessment Criteria							
	Construction $L_{A10(15minute)}$	Intrusive $L_{Aeq(15minute)}$			Amenity $L_{Aeq(Period)}$			Sleep Disturbance $L_{A1(60second)}$
	Day	Day	Evening	Night	Day	Evening	Night	
B Department of Primary Industries	51	46	50	48	50	45	40	55
E I. Scott	51	46	50	48	50	45	40	55
H R. & S. Weller	44	39	39	35	50	45	40	50
I Thompson & Jarvis	46	41	46	42	50	45	40	55
N B. & L. Daniel	50	45	38	35	50	45	40	50
O Somersby Public School	51	46[1,2]	NA	NA	45[1,2,3]	NA	NA	N/A
R Coachwood Nurseries Pty. Ltd.	48	43	42	37	50	45	40	52
S D. Studds	48	43	42	37	50	45	40	52
V L. & N. Douglass	48	43	42	37	50	45	40	52
Y C. & R. Sultana	48	43	42	37	50	45	40	52

Note 1: During learning hours only NA = Not Applicable
Note 2: Assuming 10dB(A) insertion loss from outside to inside
Note 3: $L_{Aeq\ (15\ minute)}$ (1hour) criterion for the noisiest 1-hour period when in use (from NSW DEC's INP Table 2.1)
Note 4: Shaded criteria are controlling Project Specific Noise Levels
Source: Modified after Heggies (2006a) –Tables 12 & 20 * see **Figure 4.15**

4.3.4.3 Operational Noise Design Criteria

The environmental noise criteria for the operation of the Somersby Fields Project needs to consider both the "intrusiveness" criterion which limits $L_{Aeq(15minute)}$ noise levels from industrial sources to RBL + 5dB(A), and the "amenity" criterion which considers cumulative noise impacts in areas with competing industrial noise sources. As the background noise in the area surrounding the Project Site is controlled by rural sources and traffic noise, the "amenity" criteria at the residences surrounding the Project Site have been set using the $L_{Aeq(15minute)}$ (period) contribution from industrial noise (See **Table 4.20**) in conjunction with Table 2.1 of the INP.

The INP-based noise intrusive and amenity assessment criteria at nine of the nearest residences ("assessment locations") are presented in **Table 4.20**. At each location, the controlling noise assessment criteria (ie. lowest value) is identified. These criteria are nominated for the purposes of assessing potential noise impacts from the various activities to be conducted at the proposed Somersby Fields Project.

4.3.4.4 Sleep Disturbance Design Criteria

Appropriate criteria for sleep disturbance is determined to be an $L_{A1(60second)}$ level 15dB(A) above the Rating Background Level (RBL) for the night-time period (10:00pm to 7:00am). **Table 4.20** presents the INP-based noise assessment criteria for sleep disturbance at nine of the nearest residences ("assessment locations").

The INP criteria have been selected to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Hence, provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

4.3.4.5 Traffic Noise Design Criteria

Based on the ECRTN, Peats Ridge Road is classified as a "collector" road and the applicable noise criteria are presented in **Table 4.21**.

Table 4.21
ECRTN Traffic Noise Assessment Criteria

Road	Policy	Assessment Criteria	
		Daytime $L_{Aeq(1hour)}$	Night-time $L_{Aeq(1hour)}$
Peats Ridge Road	Land use developments with the potential to create additional traffic on collector roads	60dB(A)	55dB(A)

It is noted that in those cases where the nominated criteria is already exceeded or within 2dB(A) of the criteria eg. Assessment location V of L & N Douglass where night-time noise between 6:00am and 7:00am is 56.6dB(A), traffic associated with the development should not lead to an increase in the existing noise traffic levels of more than 2dB(A).

4.3.4.6 Cumulative Noise Impacts

The INP incorporates an objective requiring the $L_{Aeq\ (period)}$ amenity level (ie. non-transport-related) not to exceed the specified acceptable or maximum noise level appropriate for the particular locality and land use. The policy aims to restrict the potential cumulative increase in amenity noise levels, otherwise known as “background creep”. Cumulative noise levels generated by the simultaneous operation of more than one quarry or other industrial noise sources is assessed against the acceptable and maximum noise amenity criteria as there is no established procedure (or regulatory requirement) to derive intrusive $L_{Aeq\ (15\ minute)}$ (15minute) noise criteria for the cumulative operation of existing and/or approved developments in a locality.

Table 4.22 lists the project-specific noise assessment criteria for the cumulative noise impact assessment for the Somersby Fields Project.

Table 4.22
INP Project Specific Noise Assessment Criteria (dB(A) re 20µPa)

Assessment Location	Land Use	Project Specific Assessment Criteria					
		Amenity $L_{Aeq(period)}$[1] Acceptable			Amenity $L_{Aeq(period)}$[1] Maximum		
		Daytime	Evening	Night-time	Daytime	Evening	Night-time
B: Department of Primary Industries	Rural	50	45	40	55	50	45
E: I. Scott	Rural	50	45	40	55	50	45
H: R. & S. Weller	Rural	50	45	40	55	50	45
I: Thompson & Jarvis	Rural	50	45	40	55	50	45
N: B. & L. Daniel	Rural	50	45	40	55	50	45
O: Somersby Public School	School Classroom	45 [2,3]	N/A	N/A	50 [2,3]	N/A	N/A
R: Coachwood Nurseries Pty. Ltd.	Rural	50	45	40	55	50	45
S: D. Studds	Rural	50	45	40	55	50	45
V: L. & N. Douglass	Rural	50	45	40	55	50	45
Y: C. & R. Sultana	Rural	50	45	40	55	50	45

Note 1: Daytime 7:00am to 6:00pm, Evening 6:00pm to 10:00pm and Night-time 10:00pm to 7:00am
Note 2: Assuming 10dB(A) insertion loss from outside to inside
Note 3: $L_{Aeq(1hr)}$ criterion for the noisiest 1-hour period when in use
Source: Heggies (2006a) – Table 21

4.3.5 Project Noise Controls

The project has been designed with an objective to minimise the noise generated by construction, sand removal and processing activities as well as the transportation of sand products from the Project Site. This sub-section summarises the design features and operational safeguards of the site establishment, operational and transportation activities of the project to meet this objective.

Design Features

- The project has been designed as a two staged development to allow for project performance during Stage 1 to be evaluated prior to the commencement of operations in the second stage, which is generally closer to a number of residences and Somersby Public School. Monitoring would be undertaken to review the performance of the project against the nominated noise criteria and model predictions of Heggies (2006a), and project noise controls or mitigation measures updated or improved should the monitoring indicate exceedances of noise criteria.
- The wash plant would be completely enclosed and located within the centre of the proposed area of disturbance, ie. generally equidistant from the northern and southern boundaries and marginally closer to the eastern boundary of the sand removal area.
- The washed sand products would be stockpiled up to 10m high in a horseshoe shape. This would provide further noise attenuation of the wash plant operation and product truck loading operations.
- A number of acoustic earth mounds, bunds and noise walls would be constructed in the following locations as part of construction activities (see **Figure 4.16**).

  (i) Northeastern Barrier – a barrier of 5m total height on the northeastern perimeter of the Project Site following the sand removal boundary and extending from 70m east of the site access road to the boundary between Stage 1/1 and Stage 1/2. This barrier would comprise a fence-like structure.

  (ii) Far-western Barrier – a barrier of 5m total height following the entire western boundary of Stage 2/1, Stage 2/2 and the northern half of Stage 2/3, and then rising to 6m total height for the remaining southern half of the western boundary of Stage 2/3. This barrier would comprise an earth mound typically 3m to 4m high and a 2m high acoustic barrier fence.

  (iii) Mid-western Barrier – an interim noise barrier of 5m total height following the entire western boundary of Stage 1/7, Stage 1/8 and Stage 1/9. This barrier would also be a fence-like structure constructed predominantly with relocated sections of the Northeastern barrier once the need for that barrier has passed, ie. after the conclusion of sand removal operations in Stage 1/6.

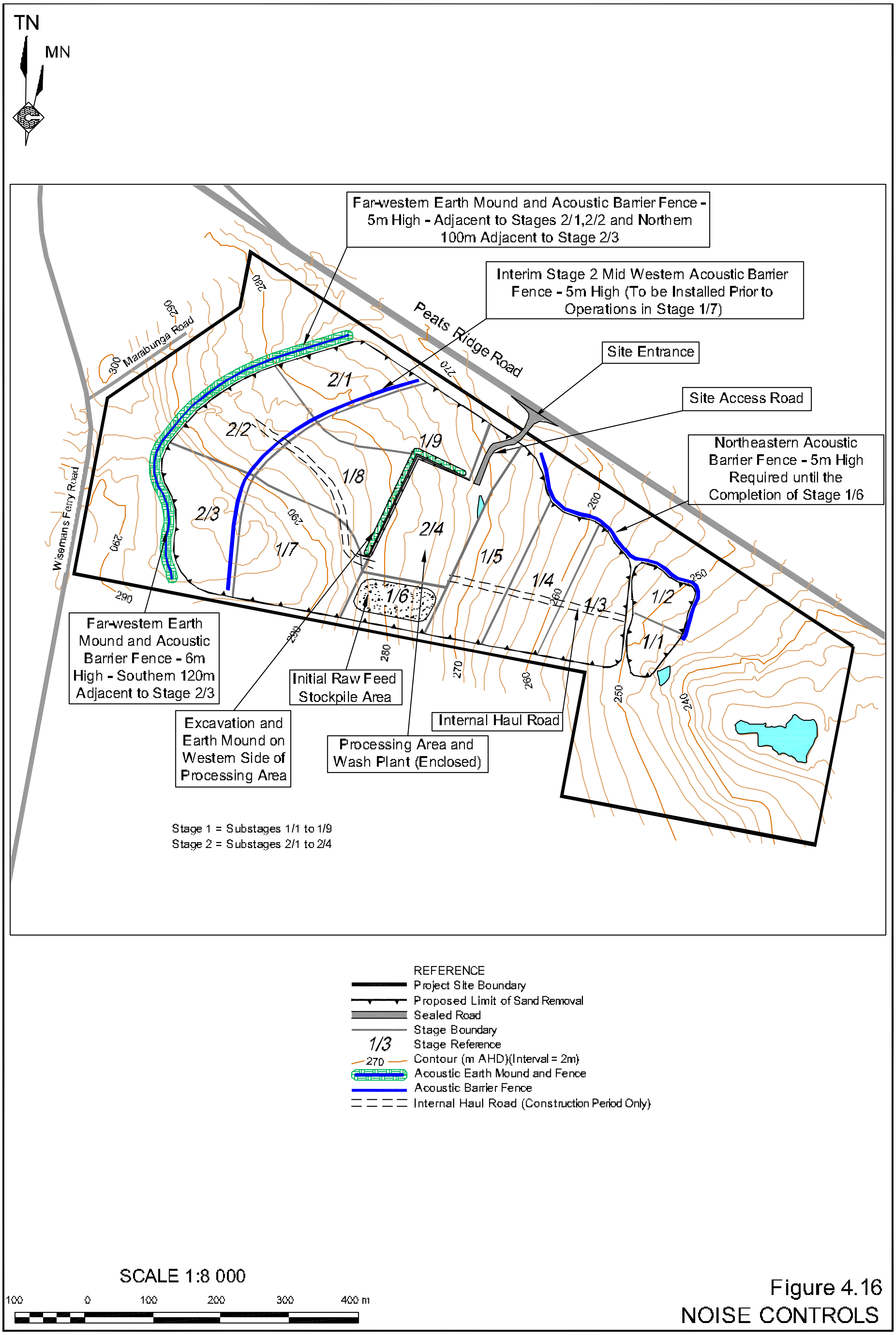


Figure 4.16
NOISE CONTROLS

- In addition, if the bulldozer is operating near surface level and is required to rip consolidated sand material in a particular area, a localised earth mound would be formed around the area in which the bulldozer is working.
- The number of truck movements associated with the project would be restricted during the early morning period (5:00am to 7:00am) to those predicted in Section 4.3.6.6 to result in noise levels compliant with the project traffic noise criteria.
- A D8 bulldozer would be used to undertake all necessary pushing and related activities in the upper 5m of the sand removal area, rather than a D10 bulldozer that can be used at depths >5m when there is a greater degree of shielding and noise attenuation.

Operational Safeguards

- All hours of operation presented in Section 2.8.2 would be strictly adhered to.
- All equipment on site would be regularly serviced to ensure sound power levels of each item remains at or below that nominated for noise modelling purposes (see Heggies, 2006a – Appendix C). The internal road network would be graded as required to limit body noise from empty trucks.
- Noise monitoring would be undertaken at nearby residences and the results and performance of the site operations discussed with local residents and landholders. Monitoring is further discussed in Section 4.3.7.2.
- Noisy plant operating simultaneously close together would be avoided wherever possible.
- Maintenance work on all plant and equipment would be carried out away from noise sensitive areas and be confined to standard daytime construction hours or daytime operational hours where practicable. Any inaudible maintenance could be undertaken beyond these core hours.

Section 8 of Heggies (2006a) provides additional noise controls and mitigation measures that would be adopted in the event monitoring indicated noise levels above those predicted by in Section 4.3.6.4.

4.3.6 Assessment of Impacts

4.3.6.1 Introduction

In order to assess the potential impact of noise generated by the proposed Somersby Fields Project, five operational scenarios, representing worst-case site establishment / construction and operational situations were modelled by Heggies (2006a). The predicted noise levels that would be received at the closest residences under these scenarios are presented and represent the conclusion of an iterative process involving a number of modifications to the proposed operating strategy and implementation of additional safeguards and management measures. The modelling results are assessed against the Project Site specific noise assessment criteria (see **Table 4.20**) and the impacts assessed.

4.3.6.2 Assessment Methodology

Construction and Operational Noise

Heggies (2006a) developed a computer model using the Sound PLAN V6.3 Industrial Module to incorporate the significant noise sources, prevailing and adverse meteorological conditions and topographical features of the Project Site and surrounding areas to predict the noise received at the assessment locations surrounding the Project Site. Five scenarios were modelled with the noise generating activities relevant to each scenario presented in **Table 4.23**.

Table 4.23
Modelled Scenarios

Scenario	Description	Activities
1	Site Establishment / Construction	Construction of site access road and site infrastructure, sediment control dams,, excavation of Dam D, wash plant erection, vegetation removal and far-western earth mound construction.
2	Stage 1 (east of wash plant) operations at surface level	Sand removal in Stage 1/3, topsoil stripping in Stage 1/4 sand haulage to wash plant, wash plant operation, product truck loading in wash plant area.
3	Stage 1 (west of wash plant) operations at surface level	Sand removal in Stage 1/9, bulldozer operations in Stage 1/8, sand haulage to wash plant, wash plant operation, product truck loading in wash plant area.
4	Stage 2 operations at surface level	Sand removal in Stage 2/1, topsoil stripping in Stage 2/2, sand haulage to wash plant, wash plant operation, product truck loading in wash plant area.
5	Stage 2 operations at 10m below surface level	Sand removal in Stage 2/2, bulldozer ripping operations in Stage 2/2, sand haulage to wash plant, wash plant operation, product truck loading in wash plant area.
Source: Heggies (2006a) – Section 5		

The modelling included all the proposed plant items operating concurrently in order to simulate the overall maximum energy equivalent, ie. the maximum $L_{Aeq\,(15\,minute)}$ intrusive noise level. The results of the five modelled scenarios therefore, represent the scenarios on site with the greatest potential to affect surrounding noise-sensitive receivers.

Noise emissions would often be lower than those predicted due to sand removal operations working below the level nominated in each scenario and some items of plant and equipment not being used concurrently. As such, the modelled scenarios represent 'worst-case' situations with compliance under these conditions indicating the ability of the project generally to comply with the nominated noise criteria.

Sleep Disturbance

As $L_{A1(60second)}$ noise levels have been demonstrated to be typically <10dB(A) greater than $L_{Aeq(15minute)}$ levels for operations similar to the project (Heggies, 2006a), compliance with the intrusive criterion (background plus 5dB(A)) would also result in compliance with the sleep disturbance criteria.

Traffic Noise

The US Environment Protection Agency's method was used for the prediction of the L_{Aeq} noise levels for the offset distances of the various residences setback from Peats Ridge Road.

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

Cumulative Noise

The only operation in the vicinity of the Somersby Fields Project Site that needs to be considered in terms of cumulative noise impacts is the Rindean Quarry, located approximately 1.2km south of the proposed area of sand removal on the Project Site (**Figure 4.5b**). The Rindean Quarry is currently not operational but as discussed in Section 4.1.4.4, the re-development of the quarry has been conditionally approved by Council. A worst case cumulative impact scenario was assessed by adding the anticipated intrusive noise limits from the Somersby Fields Project, together with the anticipated intrusive noise levels from the Rindean Quarry (as calculated from predicted noise levels reported by Atkins Acoustics and Associates Pty Ltd, in "Environmental Noise Assessment – Sand Extraction – Rindean Quarry, Somersby" – in Pacrim, 2004).

The cumulative intrusive level is then adjusted to the equivalent amenity level for comparison with the criteria presented in **Table 4.22**.

Management of Predicted Noise Levels Exceeding Established Criteria

In those cases where the Project Site specific noise criteria are exceeded, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedance of the Project Site specific noise criteria can be described as follows.

- Negligible noise level increase (<1dB(A)) – Not noticeable by all people.
- Marginal noise level increase (1dB(A) to 2dB(A)) – Not noticeable by most people.
- Moderate noise level increase (3dB(A) to 5dB(A)) – Not noticeable by some people but may be noticeable by others.
- Appreciable noise level increase (>5dB(A)) – Noticeable by most people.

For either a marginal or moderate noise level increase, the DEC recognises a noise management zone would apply. For any residence(s) that lie within the noise management zone, management procedures could include the following.

- Noise monitoring to verify the degree of exceedance.
- Discussions with relevant land owners.
- Consideration of mitigation measures at residences, where noise levels are substantiated by monitoring results.

For an appreciable noise level increase, the DEC recognises a noise affectation zone would apply. For any residence(s) that lie within the noise affectation zone, management procedures would include the following.

- Discussions with relevant land owners.
- Installation of noise mitigation at residences.
- Negotiated agreements.

It is noted that management of predicted noise exceedances discussed above is relevant to the operational stages of the project.

4.3.6.3 Results – Site Establishment / Construction Noise

The predicted noise levels generated by site establishment / construction activities at the assessment locations are presented in **Table 4.24**. The results for construction noise have been further categorised for either the operation of the D8 bulldozer at specific locations, or the completion of all other works.

Table 4.24
Predicted Construction Noise Levels – dB(A)

Assessment Location*	Predicted $L_{A10(15minute)}$ Noise Level – Bulldozer Only Located at: Far-western Bund[1]	Processing Plant[1]	Dam E[1]	Other Works[1,2]	Criteria	Noise Assessment
B: Department of Primary Industries	27	32	41	48	51	Below Criteria
E: I. Scott	22	30	32	42	51	Below Criteria
H: R. & S. Weller	25	20	15	26	44	Below Criteria
I: Thompson & Jarvis	29	23	15	27	46	Below Criteria
N: B. & L. Daniel	59	43	33	47	50	Appreciable Exceedance
O: Somersby Public School	51	39	31	44	51	Equals Criteria
R: Coachwood Nurseries Pty. Ltd.	32	29	15	32	48	Below Criteria
S: D. Studds	36	38	26	46	48	Below Criteria
V: L. & N. Douglass	30	35	36	45	48	Below Criteria
Y: C. & R. Sultana	27	31	40	48	48	Equals Criteria

Note 1: Northeastern noise barrier included in calculation
Note 2: Far-western earth mound included in calculation
Note 3: Shaded cell indicate levels above criteria
Note 4: Hatched cell indicates level equal to criteria
* See **Figure 4.15**
Source: Modified after Heggies (2006a) – Table 15

The noise modelling indicates that noise emissions from site establishment / construction activities generally comply with the respective criteria at the assessment locations.

During the construction of the far-western earth mound, the $L_{A10(15minute)}$ noise emissions from the bulldozer working in this area may be up to 9dB(A) higher than the nominated criteria at assessment location N (B. & L. Daniel). It is noted from **Table 4.24** that the predicted construction noise level at Location O (Somersby Public School) would equate with the daytime criterion, principally due to the noise associated with the construction of the far-western earth mound. As the construction of this bund is to take place during a school holiday period, any potential learning disruption due to this activity will not be an issue.

The Proponent would discuss the predicted exceedances with Mr & Mrs Daniel and would investigate opportunities to limit the impacts during the comparatively short period of construction of the far-western earth mound.

It is also noted that the predicted noise level at Location Y (C. & R. Sultana) would also equate with the daytime criterion. The impact of the predicted noise level would be diminished given Location Y is also subject to traffic noise from Peats Ridge Road.

4.3.6.4 Results – Operational Noise

The predicted noise levels generated by the operational activities of Scenarios 2 to 5 at the assessment locations are presented in **Table 4.25a** – Scenarios 2 and 3 and **Table 4.25b** – Scenarios 4 and 5. The predicted noise levels are listed together with the relevant noise criteria (in brackets) and an assessment of impact against these criteria.

Noise at levels exceeding the operational noise criteria are predicted to occur at only one residence Location N (B. & L. Daniel), where a moderate exceedance of 5dB(A) during the daytime under Scenario 4 (Stage 2) is predicted. The predicted exceedances are representative of a worst-case situation which would not always occur. In addition, it is noted this exceedance would only occur for Scenario 4 and the exceedance is of a noise level not noticeable to all people. Therefore, given the intermittent and moderate exceedance predicted, the impact is considered acceptable. Notwithstanding this assessment, the Proponent would approach Mr & Mrs Daniel prior to the commencement of Stage 2 to identify acceptable terms for an agreement during the period when noise levels during periods of Stage 2 may be exceeded. The opportunity would exist to review noise monitoring data and the effectiveness of the various safeguards implemented during Stage 1 and the availability of any new technology to further reduce predicted noise levels at the Daniel residence.

Table 4.25a
Predicted Operational Noise Levels – dB(A)

Assessment Location	Predicted $L_{Aeq(15min)}$ Emissions (Criteria)					Noise Impact Assessment
	Day	Evening	Night			
			Calm	Wind	Inversion	
Scenario 2 (Stage 1 east of wash plant)						
B: Department of Primary Industries	38 (46)	29 (45)	29 (40)	34 (40)	33 (40)	Below Criteria
E: I. Scott	34 (46)	26 (45)	26 (40)	30 (40)	30 (40)	Below Criteria
H: R. & S. Weller	20 (39)	15 (39)	15 (35)	12 (35)	19 (35)	Below Criteria
I: Thompson & Jarvis	20 (41)	15 (45)	15 (40)	12 (40)	18 (40)	Below Criteria
N: B. & L. Daniel	37 (45)	31 (38)	31 (35)	26 (35)	34 (35)	Below Criteria
O: Somersby Public School	34 (45)	N/A	N/A	N/A	N/A	Below Criteria
R: Coachwood Nurseries Pty. Ltd.	28 (43)	21 (42)	22 (37)	15 (37)	26 (37)	Below Criteria
S: D. Studds	39 (43)	33 (42)	33 (37)	30 (37)	36 (37)	Below Criteria
V: L. & N. Douglass	42 (43)	30 (42)	30 (37)	34 (37)	34 (37)	Below Criteria
Y: C. & R. Sultana	37 (43)	29 (42)	29 (37)	33 (37)	33 (37)	Below Criteria
Scenario 3 (Stage 1 – west of wash plant)						
B: Department of Primary Industries	33 (46)	29 (45)	29 (40)	34 (40)	33 (40)	Below Criteria
E: I. Scott	32 (46)	26 (45)	26 (40)	30 (40)	30 (40)	Below Criteria
H: R. & S. Weller	23 (39)	15 (39)	15 (35)	12 (35)	18 (35)	Below Criteria
I: Thompson & Jarvis	23 (41)	15 (45)	15 (40)	12 (40)	18 (40)	Below Criteria
N: B. & L. Daniel	45 (45)	31 (38)	31 (35)	26 (35)	34 (35)	Equals Criteria
O: Somersby Public School	40 (45)	N/A	N/A	N/A	N/A	Below Criteria
R: Coachwood Nurseries Pty. Ltd.	29 (43)	21 (42)	22 (37)	15 (37)	26 (37)	Below Criteria
S: D. Studds	40 (43)	33 (42)	33 (37)	30 (37)	36 (37)	Below Criteria
V: L. & N. Douglass	36 (43)	30 (42)	30 (37)	34 (37)	34 (37)	Below Criteria
Y: C. & R. Sultana	33 (43)	29 (42)	29 (37)	33 (37)	33 (37)	Below Criteria

Note 1: Northeastern and far-western earth mounds included in calculation
Note 2: Shaded cells indicate levels above criteria
Note 3: Scenario modelled at surface level, as depth of sand removal increases, noise levels at surrounding receivers will decrease

Source: Modified after Heggies (2006a) –Tables 16 & 17

Table 4.25b
Predicted Operational Noise Levels – dB(A)

Assessment Location	Predicted $L_{Aeq(15min)}$ Emissions (Criteria)					Noise Impact Assessment
	Day	Evening	Night			
			Calm	Wind	Inversion	
Scenario 4 (Stage 2 – at surface)						
B: Department of Primary Industries	33 (46)	29 (45)	29 (40)	34 (40)	33 (40)	Below Criteria
E: I. Scott	31 (46)	26 (45)	26 (40)	30 (40)	30 (40)	Below Criteria
H: R. & S. Weller	29 (39)	15 (39)	15 (35)	12 (35)	19 (35)	Below Criteria
I: Thompson & Jarvis	36 (41)	15 (45)	15 (40)	12 (40)	18 (40)	Below Criteria
N: B. & L. Daniel	50 (45)	31 (38)	31 (35)	26 (35)	34 (35)	Moderate Exceedance
O: Somersby Public School	43 (45)	N/A	N/A	N/A	N/A	Below Criteria
R: Coachwood Nurseries Pty. Ltd.	29 (43)	21 (42)	21 (37)	15 (37)	26 (37)	Below Criteria
S: D. Studds	40 (43)	33 (42)	33 (37)	30 (37)	36 (37)	Below Criteria
V: L. & N. Douglass	35 (43)	30 (42)	30 (37)	34 (37)	34 (37)	Below Criteria
Y: C. & R. Sultana	32 (43)	29 (42)	29 (37)	33 (37)	33 (37)	Below Criteria
Scenario 5 (Stage 2 – below surface)						
B: Department of Primary Industries	31 (46)	29 (45)	29 (40)	34 (40)	33 (40)	Below Criteria
E: I. Scott	28 (46)	26 (45)	26 (40)	30 (40)	30 (40)	Below Criteria
H: R. & S. Weller	24 (39)	15 (39)	15 (35)	12 (35)	19 (35)	Below Criteria
I: Thompson & Jarvis	27 (41)	15 (45)	15 (40)	12 (40)	18 (40)	Below Criteria
N: B. & L. Daniel	43 (45)	31 (38)	31 (35)	26 (35)	34 (35)	Below Criteria
O: Somersby Public School	38 (45)	N/A	N/A	N/A	N/A	Below Criteria
R: Coachwood Nurseries Pty. Ltd.	26 (43)	21 (42)	21 (37)	15 (37)	26 (37)	Below Criteria
S: D. Studds	38 (43)	33 (42)	33 (37)	30 (37)	36 (37)	Below Criteria
V: L. & N. Douglass	34 (43)	30 (42)	30 (37)	34 (37)	34 (37)	Below Criteria
Y: C. & R. Sultana	31 (43)	29 (42)	29 (37)	33 (37)	33 (37)	Below Criteria

Note 1: Northeastern and far-western earth mounds included in calculation
Note 2: Shaded cell indicate levels above criteria
Note 3: Scenario modelled at surface level, as depth of sand removal increases, noise levels at surrounding receivers will decrease

Source: Modified after Heggies (2006a) –Tables 18 & 19

4.3.6.5 Results – Sleep Disturbance

A review of noise events from operations similar in nature to the transportation, loading and processing activities associated with the Project illustrate that the maximum, or $L_{A1(60second)}$, noise levels are typically less than 10dB(A) above the $L_{Aeq(15minute)}$ intrusive level. Hence, if the $L_{Aeq(15minute)}$ intrusive criteria (ie. background plus 5dB(A)) are achieved then the DEC's sleep disturbance criterion will also be met (Heggies, 2006a).

4.3.6.6 Results – Traffic Noise

The predicted $L_{Aeq(1hour)}$ traffic noise levels for the 450 000tpa production scenario (existing plus maximum hourly future Project traffic) are shown in **Table 4.26**, together with the maximum number of allowable project-related truck movements required to meet the 2dB(A) increase criterion.

Table 4.26
Predicted Traffic Noise Levels

Time Period	Predicted Future $L_{Aeq(1hour)}$ – dB(A)			Maximum Project Truck Movements Allowable to Remain within Criterion
	B – Somersby Field Station Proposed Residence 200m from Peats Ridge Road	Residence V L. & N. Douglass 70 m from Peats Ridge Road	Residence Y C. & R. Sultana 120 m from Peats Ridge Road	
Early Morning – 5am to 6am	48.9 [55.0]	55.8 [55.8]	52.3 [55.0]	12
Early Morning – 6am to 7am	51.7 [55.0]	58.6 [58.6]	54.8 [55.0]	22
Morning Peak – 8am to 9am	53.1 [60.0]	60.0 [60.2]	56.5 [60.0]	30
Afternoon Peak – 3:00pm to 4:00pm	53.8 [60.0]	60.7 [61.1]	57.1 [60.0]	30
Evening – 6:00pm to 7:00pm	51.4 [60.0]	57.9 [60.0]	54.3 [60.0]	24
Evening – 7:00pm to 8:00pm	49.9 [60.0]	56.8 [60.0]	53.2 [60.0]	24
Evening – 8:00pm to 9:00pm	49.2 [60.0]	56.1 [60.0]	52.5 [60.0]	24
Evening – 9:00pm to 10:00pm	48.9 [60.0]	55.9 [60.0]	52.3 [60.0]	24
Note 1: Criterion for each location and time period shown in square brackets.				
Source: Heggies (2006a) – Table 24				

This approach to the assessment of traffic noise has assisted to define the maximum number of project-related truck movements that could travel on Peats Ridge Road and not cause an unacceptable level of impact at residences fronting onto Peats Ridge Road.

4.3.6.7 Results – Cumulative Noise Impact Assessment\

The predicted cumulative noise levels that would be received at the ten assessment locations, under a worst case scenario where it is assumed both quarries simultaneously emit their maximum noise emission towards an assessment location, are presented in **Table 4.27**.

Table 4.27
Predicted Cumulative Noise Levels – $L_{Aeq(day,evening)}$ (dB(A) re 20µPa)

Location	Rindean Quarry[1]	Somersby Fields Project[1]	Cumulative Noise Amenity Level	Project Specific Assessment Criteria	
				Acceptable	Maximum
B: Department of Primary Industries	25	35	35	50	55
E: I. Scott	32	31	35	50	55
H: R. & S. Weller	25	26	29	50	55
I: Thompson & Jarvis	25	33	34	50	55
N: B. & L. Daniel	23	47	47	50	55
O: Somersby Public School	22	40	40	45	50
R: Coachwood Nurseries Pty. Ltd.	20	26	27	50	55
S: D. Studds	22	37	37	50	55
V: L. & N. Douglass	24	39	39	50	55
Y: C. & R. Sultana	23	34	35	50	55
Note 1: The worst-case noise level for any operational scenario of the Project.					
Source: Heggies (2006a) – Table 23					

At all ten noise assessment locations, the cumulative noise levels from the Project Site and Rindean Quarry comply with the relevant acceptable amenity noise criteria, ie. non-transport related.

4.3.6.8 Conclusion

Noise predictions provided by Heggies (2006a) indicate that the project would, with only one short-term exception, comply with site establishment / construction noise criteria. This exceedance would only be attributable to the construction of the far-western earth mound designed to significantly attenuate noise levels throughout the Project Site. By scheduling construction of the far-western earth mound for a school holiday period, any potential learning disruption resultant from a construction noise level of 51dB(A) would be avoided.

All operations during Stage 1 would be undertaken with noise criteria being satisfied at all residences and Somersby Public School.

During Stage 2, exceedances of noise criteria are predicted to occur at only one assessment location (owned by B. & L. Daniel), with whom the Proponent would again approach to discuss an agreement regarding the predicted periods of noise exceedances when equipment is operating at or near the surface during Stage 2 operations.

The predicted operational noise levels indicate that sleep disturbance during early morning operations is unlikely to be an issue for surrounding residents.

A review of the road traffic noise level predictions presented in **Table 4.26** indicates that truck movements would need to be restricted to those levels shown during the early morning (5:00am to 7:00am) period in order to comply with the Existing Traffic Noise Level +2 dB(A) criterion at Residence V.

Cumulative noise levels associated with the concurrent operation of the Somersby Fields Project and Rindean Quarry would be within acceptable limits of the relevant amenity criteria at each assessment location.

On the basis of the noise modelling undertaken by Heggies (2006a), and the proposed design features, operational safeguards and management measures, the site establishment / construction, operations and transportation associated with the proposed Somersby Fields Project would have limited to negligible noise impact at Somersby Public School and all but one of the surrounding residences.

4.3.7 Monitoring

4.3.7.1 Introduction

The Proponent would commit to a comprehensive program of noise monitoring, designed following discussion and consultation with neighbouring land owners and the DEC. The noise monitoring program would be designed to assist in validating noise model predictions, demonstrate compliance with noise criteria and identify the need for any additional mitigation measures prior to significant disturbance occurring or complaints being received. The following noise monitoring procedures and locations considered appropriate.

4.3.7.2 Monitoring Procedures

Three types of noise monitoring would be conducted, namely:

(i) operator-attended monitoring of near-field noise emissions from plant and equipment – essentially to confirm the sound power levels of the earthmoving equipment to be used are less than or equal to the level specified by Heggies (2006a);

(ii) operator-attended monitoring of site establishment / construction and operational noise at potentially sensitive residential locations; and

(iii) supplementary unattended and/or attended noise monitoring to identify issues of concern in response to any complaints.

The monitoring plan would be refined and updated in response to operational experience as monitoring results are evaluated.

In addition to the regular monitoring of noise at residences surrounding the Project Site, supplementary monitoring would be carried out in response to any complaints, or for the purpose of refining construction or sand removal methods or techniques to minimise noise. Monitoring would normally be operator-attended under these circumstances, in order to provide immediate feedback such that corrective action (if required) can be implemented promptly.

4.3.7.3 Monitoring Locations

The Proponent would establish a number of monitoring locations at representative locations surrounding the Project Site. In order to provide for direct comparative information, and subject to land owner's consent, monitoring is proposed at the background noise monitoring sites (SN1 to SN6) together with two additional residential locations, namely:

- Residence E adjacent to Lakersteen Road - I. Scott; and
- Residence S adjacent to Dog Trap Road - G. & H. Rose.

Both of these additional residences are shown on **Figure 4.15**.

The particular monitoring location(s) used during each monitoring event would vary depending on the proximity of construction or operational activities. For example, during site establishment and construction and when sand removal is occurring east of the sand wash plant, monitoring locations V and Y may be used. These however, would be unlikely to be included in monitoring when sand removal has progressed to the western sub-stages of Stage 1.

4.4 AIR QUALITY AND HEALTH ISSUES

4.4.1 Introduction

This section presents information on existing air quality surrounding the Somersby Fields Project Site, identifies air quality and health guidelines, goals and/or criteria relevant to the project, outlines the proposed operational safeguards, mitigation measures and management procedures and concludes with an assessment of the potential impacts the project would have upon the local air quality. Additionally, this section also addresses the presence of respirable crystalline silica in the air and the possible impacts this and other airborne particulate matter or air pollutants originating on the Project Site may have on the health of project employees and surrounding residents, Somersby Public School teachers and pupils and surrounding land users.

Activities associated with the project would result in the generation of Particulate Matter (PM), ie. airborne particles typically 0.1µm to 50µm in aerodynamic diameter. Depending upon the size and concentration of particles in the air and their composition, airborne particulate matter has the potential to affect human health and contribute to the general degradation of the environment.

The human respiratory system has a built-in defensive system that prevents particles larger than about 10µm from reaching sensitive areas of the respiratory system. Particles smaller than 10µm are referred to as PM_{10} with particles smaller than 2.5µm referred to as $PM_{2.5}$. Particles larger than 10µm can also contribute to environmental degradation and therefore the air quality assessment has also considered the total mass of particles suspended in the air, ie. Total Suspended Particulate matter (TSP). TSP larger than about 30µm which tend to settle out of the atmosphere relatively quickly, eg. Onto window sills, cars etc., are referred to as deposited dust. This section compares the likely project-related generation of TSP, deposited dust, PM_{10} (dust and silica) and $PM_{2.5}$ against existing air quality and established air quality goals and/or criteria.

An understanding of the extent of potential impact particulate matter and other air emissions generated by project activities would have on local air quality is achieved by comparing predicted and existing levels against recognised air quality goals, many of which are based on health-related factors. The following sub-sections summarise the establishment of existing air quality levels through a review of historic and project specific data and the prediction of future air quality levels through the use of recognised computer models formulated to predict these levels under nominated project scenarios.

The information presented in this section is drawn largely from two reports by Heggies Pty Ltd (Heggies), which are reproduced in full as Parts 3 and 4 in Volume 1 of the *Specialist Consultant Studies Compendium,* accompanying the *Environmental Assessment*. Part 3 addresses the air quality issues specifically with respect to dust and exhaust gases whereas Part 4 addresses the health impact issues related to particulate matter and respirable silica.

4.4.2 Existing Air Quality

4.4.2.1 Introduction

Air quality standards and goals refer to total pollutant levels from both existing sources and proposed activities. To fully assess impacts against all the relevant air quality standards and goals, it is therefore necessary to obtain data or estimates on existing particulate matter airborne concentration and dust deposition levels.

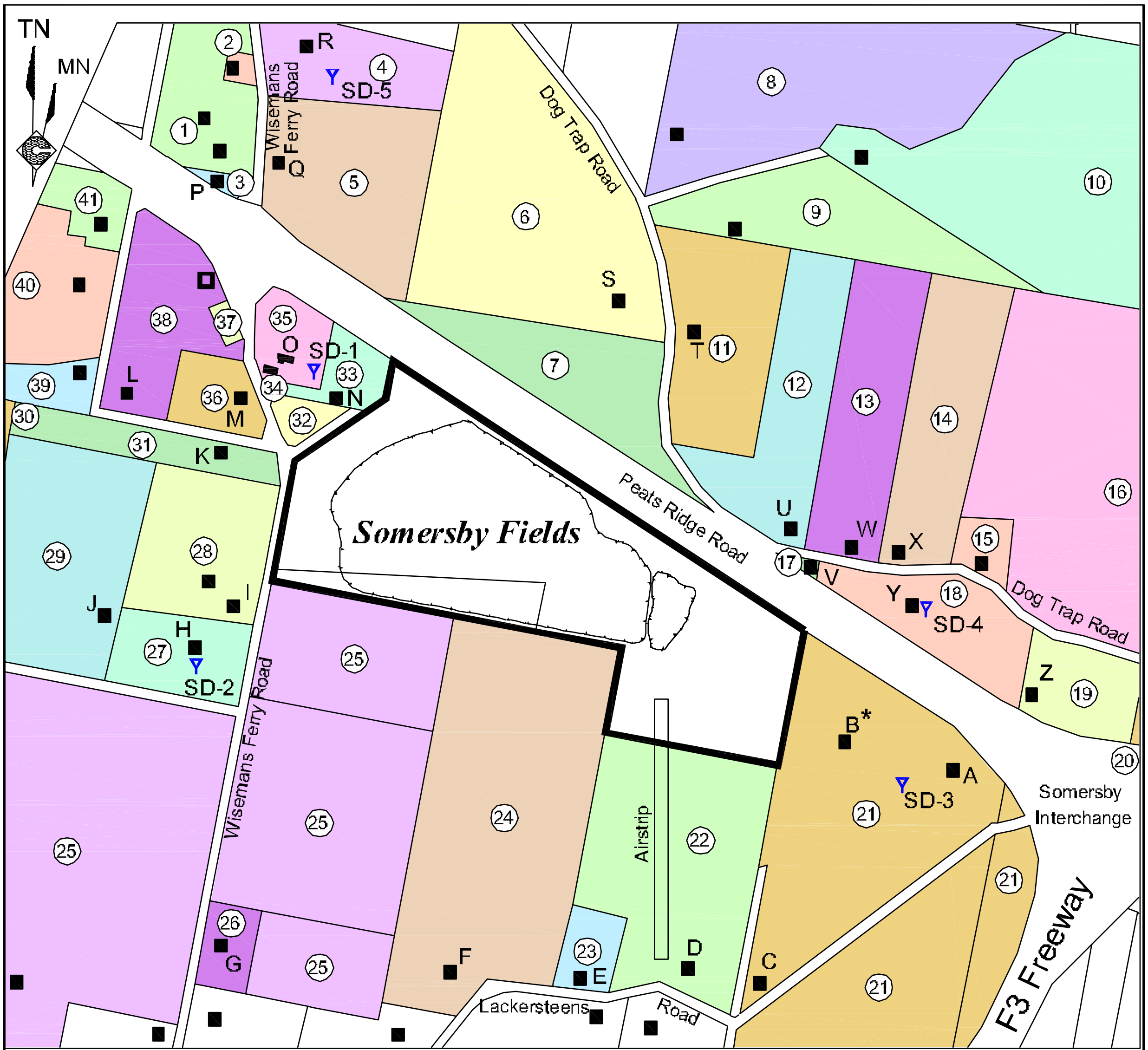
Existing air quality around Somersby is influenced by dust generated from unsealed roads or tracks (eg. Sections of Dog Trap Road), unpaved areas, and rural/agricultural pursuits. Until mid 2006, an area opposite the entrance to Somersby Public School was a constant source of dust – a feature that has reduced noticeably since sealing of frequently trafficked areas.

Estimates for airborne concentrations and dust deposition levels have been obtained through a combination of information gathered from a High Volume Air Sampler (HVAS) and dust deposition gauges placed at locations surrounding the Project Site or monitoring undertaken at locations with similar land uses and/or geography.

4.4.2.2 Dust Deposition

Information on dust deposition levels in the vicinity of the Project Site has been, and is continuing to be, obtained from five dust deposition monitoring locations established surrounding the Project Site. These monitoring locations, numbered SD1 to SD5 and presented on **Figure 4.17**, have been established in accordance with the following Australian Standards.

- AS 2922-1987 *Ambient Air – Guide for the Siting of Sampling Units* (NSW DEC Method AM-1).
- AS 3580.10.1-2003 *Methods for Sampling and Analysis of Ambient Air – Determination of Particulates – Deposited Matter – Gravimetric Method* (NSW DEC Method AM-19).



Reference	Owner
1	P. & R. Tate
2	J. & J. O'Toole
3	P. & S. Moore
4	Coachwood Nurseries Pty Ltd
5	G. & P. Radford
6	G. & H. Rose
7	M. & N. Ozbaglar
8	J. & C. McLuckie
9	G. & T. Morris
10	E. & G. Ireland
11	R. Fischer
12	F. & V. Knutson
13	P. & S. Martin
14	S. Bromfield
15	E. Grant, S. & P. Drew
16	A. Smith & P. McLoughlin
17	L. & N. Douglass
18	C. & R. Sultana
19	T. & V. Lamb
20	C. & P. Gilbert
21	Minister of Agriculture & Rural Affairs
22	A. Gregory
23	I. Scott
24	D. Ross
25	Wytown Pty Limited
26	B. & J. Thompson

Reference	Owner
27	R. & S. Weller
28	R. Thompson, B. Thompson & S. Jarvis
29	G. Williams, T. & C. Underwood, G. & H. Taylor
30	A. & A. Korogiannis
31	K. & L. Hawker & J. Woods
32	Minister for Lands
33	B. & L. Daniel
34	H. Chivers, A. Hoipo, E. Goldswain, M. Hunter & D. Studds
35	Minister for Education
36	S. & M. Cahill
37	N. Stapleton
38	W. & I. Raddatz
39	D. & B. Lyon
40	B. & S. Arms
41	C. & M. Smith

REFERENCE
Project Site Boundary
Residence
Commercial
SD-1 Deposited Dust Guage
Cadastral Boundary
*Note: Location of Planned Residence

SCALE 1:15 000
250 0 250 500 750 m

Figure 4.17
AIR QUALITY MONITORING LOCATIONS

Table 4.28 presents the recorded deposited dust levels at the five locations between the period of 29 August 2005 and 29 November 2006.

Table 4.28
Deposited Dust Levels – Somersby Area

Period	SD1		SD2		SD3		SD4		SD5	
	Total*	%Ash	Total*	%Ash	Total*	%Ash	Total*	%Ash	Total*	%Ash
29/08/05 to 30/09/05	1.5	40.0	0.2	100.0	1.8	72.2	0.2	50.0	0.3	66.7
30/09/05 to 29/10/05	2.2	13.6	0.8	37.5	1.0	40.0	0.8	50.0	0.5	60.0
29/10/05 to 29/11/05	1.3	38.5	0.8	25.0	1.1	36.4	*8.7*#	*42.5*	0.9	33.3
29/11/05 to 29/12/05	2.4	33.3	1.4	50.0	*11.0*#	*44.5*	2.5	36.0	0.9	55.6
29/12/05 to 29/01/06	1.0	50.0	0.5	60.0	*7.2*#	*12.5*	0.5	40.0	@	@
29/01/06 to 28/02/06	3.3	66.7	0.9	33.3	1.5	40.0	2.0	45.0	1.5	46.7
28/02/06 to 29/03/06	0.9	66.7	4.0	70.0	1.0	40.0	0.5	20.0	0.6	50.0
29/03/06 to 29/04/06	2.0	90.0	0.8	75.0	0.4	50.0	0.3	66.7	0.1	100.0
29/04/06 to 29/05/06	3.1	25.8	*23.6*#	*88.1*	2.3	34.8	2.2	13.6	2.2	4.5
29/05/06 to 29/06/06	1.4	42.9	2.3	65.2	1.0	80.0	0.5	20.0	1.2	66.7
29/06/06 to 29/07/06	0.4	50.0	0.4	50.0	0.5	60.0	0.2	50.0	0.5	80.0
29/07/06 to 29/08/06	1.4	21.4	1.9	31.6	1.8	55.6	1.4	21.4	2.1	28.6
29/08/06 to 14/10/06	1.1	45.5	0.4	50.0	0.4	50.0	0.2	50.0	0.2	100.0
14/10/06 to 31/10/06	1.6	68.8	1.0	80.0	1.7	76.5	0.8	75.0	1.2	75.0
31/10/06 to 29/11/06	1.4	50.0	0.8	37.5	0.8	62.5	1.0	60.0	0.5	80.0
Average	**1.7**	**46.7**	**1.2**	**58.3**	**1.2**	**49.5**	**0.9**	**41.4**	**0.9**	**59.0**

* See **Figure 4.17** for location
\# Anomalous value deleted from average calculation @ = Sample bottle broken in transit
Source: Heggies (2006b) – Table 4 * g/m^2/month

Table 4.28 represents a reliable data set on which to establish background deposited dust levels. Of the 75 dust samples collected, results were obtained for 73 of these and only four were considered anomalous based comparison with the overall data set and with other samples collected during a monitoring period. Excluding the anomalous values from the data set, an average dust deposition level of approximately $1.2g/m^2$/month is appropriate for the Somersby area. Heggies (2006b) also notes there does not appear to be any correlation between dust deposition and wind direction (through a review of continuous data recorded at the Mangrove Mountain Station No. 61375) for this data set.

4.4.2.3 Particulate Matter

As noted in Section 4.4.1, *"Particulate matter"* refers to airborne particles typically 0.1µm to 50µm in aerodynamic diameter. Particles less than 10µm and 2.5µm are referred to PM_{10} and $PM_{2.5}$ respectively.

In order to obtain current representative PM_{10} data for the Somersby area, a monitoring site has been established within the grounds of Somersby Public School, west of the Project Site (SD-1, see **Figure 4.17**). The High Volume Air Sampler used to record PM_{10} concentrations has been established at the school in accordance with the following Australian Standards.

- AS 2922-1987 *Ambient Air - Guide for the Siting of Sampling Units* (NSW DEC Method AM-1).
- AS/NZS 3580.9.6-2003 *Methods for sampling and analysis of ambient air – Determination of suspended particulate matter – PM_{10} high volume sampler with size selective inlet – Gravimetric Method.*

Table 4.29 presents the PM_{10} airborne concentrations recorded at SD1 during the period 18 September 2005 to 30 November 2006. Samples were collected approximately every 6 days in accordance with recommended DEC run cycles.

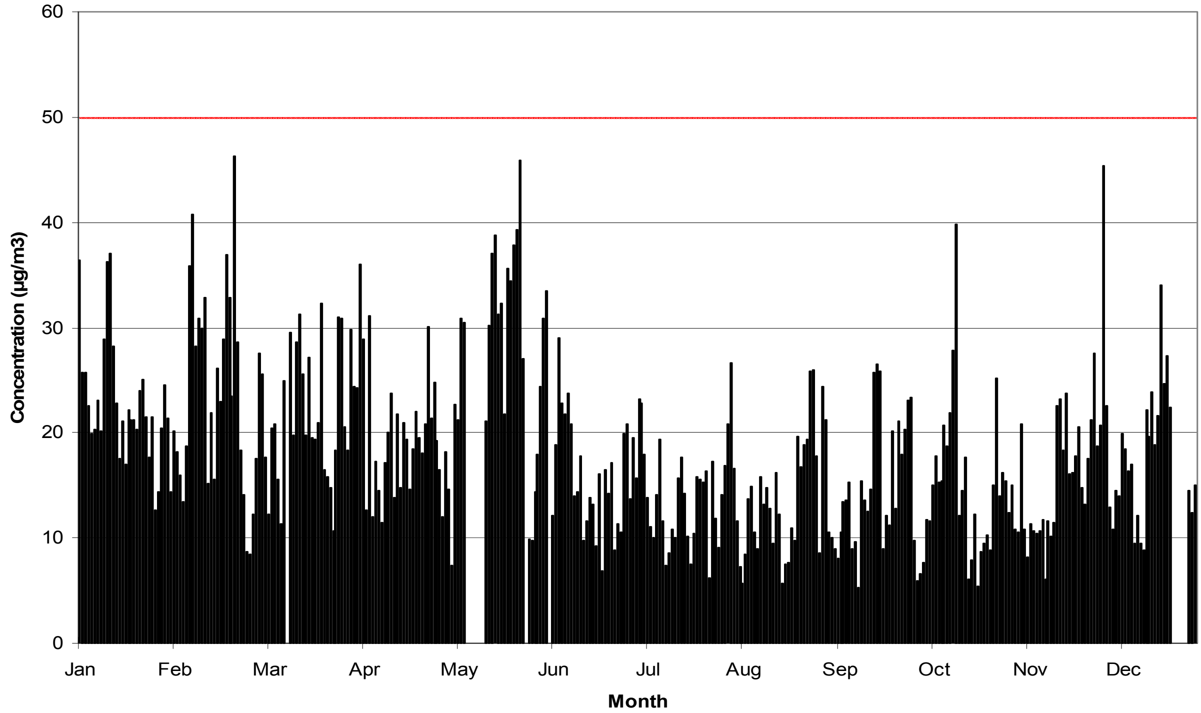
Table 4.29
PM_{10} Concentrations – SD1

September 2005	PM_{10}*	October 2005	PM_{10}	November 2005	PM_{10}*	December 2005	PM_{10}*	January 2006	PM_{10}*
18	10	6	33	5	11	5	37	4	25
24	34	12	11	11	11	11	44	10	22
30	10	18	25	17	8	17	37	16	15
		24	11	23	10	23	62	22	24
		30	<1	29	5	29	51	28	17
February 2006	**PM_{10}***	**March 2006**	**PM_{10}***	**April 2006**	**PM_{10}***	**May 2006**	**PM_{10}***	**June 2006**	**PM_{10}***
3	3	3	12	4	17	5	15	5	8
9	35	11	23	7	15	13	11	11	17
15	29	17	12	13	6	18	13	18	7
21	28	23	1	18	11	31	4	23	16
27	18	29	3	23	10			30	9
July 2006	**PM_{10}***	**August 2006**	**PM_{10}***	**September 2006**	**PM_{10}***	**October 2006**	**PM_{10}***	**November 2006**	**PM_{10}***
4	3	9	25	4	3	14	24	6	31
10	13	15	17	10	11	20	19	12	21
16	13	23	11	16	21	26	19	18	9
22	14	30	30	22	8	31	18	24	15
28	15			27	19			30	17

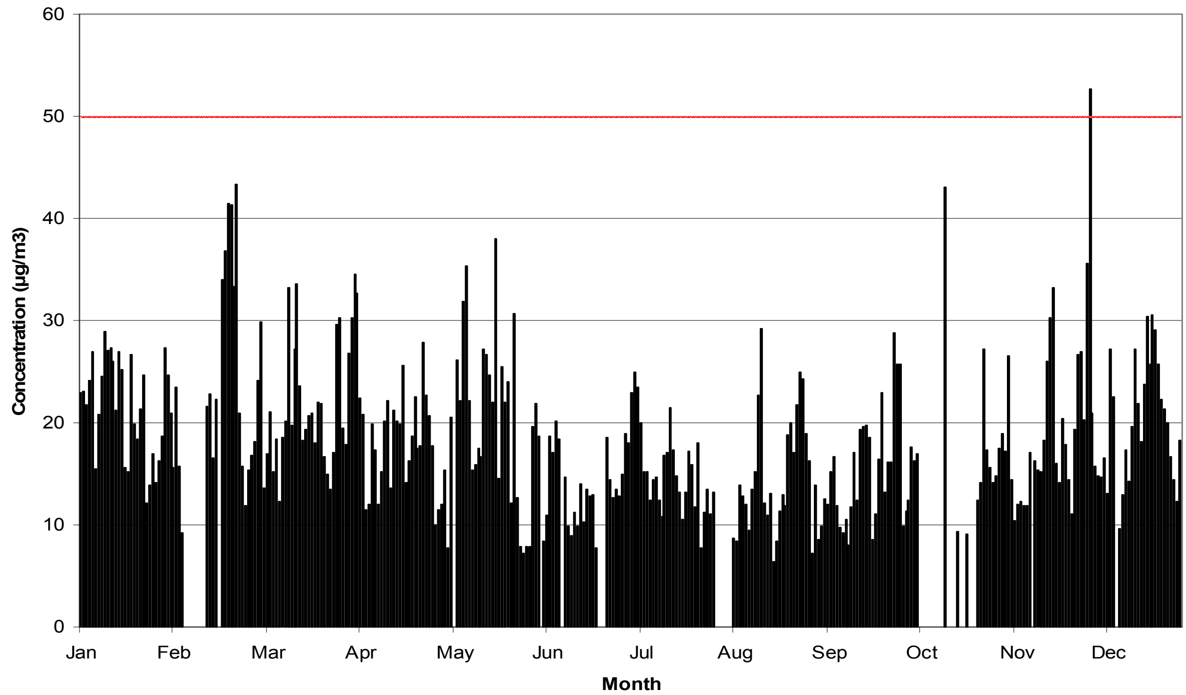
Source: Modified after Heggies (2006b) – Table 6 * µg/m^3

Average monthly PM_{10} concentrations varied from 9µg/m^3 in November 2005 to 46.2µg/m^3 in December 2005 with an average of 17.7 µg/m^3. This average is comparable to both the results of PM_{10} concentration monitoring undertaken by P. Zib and Associates Pty Ltd between 29 September 2000 and 28 November 2000 (Zib, 2000) at a similar location (22.5µg/m^3) and PM_{10} monitoring undertaken at DEC maintained sites at Richmond, 57km to the southwest of the Project Site, and Wallsend , 62km to the northeast of the Project Site, which provide annual average PM_{10} concentration of 18µg/m^3 (2004 data set). **Figure 4.18** presents the 2004 monitoring results for the Richmond and Wallsend monitoring sites and the typical range of measured 24 hour PM_{10} level.

The background PM_{10} concentration in the Somersby area has therefore been set at 18µg/m^3.



DEC PM_{10} (24-Hour Average) Monitoring Results for Richmond, 2004



DEC PM_{10} (24-Hour Average) Monitoring Results for Wallsend, 2004

Figure 4.18
PM_{10} Monitoring Results

4.4.2.4 Crystalline Silica

The existing background concentration of airborne crystalline silica originate from quartz (silicon dioxide) being emitted into the air as a component of particulate emissions produced by natural, industrial, and farming activities (US EPA, 1996). Within the Somersby area, these activities may include dust from vehicles travelling on sealed and unsealed roads, agricultural activities, bushfires, wind erosion of unsealed surfaces (eg. near Somersby shop), local construction and demolition activities and extractive industries. The sandy nature of the soils around Somersby means they naturally contain high levels of quartz. Local sand exposures eg within the sand pit at Somersby Public School are not considered to be substantial sources of airborne crystalline silica because of the size grading of the sand (typically >75µm).

Background ambient respirable silica concentrations in non-occupational environments are not measured in Australia and as a result, there is an absence of accessible information within the Australian context. It is known, however, that the crystalline silica component of ambient emissions has been observed to be higher within larger size particle size fractions (>10µm) than those fractions less than 10µm, possibly due to the quartz being more resistant to reduction to finer particle sizes due to its hard nature (US EPA, 1996). Therefore, a method of estimating ambient respirable silica concentrations is to determine the <10µm quartz content of the soils within the area of interest and assume that the percentage of crystalline silica within the emitted PM_{10} is equivalent to the fraction within the parent source (US EPA, 1996).

A <75µm fraction of material recovered from a sample of raw sand from the Somersby Fields Project Site was submitted for determination of the <10µm quartz content by cyclosizing and X-ray diffraction analysis. As a result, the analysed quartz content of the <10µm fraction of the raw sand is 4% (Heggies, 2006c). Thus, the derivation of estimated background annual average respirable quartz is as follows.

- The estimated background annual average PM_{10} concentration is 18.0µg/m^3 (as discussed in Section 4.4.2.3).
- Therefore, the estimated existing background annual average respirable quartz concentration is 18.0µg/m^3 x 4% = 0.72µg/m^3.

It is acknowledged that this approach produces a conservative estimate because it is based on a sample taken at a depth from the Project Site and in reality much of the landform in the Somersby area is covered by grass, native flora, bitumen and concrete and will not be affected by wind erosion.

The estimate of 0.72µg/m^3 for the Somersby area is, however, similar to concentrations reported by Collin et al (2005) and the California EPA (OEHHA, 2004) for a rural site (0.6µg/m^3) and a remote background site (0.2µg/m^3).

Heggies (2006c) also calculates that the existing background level of airborne respirable crystalline silica over a 70 year period would be 50.4µg/m^3 .years.

4.4.2.5 Total Suspended Particulate Matter (TSP)

In order to estimate a background concentration of annual TSP, the established annual average PM_{10} concentration of 18µg/m^3 was multiplied by a factor of 2. This approach is adopted as the PM_{10} sub-set is typically approximately 50% of total suspended particulates (TSP) in the ambient air in regions where road traffic is not the dominant particulate source, such as rural areas (US EPA, 2001). This is a standard approach endorsed by the Department of Environment and Conservation.

Thus a background TSP concentration of 36µg/m^3 is appropriate for the Somersby area.

4.4.2.6 Nitrogen Dioxide and Sulphur Dioxide

The concentrations of both NO_2 and SO_2 in the Somersby area are likely to be influenced by the proximity of the Project Site and surrounding land to the F3 Freeway particularly during periods of on-shore winds. Concentrations from the DEC's Richmond monitoring site in 2004 have been assumed to be indicative of those likely to occur around Somersby albeit that they may underestimate concentrations at Somersby during periods of on-shore winds.

4.4.2.7 Background Air Quality Summary

Overall, the quality of air in the Somersby area from the perspective of particulate matter and deposited dust is good. However, the proximity of 70 000 vehicles per day travelling along the F3 Freeway is likely to affect local air quality with respect to gases such as NO_2 and SO_2.

For the purposes of the air quality assessment to the Somersby Fields Project the background air quality concentrations and levels for the Somersby area are summarised in **Table 4.30**.

Table 4.30
Background Air Quality Environment for Assessment Purposes

Air Quality Parameter	Averaging Period	Assumed Background Level
Deposited Dust	Annual	1.2g/m^2/month
Total Suspended Particulate Matter	Annual	36µg/m^3
PM_{10}	24-Hour	Daily varying[1]
	Annual	18µg/m^3
Crystalline Silica	Annual	0.72µg/m^3

[1] Daily-varying 24-hour average PM_{10} concentrations have been used within the PM_{10} modelling.
Source: Modified from Heggies (2006b) – Table 7

4.4.3 Air Quality Goals

4.4.3.1 PM_{10} and $PM_{2.5}$

Heggies (2006b) cite that the NSW DEC PM_{10} impact assessment goals, as expressed in their document *Approved Methods and Guidance for Modelling and Assessment of Air Pollutants in New South Wales*, are:

(i) a 24-hour maximum of 50µg/m^3; and

(ii) an annual average of 30µg/m^3.

These goals reflect health research to achieve acceptable air quality for the entire community.

A review in 2000 by the National Environment Protection Council (NEPC) concluded that there was sufficient community concern regarding $PM_{2.5}$ to consider it an entity separate from PM_{10}. As such, a variation to the Ambient Air Quality National Environment Protection Measure (NEPM) was made to extend its coverage to $PM_{2.5}$ in July 2003. This document references the following goals for $PM_{2.5}$, namely:

(i) a 24-hour maximum of 25µg/m^3; and

(ii) an annual average of 8µg/m^3.

4.4.3.2 Respirable Crystalline Silica

Heggies (2006c) refers to three separate goals that that have been developed for assessing the health-related impacts of exposure to respirable crystalline silica as follows.

1. Ambient respirable crystalline silica criteria.
2. Silicosis potency estimates.
3. Occupational health and safety goals.

Ambient Respirable Crystalline Silica Criteria

The chronic Reference Exposure Level (REL) for respirable crystalline silica, ie. the airborne level of respirable crystalline silica at or below which no adverse health effects are anticipated in individuals indefinitely exposed to that level, has been estimated as 3µg/m^3 by the Office of Environmental Health Hazard Assessment (OEHHA) in California. This REL has been adopted for the Somersby Fields Project given RELs are developed from the best available published scientific data, based primarily on health considerations (Heggies, 2006c).

Silicosis Potency Estimates

Cumulative exposure to respirable crystalline silica, ie. an estimate of the average respirable crystalline silica concentration to which a person is exposed over the course of a year multiplied by the number of years exposed, may result in an increased risk to diseases such as silicosis. Research conducted by the US EPA (1996), which examined the non-cancer epidemiological literature on silica induced diseases, concluded that the cumulative risk of silicosis at or below 1000µg/m^3.years, or 14.3µg/m^3 per year for 70 years, is close to 0% (US EPA, 1996).

NSW Occupational Health and Safety Goals

In New South Wales, WorkCover NSW is the primary statutory authority with regards to occupational exposures to dust and airborne concentrations of respirable crystalline silica. **Table 4.31** lists the occupational criteria for dust and quartz noted by the Australian Safety and Compensation Council (ASCC) and the American Council of Governmental Industrial Hygienists (ACGIH).

Table 4.31
Occupational Criteria for Dust and Quartz

	TWA mg/m^3	Organisation
Quartz	0.1	ASCC
Quartz	0.05	ACGIH
Respirable dust	3.0 *	ACGIH
Inhalable dust	10.0 *	ASCC
Note: * This level requires that inspirable dust has no toxic substances; otherwise a lower or alternative standard applies		
Source: Heggies (2006c) – Table 3		

The Time-Weighted Average (TWA) is the concentration for a conventional 8-hour workday and a 40-hour workweek, to which it is believed that nearly all workers may be repeatedly exposed, day after day, for a working lifetime without adverse effect.

The more stringent of these criteria, ie. those of ACGIH, would be adopted as goals for the workforce working on the Project Site.

4.4.3.3 Goals Applicable to Total Suspended Particulate Matter (TSP)

The annual goal for TSP is 90µg/m^3, as recommended by the National Health and Medical Research Council (NHMRC) in 1981.

In areas such as the Project Site, where road traffic is not the dominant particulate source, the PM_{10} proportion is typically approximately 50% of TSP. The TSP goal would therefore be consistent with an annual PM_{10} goal of approximately 45µg/m^3 under these circumstances. Thus, the historical NHMRC goal may be regarded as not as stringent as the newer PM_{10} goal of an annual average of 30µg/m^3.

As the annual TSP goal would easily be achieved if the annual PM_{10} goal is satisfied, TSP has not been considered further in this assessment

4.4.3.4 Deposited Dust

The NSW DEC impact assessment goals for deposited dust, showing the allowable increase in dust deposition level over the ambient level which would be acceptable to avoid dust nuisance, is indicated in **Table 4.32**.

Table 4.32
DEC Goals for Allowable Dust Deposition

Averaging Period	Maximum Increase in Deposited Dust Level	Maximum Total Deposited Dust Level
Annual	$2g/m^2$/month	$4g/m^2$/month
Note 1. Dust is assessed as insoluble solids as defined by AS 3580.10.1-1991. Source: "Approved Methods & Guidance for the Modelling and Assessment of Air Pollutants in NSW", DEC 2001		
Source: Heggies (2006b) – Table 8		

Given the established background dust deposition for the area is $1.2g/m^2$/month, the maximum deposited dust level goal at surrounding residences and Somersby Public School is reduced to $3.2g/m^2$/month.

4.4.3.5 NO_2 and SO_2

The NSW DEC has established impact assessment goals as expressed in their document *Approved Methods and Guidance for Modelling and Assessment of Air Pollutants in New South Wales*. The goals specified by the DEC for NO_2 and SO_2 are presented in **Table 4.33**.

Table 4.33
NSW DEC Air Quality Goals - NO_2 and SO_2

Pollutant	Averaging Time	Maximum Concentration
Nitrogen dioxide (NO_2)	1 hour Annual	$246\mu g/m^3$ $62\mu g/m^3$
Sulphur Dioxide (SO_2)	10 Minutes 1 hour 24 hours Annual	$712\mu g/m^3$ $570\mu g/m^3$ $228\mu g/m^3$ $60\mu g/m^3$
Source: Heggies (2006b) – Table 9		

4.4.3.6 Project Site Air Quality Goals

In summary, the specific goals being applied to the project, which conform to current DEC air quality targets, are as follows.

PM_{10}: A 24-hour maximum of $50\mu g/m^3$
An annual average of $30\mu g/m^3$.

$PM_{2.5}$: A 24-hour maximum of $25\mu g/m^3$.
An annual average of $8\mu/m^3$.

Respirable Crystalline: An annual REL of $3\mu g/m^3$
A lifetime exposure to respirable crystalline silica of 1 000$\mu g/m^3$

Deposited Dust: Nuisance expected to impact on residential areas when annual average dust deposition levels exceed $3.2g/m^2$/month.

NO_2: A 1 hour maximum of 246µg/m^3.
An annual average of 62µg/m^3 (DEC).

SO_2: A 10-minute maximum of 712µg/m^3.
A 1-hour maximum of 570µg/m^3.
A 24-hour maximum of 228µg/m^3.
An annual average of 60µg/m^3 (DEC).

4.4.4 Potential Sources of Air Contaminants

4.4.4.1 Particulate Emissions

The main sources of particulate matter (dust) generated by the project would include the following.

- Topsoil stripping and overburden removal.
- Excavation of sand.
- Loading and unloading of raw feed and products to trucks and stockpiles.
- Screening of the raw sand material within the mortar sand plant.
- Vehicles travelling on unsealed surfaces.
- Wind erosion from stockpiles and exposed unsealed, unvegetated areas.

4.4.4.2 Vehicle Exhaust Emissions

Other possible sources of air emissions would be exhaust fumes from vehicles, mobile and fixed plant on site. These emissions would include NO_2, SO_2, PM_{10} and $PM_{2.5}$.

4.4.5 Management of Air Quality

The Proponent proposes to adopt the following design features, and operational safeguards and management procedures to limit the generation of particulate matter from project activities.

Design Features

(i) The sand wash plant would be enclosed with limited openings to allow entry and exit of conveyors and access by personnel.

(ii) The area of surface disturbance available for wind erosion would be limited by ensuring that clearing and soil stripping is limited to the area required for immediate sand removal activities and conducting progressive rehabilitation on available areas.

(iii) The construction of earth mounds, bund walls and acoustic barriers adjacent to dust generating activities.

(iv) The raw feed material delivered to the mortar sand and sand wash plants would have a degree of inherent moisture (estimated to be 8%) that would contribute to the overall control of dust.

Operational Safeguards and Management Procedures

(i) A 20kL water cart would be used to wet the active internal unsealed roads. Watering of the unsealed roads would occur with an application rate of approximately $1.5L/m^2$ per application, and up to five times per day, depending on weather conditions.

(ii) The drop heights between front-end loader buckets and trucks carrying sand, soil or overburden would be minimised through operator training and education on the management of dust.

(iii) Soil stockpiles, acoustic earth mounds and bund walls and areas where landform preparation is complete would be seeded with either native species, or non-persistent cover crop species to assist in stabilising the exposed surface.

(iv) All vehicle exhausts would be directed upward so as not to cause any dust lift-off from unsealed areas.

The safeguards and management procedures would be reviewed as part of annual reporting for the Project Site and any changes to the operation reflected in the review of dust management strategies adopted on site.

4.4.6 Assessment Methodology

4.4.6.1 Modelling Methodology

Heggies (2006b) conducted the air quality impact modelling using the Ausplume Gaussian Plume Dispersion Model software, which is the approved dispersion model for the majority of applications throughout NSW.

Appropriate use of the model requires the input of meteorological conditions specific to the Project Site, hence The Air Pollution Model (TAPM) software was used to simulate the meteorology in the absence of detailed Project Site information relating to wind and air turbulence. The model predicts wind speed and direction, temperature, pressure, water vapour, cloud, rain and turbulence. For the proposed Somersby Fields Project assessment, TAPM was used to generate a 2004 meteorological data set for the Project Site, incorporating hourly observations recorded at the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Mangrove Mountain. The 2004 data set is consistent with the daily-varying background PM_{10} data to be utilised in the atmospheric dispersion modelling.

The nearest residences and Somersby Public School ("assessment locations") were identified and **Table 4.34** provides details relating to the distance and orientation of each assessment location to the Project Site. The intervening topography between the Project Site and the assessment locations was assessed as unlikely to have an impact on the dispersion of particulate matter from the Project Site and hence was not included in the model.

Table 4.34
Details of Surrounding Residences

Assessment Location*	Land Owner	Distance (m) / Direction from Residence to:		
		Processing Area	Stage 1/5	Stage 2/2
B	Minister for Agriculture	775 NW	680 NW	1,070 NW
F	D. Ross	880 N	775 N	1,000 NNE
I	R. Thompson, B. Thompson & S. Jarvis	545 E	605 E	330 NE
M	S. & M. Cahill	620 ESE	720 ESE	270 E
N	B. & L. Daniel	430 SE	535 ESE	145 SE
O	Minister For Education	640 SE	700 ESE	350 SE
S	D. Studds	510 SSW	410 S	535 WSW
T	R. Fischer	560 SW	425 SSW	635 WSW
U	F. & V. Knutson	530 W	425 W	780 W
V	L. & N. Douglass	580 WNW	475 WNW	820 WNW
Y	C. & R. Sultana	820 WNW	705 WNW	1,060 WNW
Source: Heggies (2006b) – Table 11				* See **Figure 4.17**

The modelling undertaken by Heggies at the 11 assessment locations has assumed the adoption of operational controls as set out in Section 4.4.5.

4.4.6.2 Modelling Scenarios

Particulate Matter

Two scenarios have been modelled to reflect when worst case particulate-generating activities are in place on either the eastern or western side of the Project Site. Each scenario takes into consideration the location of sand removal activities, the internal haul route used to transport material to the processing plants and the location of the processing plants. The scenarios are therefore considered representative of different operating conditions during the life of the operation.

The two scenarios modelled are as follows.

- Scenario 1 - Sand removal within Stage 1/5, located in the eastern side of the Project Site.
- Scenario 2 - Sand removal within Stage 2/2, located in the western side of the Project Site.

Details of the locations of operating equipment for each scenario are presented on Figure 5.1 (Appendix 5) of Heggies (2006b).

The results of Scenario 2 modelling were used to assess worst case concentrations of PM_{10} and respirable crystalline silica at the Somersby Public School. These results have been referred to as 'Scenario 3'. The assessment of established emission factors was applied to the proposed earthmoving and processing equipment included in each scenario and a number of operational assumptions included in the dispersion model. The emission inventory and related assumptions are presented in full in the Heggies (2006b) as Part 4 of the *Specialist Consultant Studies Compendium*.

Combustion Emissions

Atmospheric emissions of both SO_2 and NO_2 from diesel fuel combustion by earthmoving equipment operating within the Project Site were modelled using the following information.

- An on-site diesel consumption rate of approximately 580kL per annum.
- Emission rates for SO_2 and NO_2 based on the Australian National Pollutant Inventory (NPI) Emission Estimation Technique Manuals for "*Combustion Engines*".
- Sulphur concentration within the diesel of 500ppm (0.05%).
- 20% of emissions of oxides of nitrogen (NO_X) would be converted to nitrogen dioxide (NO_2) between the point of emission and the nearest receptor.

Conservative point source emissions characteristics of 3m release height and 5m/s exit velocity were modelled for aggregated combustion emissions from the site to provide for worst-case concentration and dispersion properties.

4.4.7 Impact Assessment

4.4.7.1 Dust Deposition

The results of the Ausplume modelling predictions for dust deposition at each assessment location are listed in **Table 4.35**. The results show the mean average monthly deposition (ambient plus incremental) predicted at the assessment locations surrounding the Project Site. A contour plot of the mean average monthly incremental dust deposition values (measured as g/m^2/month) predicted around the proposed Somersby Fields Project is presented on **Figure 4.19**.

With the project design features and operational safeguards discussed in Section 4.4.5 being implemented during the operation of the project, incremental monthly dust deposition rates are predicted to be well below the $2.0g/m^2$/month at all assessment locations for the two scenarios modelled.

Heggies (2006b) note that the incremental dust deposition would be chemically inert and therefore when considered in conjunction with the $<2.0g/m^2$/month increment, would not present any significant impact on the local vegetation, including the horticultural activities at local nurseries.

Table 4.35
Ambient and Predicted Incremental Dust Deposition at Assessment Locations

Assessment Location	Dust – Annual Average (g/m^2/ month)				
	Background	Increment	Background + Increment	Criteria	Compliance
Scenario 1					
B	1.2	0.3	1.5	3.2	Yes
F	1.2	0.2	1.4	3.2	Yes
I	1.2	0.4	1.6	3.2	Yes
M	1.2	0.3	1.5	3.2	Yes
N	1.2	0.4	1.6	3.2	Yes
O@	1.2	0.2	1.4	3.2	Yes
S	1.2	0.2	1.4	3.2	Yes
T	1.2	0.2	1.4	3.2	Yes
U	1.2	0.3	1.5	3.2	Yes
V	1.2	0.3	1.5	3.2	Yes
Y	1.2	0.2	1.4	3.2	Yes
Scenario 2					
B	1.2	0.3	1.5	3.2	Yes
F	1.2	0.3	1.5	3.2	Yes
I	1.2	0.7	1.9	3.2	Yes
M	1.2	0.6	1.8	3.2	Yes
N	1.2	1.2	2.4	3.2	Yes
O@	1.2	0.4	1.6	3.2	Yes
S	1.2	0.2	1.4	3.2	Yes
T	1.2	0.2	1.4	3.2	Yes
U	1.2	0.3	1.5	3.2	Yes
V	1.2	0.3	1.5	3.2	Yes
Y	1.2	0.2	1.4	3.2	Yes

Source: Modified after Heggies (2006b) – Table 13 @ Somersby Public School

4.4.7.2 PM_{10}

Table 4.36 presents the results of the Ausplume predictions for 24-hour average and annual average PM_{10} concentrations at the assessment locations. A contour plot of the annual average and 24-hour average PM_{10} predicted levels in the vicinity of the Project Site is presented in **Figures 4.20** and **4.21**.

With respect to the 24-hour average, the maximum PM_{10} concentrations of the maximum background level and the increment due to the project are predicted to be less than the site specific goal 50µg/m^3 at all assessment locations for both worst case scenarios. It is further noted that the increment due to operation for 24 hour average concentration would vary from 0 to 2.9µg/m^3 ie. a maximum of only 5.8% of the 24 hour PM_{10} criterion of 50µg/m^3.

At all assessment locations, total annual average PM_{10} concentrations associated with the operation of the project are predicted to be less than 21µg/m^3 for both worst case scenarios, thereby complying with the site specific goal of 30µg/m^3.

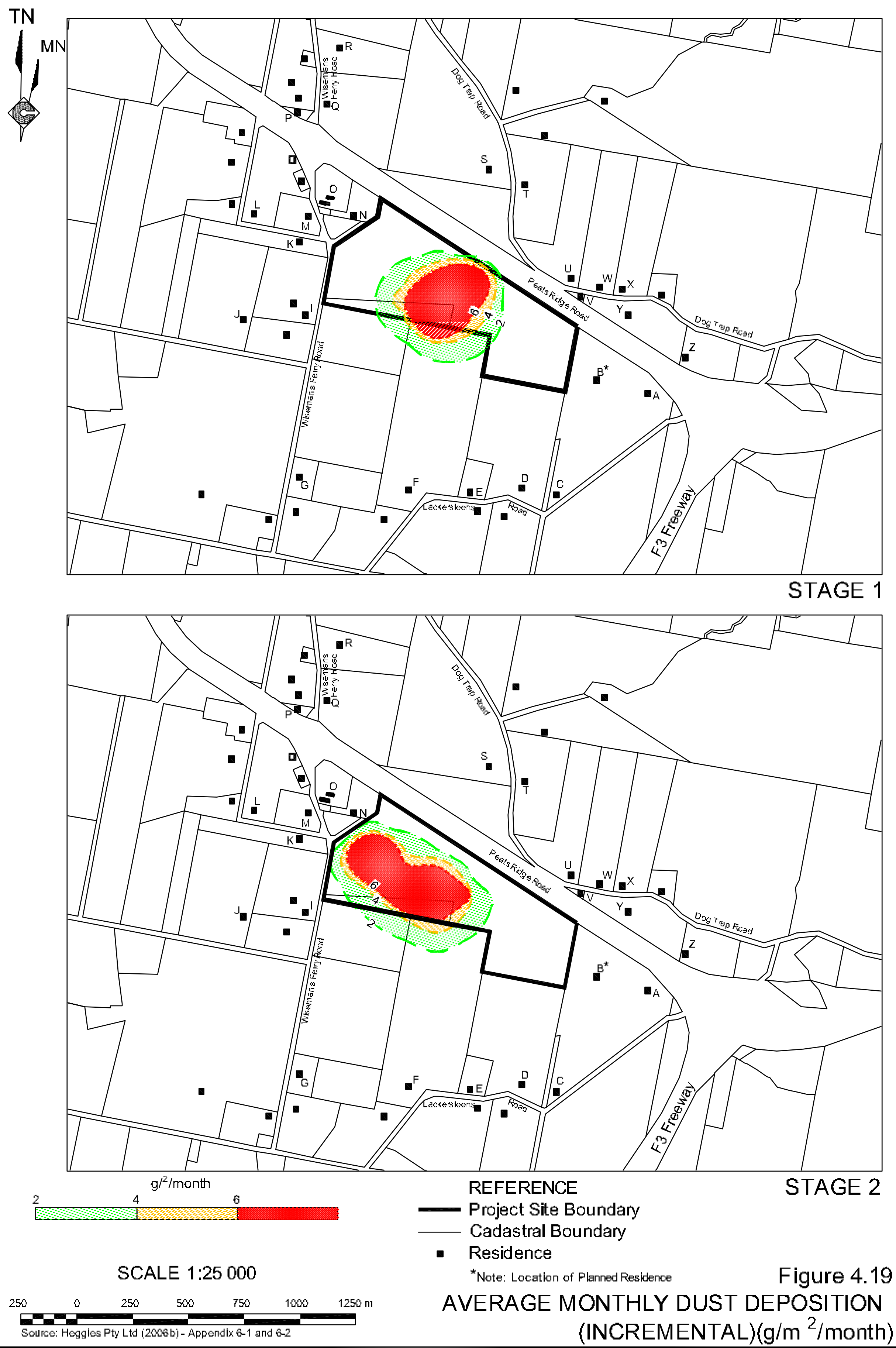


Figure 4.19
AVERAGE MONTHLY DUST DEPOSITION (INCREMENTAL)(g/m ^{2}/month)

Table 4.36
Ambient and Incremental PM_{10} Concentrations at Assessment Locations

Assessment Location #	PM_{10} – 24-hour Average µg/m³					PM_{10} – Annual Average µg/m³				
	Ambient	Increment due to Operation	Ambient + Increment (Rounded)	Goal (µg/m³)	Compliance	Ambient	Increment due to Operation	Ambient + Increment (Rounded)	Goal (µg/m³)	Compliance
Scenario 1										
B	46.2	0.8	47.0	50	Yes	18	0.6	18.6	30	Yes
F	45.9	2.9	48.8	50	Yes	18	0.5	18.5	30	Yes
I	46.2	0	46.2	50	Yes	18	0.9	18.9	30	Yes
M	46.2	0.2	46.4	50	Yes	18	0.6	18.6	30	Yes
N	46.2	0.4	46.6	50	Yes	18	1.0	19.0	30	Yes
O@	46.2	0.2	46.4	50	Yes	18	0.5	18.5	30	Yes
S	46.2	0	46.2	50	Yes	18	0.6	18.6	30	Yes
T	46.2	0	46.2	50	Yes	18	0.7	18.7	30	Yes
U	46.2	0.2	46.4	50	Yes	18	0.6	18.6	30	Yes
V	46.2	0.2	46.4	50	Yes	18	0.6	18.6	30	Yes
Y	46.2	0.1	46.3	50	Yes	18	0.4	18.4	30	Yes
Scenario 2										
B	46.2	0.7	46.9	50	Yes	18	0.5	18.5	30	Yes
F	45.9	2.2	48.1	50	Yes	18	0.5	18.5	30	Yes
I	45.9	1.0	46.9	50	Yes	18	1.4	19.4	30	Yes
M	46.2	0.4	46.6	50	Yes	18	1.3	19.3	30	Yes
N	46.2	0.6	46.8	50	Yes	18	2.5	20.5	30	Yes
O	46.2	0.2	46.4	50	Yes	18	0.9	18.9	30	Yes
S	46.2	0	46.2	50	Yes	18	0.6	18.6	30	Yes
T	46.2	0	46.2	50	Yes	18	0.5	18.5	30	Yes
U	46.2	0.2	46.4	50	Yes	18	0.5	18.5	30	Yes
V	46.2	0.2	46.4	50	Yes	18	0.5	18.5	30	Yes
Y	46.2	0.1	46.3	50	Yes	18	0.3	18.3	30	Yes

Source: Modified after Heggies (2006b) – Tables 14 and 16 # See **Figures 4.20** and **4.21** @ Somersby Public School

Heggies (2006b) also assessed the 24-hour maximum PM_{10} concentrations at the most effected assessment locations, namely Residence T and Residence N for Scenario 1 and Scenario 2 respectively. In all cases, the maximum 24-hour PM_{10} concentration was predicted to be less than the 50µg/m³ criteria.

4.4.7.3 $PM_{2.5}$

Heggies (2006b) cite that approximately 28.6% of the PM_{10} particle size fraction can be assumed to constitute $PM_{2.5}$. Based on this proportion, the worst case 24-hour average $PM_{2.5}$ levels were predicted to be in the order of 14µg/m³ (28.6% of 48.8µg/m³) and annual average $PM_{2.5}$ predicted to be in the order of 5.8µg/m³ (28.6% of 20.5µg/m³). As such, the 24-hour average $PM_{2.5}$ goal of 25µg/m³ and annual average goal of 8µg/m³ $PM_{2.5}$ would be satisfied.

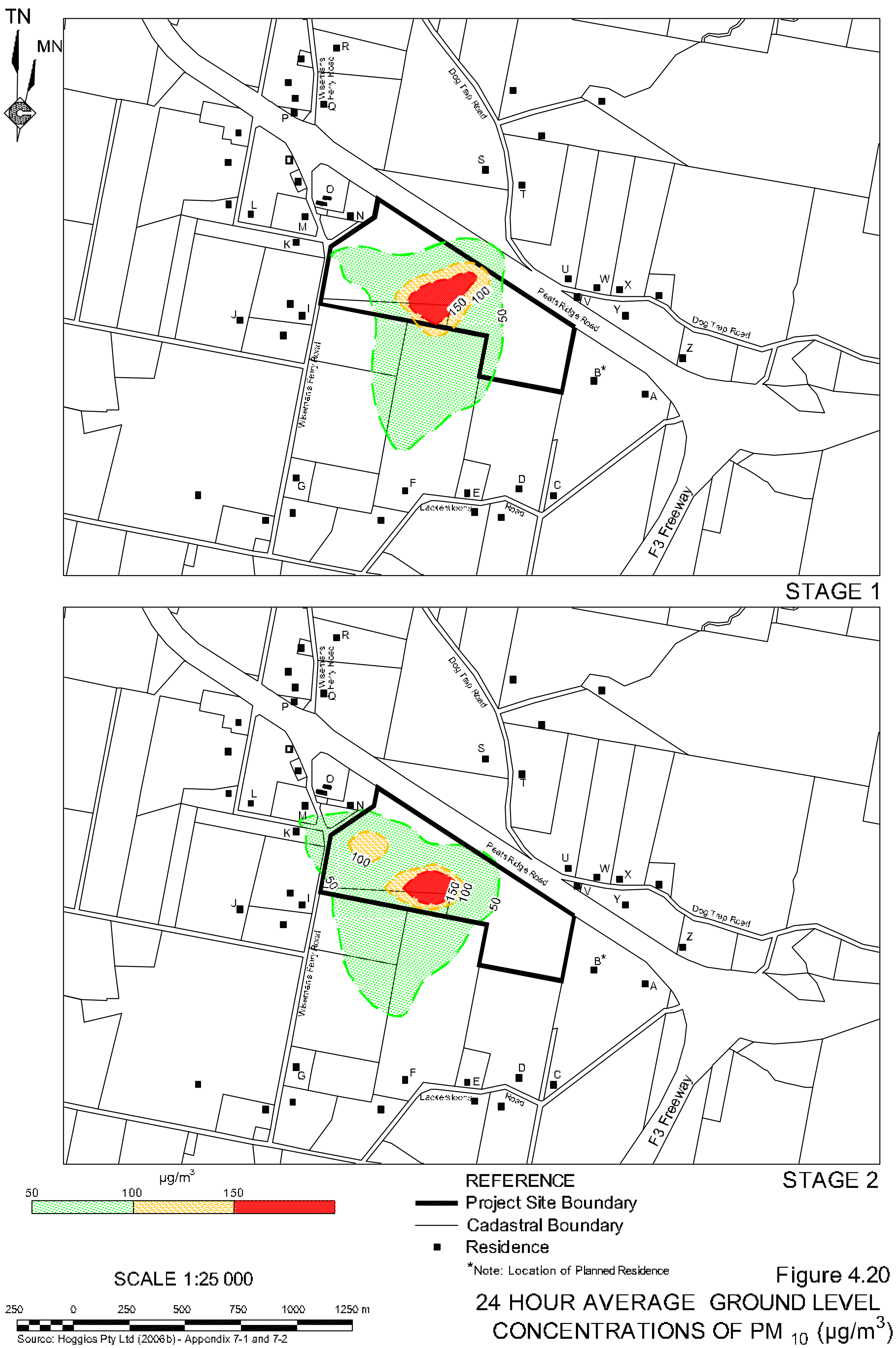


Figure 4.20
24 HOUR AVERAGE GROUND LEVEL CONCENTRATIONS OF PM $_{10}$ (μg/m^3)

Figure 4.21
MAXIMUM PREDICTED ANNUAL AVERAGE GROUND LEVEL CONCENTRATIONS OF PM_{10} (μg/m³)

4.4.7.4 Respirable Crystalline Silica

The principal health issue relevant to the Somersby Fields Project and the Somersby community relates to the concentration of respirable crystalline silica in the air, ie. particles of quartz <10µm in diameter. This sub-section specifically addresses this issue through a detailed assessment of the PM_{10} predicted data and comparison with the internationally recognised health criteria.

Chronic REL and Silicosis Potency

Based on the modelling undertaken by Heggies (2006c), the incremental increase in 24-hour and annual average PM_{10} and annual average respirable silica were predicted. **Table 4.37** presents the incremental increases predicted to be generated by the project, ie. for the three scenarios discussed earlier.

Table 4.37
Incremental Increase in PM_{10} and Respirable Silica Concentrations

	Scenario 1	Scenario 2	Scenario 3
24-hour average PM_{10}	2.9µg/m^3	2.2µg/m^3	0.2µg/m^3
Annual average PM_{10}	1.0µg/m^3	2.5µg/m^3	0.9µg/m^3
Annual average respirable silica	0.04µg/m^3	0.1µg/m^3	0.04µg/m^3
Source: Modified after Heggies (2006c) – Tables 4 & 5			

Based on the predicted incremental increases in annual average respirable silica (see **Table 4.37**), the predicted Chronic REL and Silicosis Potency were calculated for each of the three scenarios as follows.

- Chronic REL (Annual Average) = existing background + incremental increase.
- Silicosis Potency = [annual average x life of project (15 years)]

  \+

  [background average x remaining individual life (est. 55 years)]

Table 4.38 presents the results of modelling for each of the three scenarios. In the event the project life was extended to 18 years, the additional period would have no substantial impact upon the silicosis potency.

Table 4.38
Summary of Modelling Results of Chronic REL and Silicosis Potency

Parameter	Unit	Criteria Value	Health Impact Assessment Calculated		
			Scenario 1	Scenario 2	Scenario 3
Annual average PM_{10}	µg/m^3	30	19.0	20.5	18.9
Chronic REL	µg/m^3	3	0.76	0.82	0.77
Silicosis Potency	µg/m^3.years	1000	51.15	51.9	51.15
Source: Modified after Heggies (2006c) – Tables 6, 7 & 8					

The most notable outcome of the assessment by Heggies (2006c) is that the additional airborne respirable crystalline silica at Somersby Public School attributable to the Somersby Fields Project would be 1.5% of the predicted existing background levels at the school.

Neither the Chronic REL or Silicosis Potency criteria are predicted to be exceeded by the project at either the most affected residences or the Somersby Public School. Rather, the actual levels are considerably lower than the criterion, often by a factor of 19.

It is concluded that the risk of silicosis as a result of operations of the Somersby Fields Project is negligible. This conclusion is consistent with the statement made by the World Health Organisation that "*to date, there are no known adverse health effects associated with non-occupational exposure to quartz dust"* (CICAD, 2000).

Occupational Exposure and Risks

A review of occupational air monitoring programs undertaken by Heggies (2006c) for activities similar to those planned on the Project Site indicate a marked decrease in airborne respirable dust and respirable crystalline silica levels with distance from the source. For example, respirable silica results from monitoring at an operation involved in the winning of sandstone material ranged from 0.6mg/m^3 at the Jaw Crusher to less than 0.01mg/m^3 at the Central Plant Area.

As a consequence of this rapid decrease in respirable crystalline silica levels with distance from the source, there is potentially greater exposure to respirable dust and respirable silica for operators of mobile equipment and crushing equipment. However, assuming the adoption of appropriate controls and safeguards such as the complete enclosure of mobile equipment cabs, enclosure of the crushing equipment within the sand wash plant and enforcing site employees to wear appropriate safety equipment when potentially exposed to respirable silica generating activities, the potential for employee exposure to TWA levels of respirable silica above the nominated occupational criteria (see **Table 4.31**) would be low. Therefore, the risk of adverse health effects to persons working at the Project Site from exposure to respirable dust and respirable silica is negligible.

4.4.7.5 Sulphur Dioxide and Nitrogen Dioxide

The results of modelling undertaken by Heggies (2006b) simulating emissions of SO_2 and NO_2 on the Project Site established that all project air quality goals relating to SO_2 and NO_2 would be safely met.

4.4.7.6 Greenhouse Gases

Heggies (2006b) predict the total annual greenhouse emissions from operations on the Project Site would be 2 484 tonnes. This amounts to less than 0.0001% of the total baseline Australian emissions annually.

It is noted that in the longer term, the carbon sink created by the vegetation currently on site would be progressively re-instated as the Proponent's revegetation program progresses.

4.4.8 Conclusion

Heggies (2006b; 2006c) concluded that with the implementation of the air quality management measures described in Section 4.4.5, the potential air quality impact from the project would be within the current NSW DEC (and NEPM) air quality goals at all surrounding residences and at Somersby Public School.

4.4.9 Monitoring

Subject to the agreement of the respective land owners, the Proponent would continue to monitor PM_{10} concentrations at the established HVAS monitoring location (SD1) within the grounds of Somersby Public School and deposited dust at the five established dust monitoring locations (SD1 to SD5). In addition to these locations, the Proponent would establish a dust monitoring location within Stage 2 of the Project Site to monitor the operational emissions created during Stage 1 sand removal. This additional deposited dust gauge would be positioned approximately 260m from the closest activity in Stage 1 to replicate the closest distance between the class rooms at Somersby Public School and the closest point on the Stage 2 sand removal operations.

All monitoring results would be reported in an Annual Environmental Management Report for the project.

4.5 TRANSPORTATION

4.5.1 Introduction

The Proponent proposes to transport sand products between the site entrance on Peats Ridge Road and markets in the Central Coast and Northern Sydney. This section provides a summary of a traffic assessment completed by Cardno (NSW) Pty Ltd (Cardno NSW, 2006) and includes information on:

- the existing regional and local road network, including existing road classifications, traffic levels and safety considerations (Section 4.5.2);
- the project related roadworks and proposed traffic types and levels (Section 4.5.3);
- the proposed management of traffic and operational safeguards (Section 4.5.4); and
- an assessment of the potential impacts of the project and project related roadworks on the local and regional road network and road users (Section 4.5.5).

Cardno NSW (2006) is presented in full as Part 8 in Volume 2 of the *Specialist Consultant Studies Compendium*.

4.5.2 The Existing Environment

4.5.2.1 Local Road Network

The Somersby Fields Project Site is located adjacent to Peats Ridge Road approximately 800m west of the Somersby Interchange on the Newcastle–Sydney (F3) Freeway. **Figure 4.22** displays the F3 Freeway, Peats Ridge Road, Wisemans Ferry Road and the remaining local roads around the Somersby Fields Project Site.

The Newcastle-Sydney (F3) Freeway is part of a major road transport route linking Sydney with the Central Coast and Newcastle. The F3 is a high speed, divided three-lane two-way Freeway. The RTA has management and maintenance responsibility for the F3.

Peats Ridge Road (MR 455) is an undivided two-lane two-way rural arterial road. Peats Ridge Road was formerly a main road that carried all major traffic between Newcastle and Sydney before the F3 Freeway was completed. The road now provides an important link for residents and businesses on the Somersby Plateau to the F3 Freeway. It is noted that both the hard rock quarries at Peats Ridge and Kulnura direct a proportion of their product trucks to the Somersby Interchange on the F3 Freeway via Peats Ridge Road. Peats Ridge Road is managed by Gosford City Council and the Roads and Traffic Authority (RTA) (who provide part funding for road maintenance).

Wisemans Ferry Road is a local undivided two-lane two-way rural collector road which provides generally north-south access across the Somersby Plateau from the Somersby Industrial Estate (near the F3 Gosford Interchange) and various centres north and northwest of Somersby (eg. Mangrove Mountain). Wisemans Ferry Road is also used by product trucks travelling to and from two quarries fronting onto Grants Road, Somersby. Wisemans Ferry Road is managed by Gosford City Council and the RTA (who provide part funding for road maintenance).

Marabunga Road is a ‘no through’ local road (180m long) providing access to one rural-residential lot, the western boundary of the Project Site and to various communications towers on both sides of the road. Marabunga Road is a minor local road, managed by Gosford City Council.

The road formations for Peats Ridge Road, Wisemans Ferry Road and Marabunga Road essentially consist of travelling traffic lanes in each direction, shoulders, verges, batters and table drains. **Table 4.39** presents the existing road formation widths. **Figure 4.23** shows the existing traffic management adjacent to the Project Site.

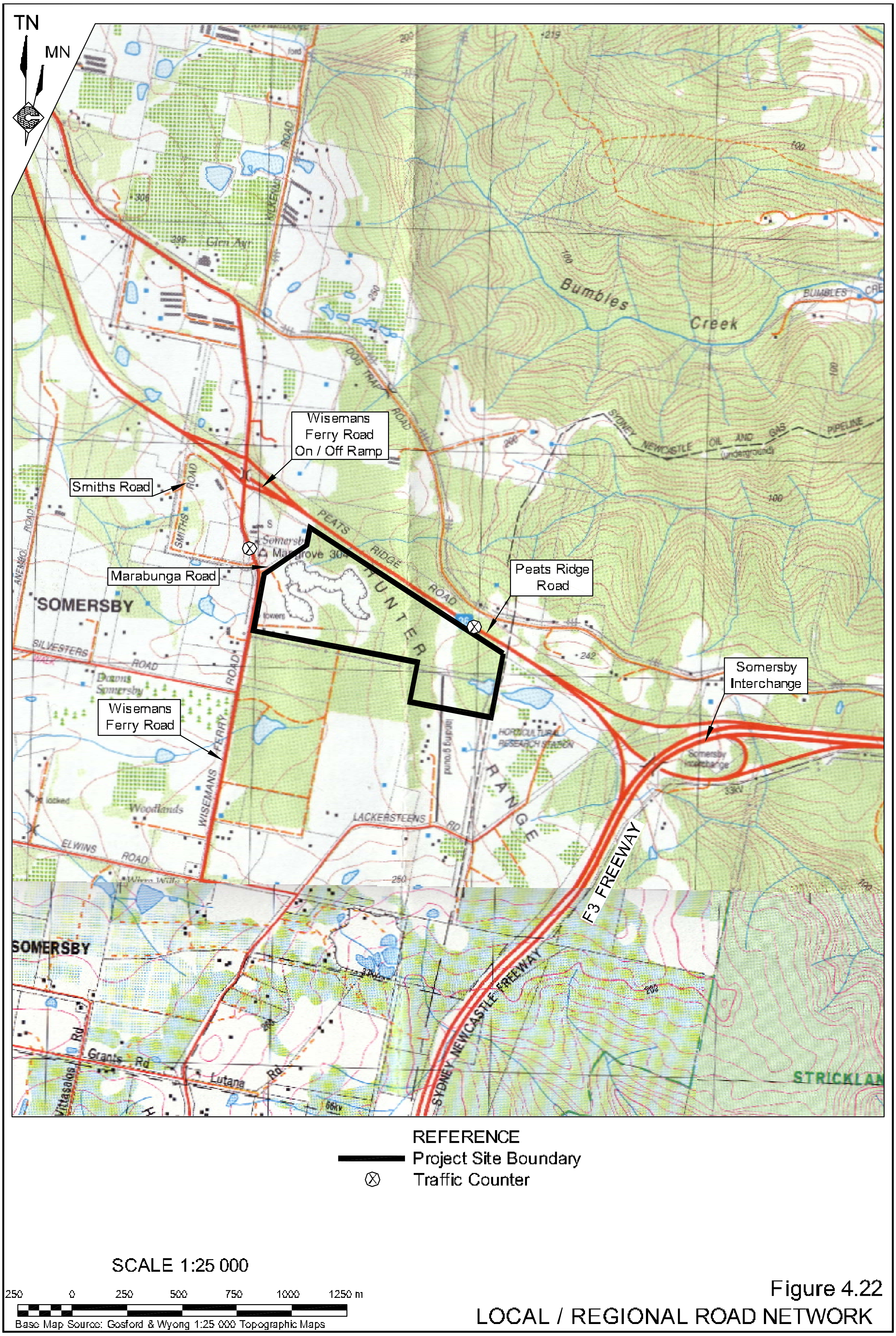


Figure 4.22
LOCAL / REGIONAL ROAD NETWORK

Table 4.39
Road Formation Widths

Road Classification or Hierarchy	Road Name	Traffic Lanes	Shoulders	Verges
Freeway	F3	3.5m sealed	2m-left & 1m-right	1m to 2m and variable batter to drains
Rural Arterial	Peats Ridge Road (MR455)	3.5m to 4.0m sealed	1.2m sealed	2.5m and variable batter to drains
Rural Collector	Wisemans Ferry Road	3.2m sealed	1.2m unsealed	Variable width batter to drain
Local Road	Marabunga Road	3.0m part sealed/unsealed	1.0m unsealed	Variable width batter to drains
Source: Cardno NSW (2006) – Table 2.0				

Cardno NSW (2006) provides greater detail on the existing traffic management of these roads including lane widths, intersections, traffic speed zones, road formation and street lighting.

4.5.2.2 Traffic Levels and Conditions

4.5.2.2.1 Traffic Levels

Automatic traffic counters were placed on Peats Ridge Road 1.5km west of the Somersby Interchange and Wisemans Ferry Road 30m north of Smith Road (see **Figure 4.22**) for the period of 28 August 2005 to 16 September 2005. These traffic counters recorded hourly vehicle volumes, vehicle classification and vehicle speed at these locations.

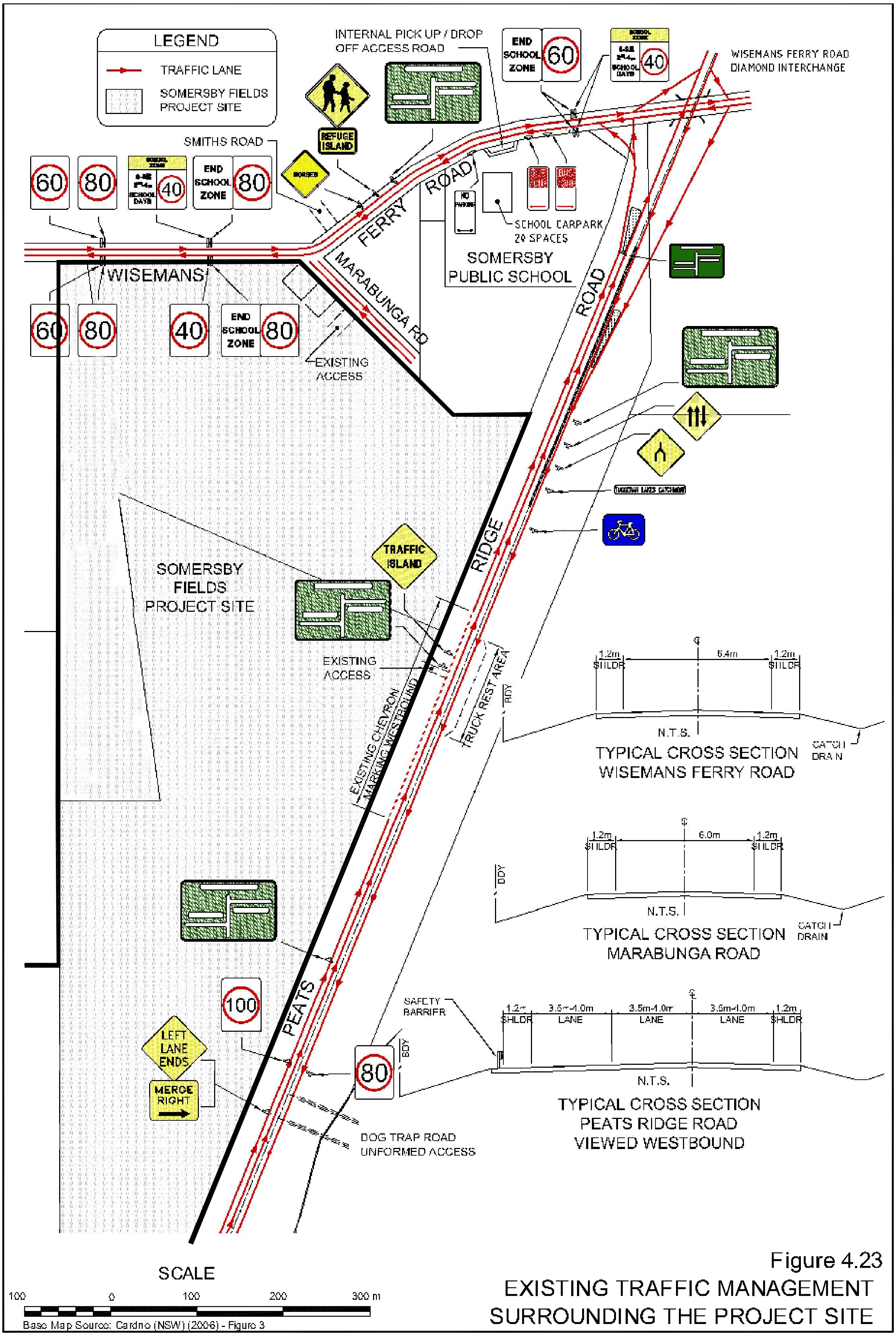
Average Daily Traffic

Table 4.40 compares the recorded September 2005 traffic counts for Average Daily Traffic (ADT) against the RTA's maximum ADT volumes for the respective road types.

Table 4.40
Estimated Existing Average Daily Traffic Volumes

Road Name	Road Type	Estimated ADT (vpd) #	RTA Maximum ADT (vpd)*
F3	Freeway	>70,000	>30,000
Peats Ridge Road	Arterial	3,400	30,000
Wisemans Ferry Road	Collector	1,980	3,000
Marabunga Road	Local	10	300
* Maximum 24 hour volumes	vpd = vehicles per day		# Based on recorded volumes
Source: Cardno NSW (2006) - Table 3.0			

The comparison of **Table 4.40** illustrates that with the exception of the F3 Freeway, the local road network carries daily traffic volumes that are much less than the RTA nominated capacity. ADT volumes are considered light and the existing road links can carry greater volumes of traffic.



Base Map Source: Cardno (NSW) (2006) - Figure 3

Figure 4.23
EXISTING TRAFFIC MANAGEMENT SURROUNDING THE PROJECT SITE

Existing Hourly Traffic Flow

Figure 4.24 presents the ADT pattern for a 24-hour period for Peats Ridge Road and Wisemans Ferry Road.

Each road exhibits an AM and PM peak period. Traffic on Peats Ridge Road follows a typical rural pattern with an estimated peak hour flow of 340 vehicles per hour (vph). Wisemans Ferry Road follows a typical urban pattern, due to the existing land use activity (school, general store and BP garage) and business hour operational times that attracts regular customers with an estimated peak hour flow of 200vph.

4.5.2.2.2 Existing Traffic Conditions

F3 Freeway

The F3 Freeway between the Central Coast and Sydney is one of the busiest National Highway corridors, carrying more than 70 000 vehicles daily. The F3 Freeway carries between 15% and 25% heavy vehicles, depending on the time of day.

The traffic conditions along the F3 Freeway are variable and subject to change due to:

- daily peak period and seasonal traffic demands;
- freeway capacity limitation and bottle necks;
- variable speed limits;
- accidents;
- ongoing maintenance; and
- bushfire hazard.

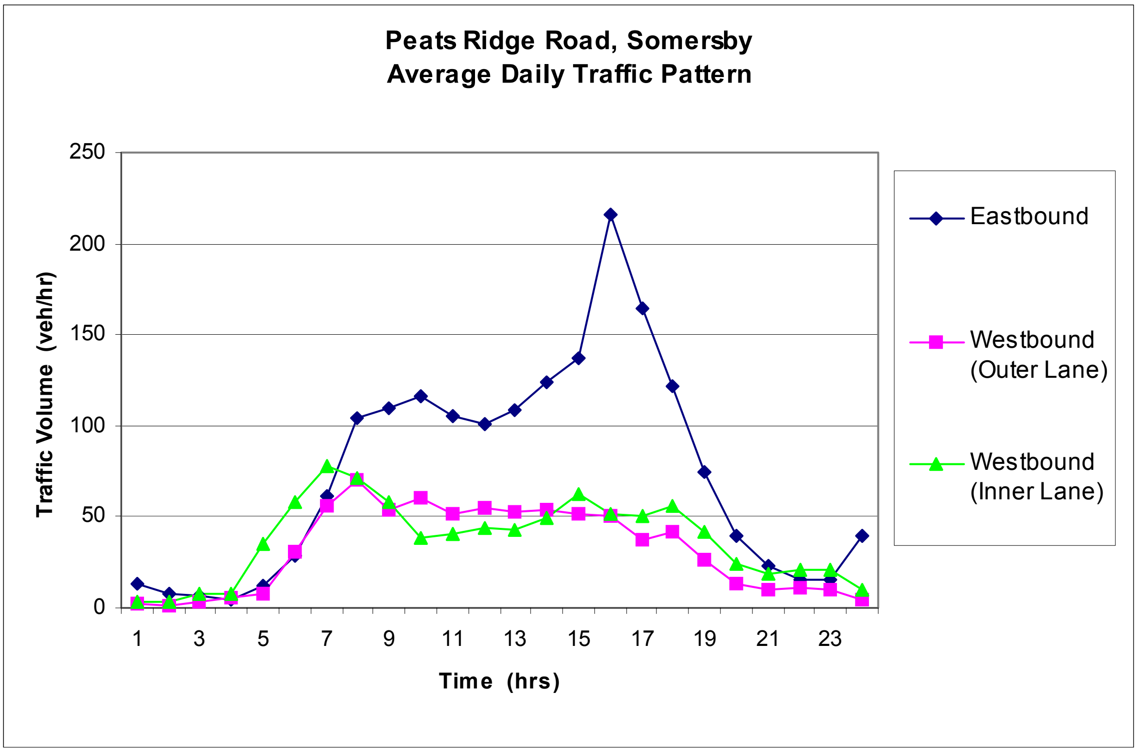
Annual traffic growth on the F3 Freeway since the late 1980's has been approximately 5%.

Peats Ridge Road

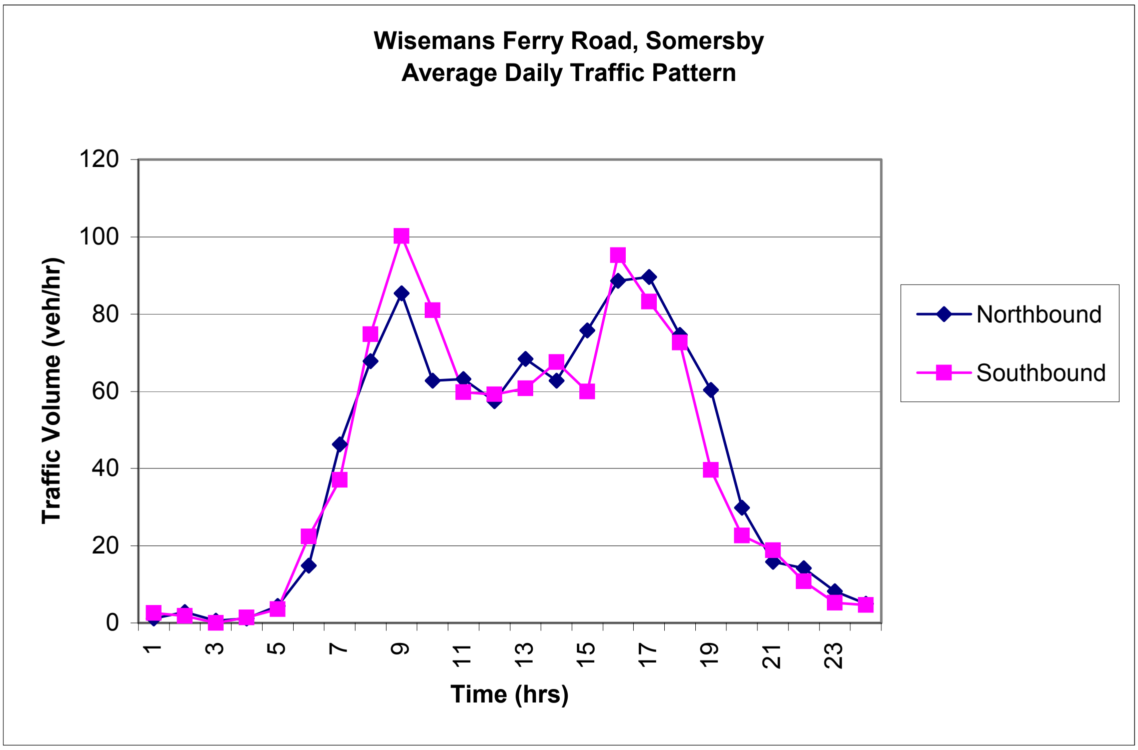
- Peats Ridge Road forms part of the Gosford Local Government Area regional road network with an APT of 3 400vpd and a historical growth rate of 2.5%. Peats Ridge Road operates with an 'A' level of service, ie. operating conditions are good with negligible delays and minor queuing. **Table 4.41** presents a summary of vehicle classification and vehicle speeds travelling on Peats Ridge Road.

Table 4.41
Peats Ridge Road Vehicle Classification and Speed Summary

Eastbound		Westbound Outer Lane		Westbound Inner Lane	
Vehicle Classification					
Light	Heavy	Light	Heavy	Light	Heavy
87%	13%	73%	27%	93%	7%
Vehicle Speed Summary					
Mean	85th Percentile	Mean	85th Percentile	Mean	85th Percentile
95 km/hr	104 km/hr	88 km/hr	101 km/hr	92 km/hr	101 km/hr
Source: Modified after Cardno NSW (2006) – Tables 4.0 and 5.0					



PEATS RIDGE ROAD



WISEMANS FERRY ROAD

Source: Cardno NSW (2006) – Figures 4.0 and 5.0

Figure 4.24
24-HOUR DAILY TRAFFIC PATTERNS

The high proportion of heavy vehicles is consistent with the percentage of heavy vehicles found on other main roads and it reflects the presence of a number of sand quarries, hard rock quarries and agricultural enterprises within the Somersby area. The high 85th percentile speed compared to the statute speed limit reflects the fact that traffic conditions are light and drivers' are generally free to choose their speed in an uninterrupted traffic flow environment.

Wisemans Ferry Road

Wisemans Ferry Road operates in peak periods with an 'A' level of service. The traffic volume of 1980vpd presented in **Table 4.40** is considered light. **Table 4.42** presents a summary of vehicle classification and vehicle speeds travelling on Wisemans Ferry Road.

Table 4.42
Wisemans Ferry Road Vehicle Classification and Speed Summary

Northbound		Southbound	
Vehicle Classification			
Light	Heavy	Light	Heavy
90%	10%	91%	9%
Vehicle Speed Summary			
Mean	85th Percentile	Mean	85th Percentile
63 km/hr	71 km/hr	62 km/hr	71 km/hr
Source: Modified after Cardno NSW (2006) – Tables 6.0 and 7.0			

As is the case for Peats Ridge Road, the high proportion of heavy vehicles reflects the presence of a number of sand quarries, hard rock quarries and agricultural enterprises within the Somersby area. The high 85th percentile speed compared to the statute speed limit reflects the fact that traffic conditions are light. Despite this, these elevated 85th percentile speed has the potential to be hazardous to unaware pedestrians and turning vehicles, as the stopping sight distance at the 85th percentile speed would almost double that for the statute speed limit.

Marabunga Road

As Marabunga Road is a local access road providing access to property, transmission and electrical infrastructure, it is estimated that this road carries about ten (10) vehicle movements daily.

Intersections

There are two intersections in the immediate vicinity of the Project Site, namely:

- Wisemans Ferry Road - Peats Ridge Road; and
- Marabunga Road - Wisemans Ferry Road.

Both operate with an 'A' level of service, and operating conditions are good with minimal delays and spare capacity (Cardno NSW, 2006).

In addition to these two intersections, the delivery of sand products from the Project Site would require the use of a further intersection within the local road network, namely:

- F3 Freeway - Peats Ridge Road (Somersby Interchange).

The Somersby Interchange is a T – Interchange where all crossing conflicts are eliminated, and all manoeuvres to and from Peats Ridge Road take place by merging and diverging via on and off ramps. Based upon calculations using a combination of historical and current traffic data the expected existing level of service (LoS) would range from LoS "A" in off-peak times to a LoS "C" in the peak periods, that is satisfactory with drivers' required to carefully plan and negotiate their merging and diverging manoeuvres during the peak periods.

4.5.2.3 Road Safety Conditions

Accidents, accident rates and pedestrian exposure, are measures of road safety used to assess the safety of the local road network.

Accidents and Accident Rates

Accident records for the local road network were obtained from the RTA for the 5 year period 2000 - 2004. **Table 4.43** presents a summary of all recorded intersection and mid block accidents in this time period.

Table 4.43
Summary Accidents within Study Area 2000-2004

Location	Accident Severity			Heavy Vehicle Accident	Light Vehicle Accident	Total Vehicle Accidents
	Killed	Injury	Tow-away			
Intersection						
Wisemans Ferry Road with						
• Smith Street (south)	0	0	0	0	0	0
• Marabunga Road	0	0	0	0	0	0
• Peats Ridge Road On & Off Ramps	0	1	1	0	2 x Car	2
F3 Somersby Interchange	0	5	20	1 x Truck	24 x Car	25
INTERSECTION TOTAL	**0**	**6**	**21**	**1**	**26**	**27**
Midblock						
Wisemans Ferry Road	0	0	1		2 x Car	2
Peats Ridge Road	0	3	1	3 x Truck	1 x Car	4
Midblock Total	**0**	**3**	**2**	**3**	**3**	**6**
Source: Cardno NSW (2006) – Table 9.0						

No fatal accidents were recorded with intersection accidents accounting for 82% of all accidents (27 of 33). The remaining 18% of accidents (6 of 33) occurred midblock. All accidents involved vehicle/vehicle or vehicle/object crashes. Notably, only a small proportion (15%), of total accidents involved trucks.

Table 4.44 presents the accident rate for the local road network.

Table 4.44
Accident Rates

Location	Average Accidents Rates (Mvkt* per year)
Peats Ridge Road	0.366
Wisemans Ferry Road	1.10
Marabunga Road	0
* Mvkt = million vehicle kilometres travelled	
Source: Cardno NSW (2006) – Table 10.0	

A comparison between the average accident rate for rural two-lane undivided roads (RTA, 2004) and the local road network rate indicates the accident rate of Peats Ridge Road and Wisemans Ferry Road is higher than the NSW average of 0.328 accidents per million vehicle kilometres travelled.

Other Road Users

Cyclists, horse riders and pedestrians also use the local road network with details for each user provided in Cardno NSW (2006) (see Sections 5.3 to 5.6).

Observations undertaken along Peats Ridge Road and Wisemans Ferry Road indicated only a small number of pedestrian movements within the local road network, with pedestrian movements occurring more frequently along Wisemans Ferry Road (Cardno NSW, 2006). Given the number of pedestrians and vehicle traffic flow are low in those areas most frequently used by pedestrians, Cardno NSW (2006) consider the current pedestrian exposure or risk of accident to be low. RTA accident records (RTA, 2004) confirm this with no records of accidents involving pedestrians.

4.5.3 Project-related Roadworks and Traffic

4.5.3.1 Project-related Roadworks

The proposed Somersby Fields Project would require the construction of a grade T-intersection with a right turn channelisation (CHR) defined by painted medians and lane markings. Truck movements would be left turn in and right turn out only. **Figure 2.11** presented the conceptual layout incorporating this treatment which would require road widening and intersection construction works. These works would potentially impact on short term traffic flow conditions because of the proposed extent and physical nature the roadworks.

4.5.3.2 Project-related Traffic

Section 2.7 presented the proposed traffic types and volumes to be generated by the project. Product transportation would operate the equivalent to 280 days per year, weekdays between 5:00am and 10:00pm and weekends (Saturday only) between 5:00am and 4:00pm. It is estimated that the Project Site would attract 12 external truck trips per hour in the peak period.

The site entrance - Peats Ridge Road intersection would also attract minor volumes of traffic as result of:

- the sale of small quantities mulch/chipped vegetation that is a natural by-product of the vegetation clearing at the beginning of the commissioning and subsequent sand removal staging;
- visits by the garbage truck on an as-needed basis;
- maintenance of the processing plants; and
- the supply of fuel to the on-site 15 000 litre diesel tank and on-site mobile earthmoving equipment daily. All product trucks would be fuelled off site.

These "other" trips are assessed as 10 vehicle trips per day or 1 vehicle per hour, inbound and outbound in the peak periods.

4.5.4 Proposed Design Features, Traffic Management and Safeguards

4.5.4.1 Design Features

Site Entrance – Peats Ridge Road intersection

Two site entrance designs were considered for the entry and exit of heavy vehicles from the Project Site; the conceptual design presented as **Figure 2.11** and a short Auxiliary Right Turn Treatment (AUR) for left turn in and left turn out traffic. This intersection design would have required the movement of heavy vehicles through the Wisemans Ferry interchange to enable a U-turn back to the F3 Freeway. To minimise the potential impact on road users and pedestrians of Wisemans Ferry Road, and the Somersby Public School, this alternative was discounted.

The incorporation of an eastbound acceleration lane for Project Site exiting trucks was considered but ultimately discounted due to the limited inter-visibility that would occur between the merging truck driver and the eastbound through traffic. The RTA guidelines support this design feature for intersections where the movement is predominantly used by a high proportion of trucks (Cardno NSW, 2006).

An existing rock embankment, approximately 45m to 75m east of the site entrance would be trimmed back to ensure an uninterrupted site line in this direction.

To facilitate the safe entry of project-related vehicles onto Peats Ridge Road, Cardno NSW (2006) recommend the extension of the 80km per hour speed zone limit to the Wisemans Ferry Road Interchange Overpass.

Site Access Road

The site access road has been designed to 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 14.5%.
- The site access road would be sealed from a wheel wash facility to Peats Ridge Road to reduce the tracking of mud onto the local road network.
- Pavements would be designed for heavy vehicle loadings and in-situ sub-grade conditions to ensure adequate serviceability in wet weather conditions for the 15 to 18 year project life.
- The road layout would ensure that all vehicles could enter and exit the site in a forward direction.

In addition, the onsite maximum truck speed would be signposted and restricted to 30kmh.

4.5.4.2 Operational Safeguards and Management Measures

The level of impact associated with the proposed transportation of sand products would ultimately depend on the management of heavy vehicles entering and exiting the Project Site. The following management procedures and operational safeguards are proposed and would be strictly enforced.

(i) All construction related traffic would be managed in accordance with the Australian Standards including a short term reduction in the speed limit approaching and adjacent to road construction works.

(ii) A "Dial - Before -You – Dig" enquiry and site verification would be undertaken to verify the location of all services prior to commencing construction.

(iii) The number of trucks entering and exiting the Project Site would be initially restricted to the number required to despatch 250 000t of sand per year, ie. average of 60 movements and 85th Percentile of 80 movements each day. This would increase to an average of 108 movements and 85th Percentile of 144 movements each day as production is increased to the 450 000tpa anticipated by Year 3 or 4 of the project.

(iv) Transport operations would adhere to the proposed (and subsequent approved) hours of operation (see **Table 2.6**), that is, no vehicles would enter or leave the site outside the designated hours.

(v) All speed limits would be strictly adhered to.

(vi) The Proponent would establish a complaints register, advertised in the local telephone directory, to allow concerned residents to report any traffic-related incidents, unsafe operation or general concern. The Proponent would investigate all complaints and act decisively on substantiated incidents.

(vii) All exiting trucks would use an on-site weighbridge to ensure all weight restrictions (GVM < 50t) are adhered to.

(viii) Mechanical road sweeping would be undertaken if required to reduce the potential for dust lift-off.

(ix) The Proponent would ensure all loads are covered to minimise, dust and particulate matter and debris emissions.

(x) The Proponent's expectations of all truck drivers would be explicitly recorded in a Driver's Code of Conduct that each driver would be required to sign prior to leaving site for the first time.

The transport operation and the project, in general, would be operated in an open and transparent fashion. Through the establishment of the complaints register and ongoing consultation with the local community, the Proponent would maintain and improve its performance against all transport-related criteria.

4.5.5 Assessment of Impacts

4.5.5.1 Introduction

The project would require the construction of an intersection with Peats Ridge Road to allow for the entry and exit of project related traffic. Traffic would be generated / attracted to the Project site during the construction, product transportation and decommissioning phases, as shown in **Table 4.45**.

Table 4.45
Proposed Traffic Generation - Peats Ridge Road

	Indicative Period	Heavy Vehicle Movements per Day	Light Vehicle Movements per day
Construction	Year 0 to Year 1	10	30
Product Transportation (250 000tpa)	Year 1 to Year 2	Min 20 Average 60 85^{th}% 80	Site Work Force 16 Other Vehicles 4 Total = 20
Product Transportation (450 000tpa)	Year 3 to Year 14.	Min 20 Average 108 85^{th}% 144	Site Work Force 30 Other Vehicles 6 Total = 36
Decommissioning	Year 15	10	30
Source: Cardno NSW (2006) – Table 11.0			

The following sub-sections assess the impact of this proposed construction and traffic levels on the local road network function and operation.

4.5.5.2 Functional Impacts

4.5.5.2.1 Traffic Management During Construction

Construction work would be undertaken outside the existing travel lanes and involve the clearing, stripping, bulk earthworks, drainage works, pavement works and line marking necessary to enhance safe and convenient all weather access.

By managing traffic approaching, and adjacent, to the proposed roadworks in accordance with the Australian Standards, the proposed construction works would have a negligible impact on the operation and functioning of Peats Ridge Road and Wisemans Ferry Road.

4.5.5.2.2 Site Entrance – Peats Ridge Road intersection

The site entrance – Peats Ridge Road intersection would be positioned sufficient distance (estimated to be 115m) east of the merge zones of the Wisemans Ferry Road Interchange to allow drivers' at the 80km/hr design speed sufficient time to observe the approaching intersection, prevailing traffic conditions, react, manoeuvre, or stop if necessary, before entering a conflict area. Allowing for the intersection layout dimensions, the centreline of the site entrance would be located 385m east of the end of the Wisemans Ferry Road Interchange Peats Ridge Road eastbound on ramp. To improve overall safety the existing 80km per hour speed zone would need to be moved west to the Wisemans Ferry Road Interchange overpass.

Assuming an existing rock embankment east of the site entrance is trimmed back, approach intersection sight distance (ASD) and safe intersection sight distance (SISD) would be provided by the site entrance – Peats Ridge Road intersection.

4.5.5.2.3 Pavement Maintenance Issues on Peats Ridge Road

The added heavy vehicle movements to the existing traffic levels would influence the existing pavement performance. Pavement maintenance issues due to an increase in heavy vehicle movements would include:

- repairs to forms of distress;
- provision of additional pavement strength;
- rehabilitation strategies; and
- restoration of pavement shape.

The extent to which an increase in heavy vehicle movements from the Somersby Fields Project would cause or precipitate such maintenance action, would depend upon the number, size and type of additional vehicles. To assess the loading impact, the number and type of heavy vehicles is broken down into axle groups and expressed in terms of Equivalent Standard Axles (ESAs). The loads on each of the axle groups are considered to be equivalent as they produce the same maximum surface deflection and cause the same relative damage to a pavement.

Table 4.46 presents the estimated ESA's "without" and "with" the project related traffic for the 15 year life span of the project, assuming a growth rate of 2.5%.

The results in **Table 4.46** indicate a 15% increase in the estimated ESA's for the life of the Somersby Fields Project.

Cardno NSW (2006) estimate the cumulative roughness[2] of Peats Ridge Road over the 15 to 18 year project life would be increased from 37.5 counts per km to 43.18 counts per km. This represents an increase of 5.6% and reduction in the pavement design life of 2.27 years. As such, the project would have a low impact on the condition of the road pavement over the life of the project.

Table 4.46
Estimated ESA's Without and With the Development

Year	Average Daily Traffic Without Development	Development Additional Traffic	Average Daily Traffic With Development	% Heavy Vehicles	ESA's Without Development	ESA's With Development
2005	3400	0	-	15.70%	-	-
2006	3485	36	3521	16.66%	379445	406723
2007	3572	72	3644	17.02%	388931	430187
2008	3661	108	3769	17.48%	398654	457030
2009	3753	144	3897	17.92%	408621	484264
2010	3847	144	3991	17.87%	418836	494478
2011	3943	144	4087	17.82%	429307	504947
2012	4042	144	4186	17.77%	440040	515677
2013	4143	144	4287	17.72%	451041	526676
2014	4246	144	4390	17.67%	462317	537950
2015	4352	144	4496	17.62%	473875	549506
2016	4461	144	4605	17.58%	485722	561351
2017	4573	144	4717	17.53%	497865	573492
2018	4687	144	4831	17.49%	510311	585937
2019	4804	144	4948	17.45%	523069	598693
2020	4924	144	5068	17.41%	536146	611768
				TOTAL ESA's	**6804181**	**7838680**
Source: Cardno NSW (2006) – Table 13.0						

4.5.5.3 Operational Impacts

4.5.5.3.1 Traffic Conditions

The proposed site entrance – Peats Ridge Road intersection would cater for left turn entry and right turn exit from the Project Site. Due to fully laden heavy vehicles requiring about 60 to 80 seconds to accelerate to the proposed 80km/hr design speed of the through traffic, through traffic would need to slow down behind the laden truck as it accelerates to the 80km/hr speed limit. Under this circumstance, the uninterrupted traffic flow conditions would be disturbed causing some minor traffic congestion and delay to through traffic. Light vehicles departing by the left turn movement would need to manoeuvre their vehicle into a suitable gap (>14seconds) in the near side traffic stream.

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[2] A pavement's condition or rate of deterioration is typically measured in terms of roughness (counts per km). Research indicates that pavement roughness at the end of its design life would be approximately 150 counts per km and a new pavement would have an initial roughness of 50 counts per km. Arterial Road pavements typically have a design life of 20 years to 40 years. Peats Ridge Road was and still is an important major road link in the road network, therefore a 40 year pavement design life is considered appropriate for this impact assessment.

There may also be a slight increase in the potential for vehicle/vehicle accidents mid-block on Peats Ridge Road.

During the operation of the project, traffic volumes generated and attracted to the Project Site at the Peats Ridge Road entrance would peak in association with the quantity of product despatched. This is anticipated to occur in Year 4 and continue at this level until Year 15 of the project life span. Therefore, the main traffic operational impacts on Peats Ridge Road would occur between Year 4 and Year 15.

Traffic growth has been estimated at 2.5% annually and **Figures 4.25** and **4.26** present hourly traffic levels for the morning and afternoon peak periods in Year 4 (2009) and Year 15 (2020), with Project Site peak hourly traffic levels superimposed.

The figures show a distribution of the expected vehicular movements to and from the site, with one trip equal to two vehicle movements. The associated trip distribution is as follows.

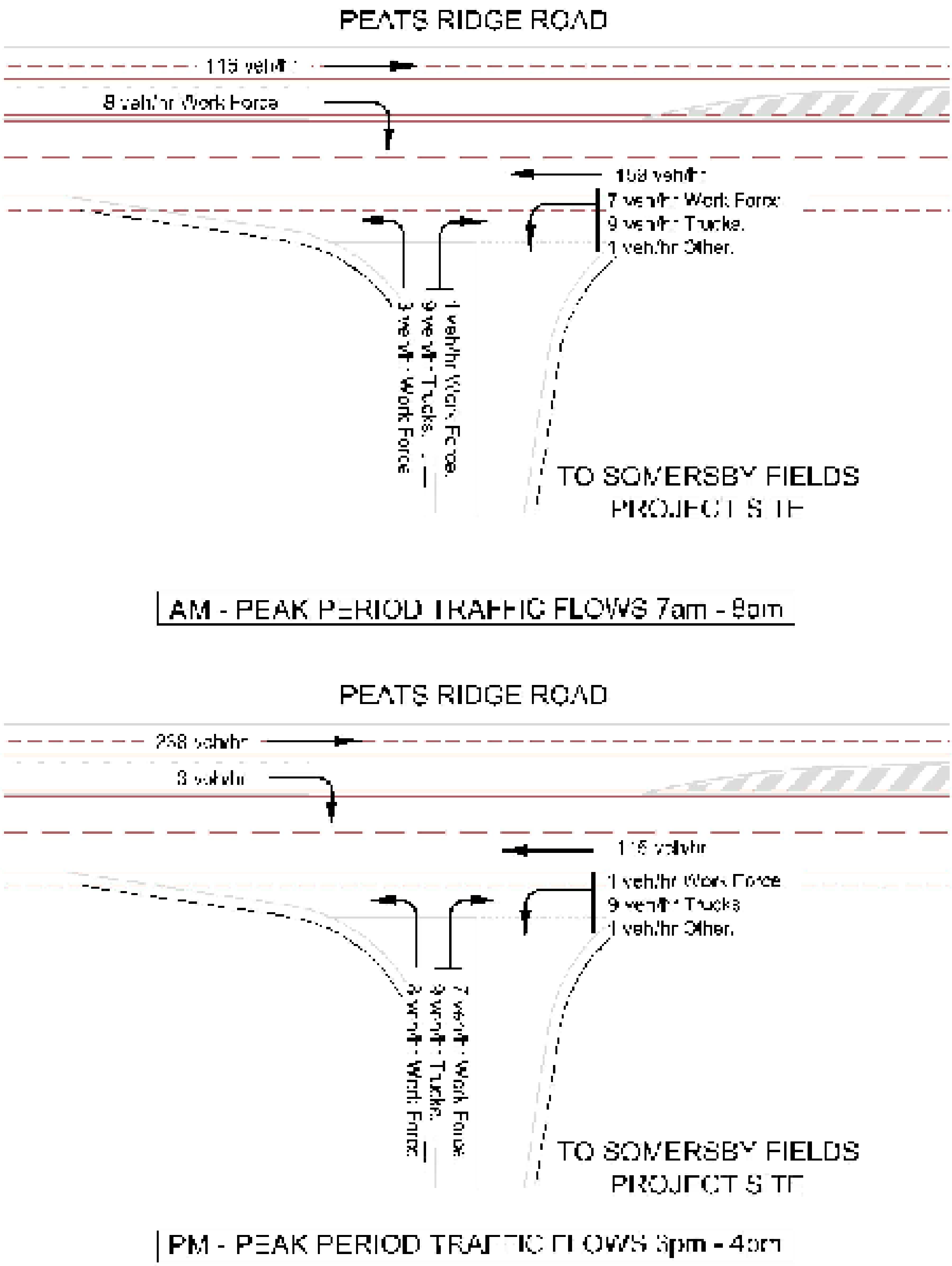
- Truck Trips: AM and PM 50% inbound and 50% outbound.
- Work Force Trips: AM peak 80% inbound and 20% outbound.
- Work Force Trips: PM peak 20% inbound and 80% outbound.
- Other Trips: AM and PM 100% inbound and 100% outbound.

Traffic volumes in Year 4 (2009) and Year 15 (2020) (see **Figure 4.25** and **4.26**) are below the traffic volumes at which capacity analysis for an at grade intersection is warranted (Cardno NSW, 2006 – Section 4.4). The intersection level of service would be rated as Level of Service "A" in accordance with RTA guidelines. That is, operating conditions are good with negligible delays and minor queuing.

4.5.5.3.2 Risk to Safe Travel of Somersby Public School Children and Staff

All product trucks leaving and returning to the Project Site would use Peats Ridge Road and travel directly to and from the F3 Freeway. As such, no project-related trucks would travel in the vicinity of school children drop-off points or pedestrian access to the Somersby Public School. Potentially, a proportion of the on-site workforce in private cars would use Wisemans Ferry Road to gain access to the Project Site (~10vph), although most of the workforce would be travelling well outside the periods when school children arrive and depart from school.

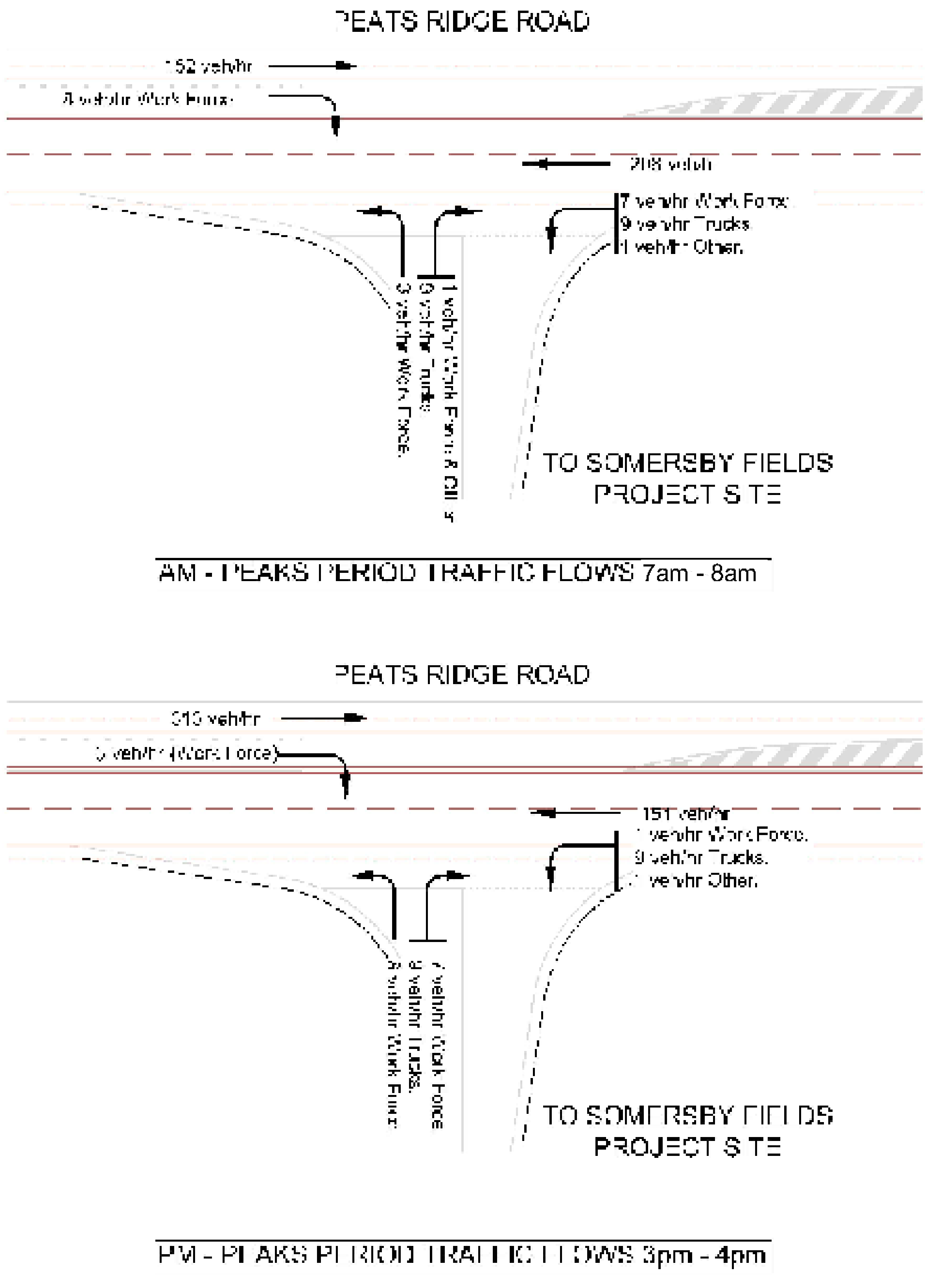
With the Somersby Fields Project, the maximum peak period traffic is estimated to be 278vph (268vph + 10vph) and therefore the increased traffic generated by the Somersby Fields Project superimposed on the background traffic up to Year 15 is not significant enough to alter the existing low risk or exposure rating outlined in Section 4.5.2.3. After Year 2020, the Somersby Fields Project would be decommissioned eliminating project generated traffic and any potential or perceived risk brought about by the Project.



Source: Cardno (NSW) (2006) - Figure 11.0

Figure 4.25
HOURLY TRAFFIC LEVELS - YEAR 4

Note: A Colour Version of this figure is available on the project CD



Source: Cardno (NSW) (2006) - Figure 12.0

Figure 4.26
HOURLY TRAFFIC LEVELS - YEAR 15

Note: A Colour Version of this figure is available on the project CD

4.5.5.4 Cumulative Impacts

The assessment of impacts outlined above takes into account the cumulative impacts of trucks travelling to and from other quarries on the Somersby Plateau as traffic movements associated with these quarries are already captured in the measured traffic counts recorded in August / September 2005. At the time of those traffic counts, the Rindean Quarry adjacent to Wisemans Ferry Road at Somersby was not operational. This quarry received a deferred commencement development consent from Gosford City Council in June 2006 (see Section 4.1.4.4) which would enable the resumption of truck movements from the quarry. The Environmental Impact Statement for the redevelopment of the quarry noted that the bulk of the average 20 loads per day would be destined to Sydney markets and would involve traffic movements to the south along Wisemans Ferry Road. A small proportion, less than an average of 2 truck movements per hour, would travel northwards along Wisemans Ferry Road (past Somersby Public School), onto Peats Ridge Road and to the F3 Freeway. In light of these additional movements on Peats Ridge Road, if the quarry redevelopment proceeds, there would be negligible cumulative impact arising from the operation of the Rindean Quarry.

4.5.5.5 Conclusion

The impact assessment describes the impact in the following way. Either there would be:

- a benefit;
- **no impact** on the environment;
- **minor impact** on the environment during or as a result of the activity or process which can be minimised by appropriate mitigation measures;
- **substantial impact** on the environment that would require detailed consideration, modification of the activity, rectification, repairing, restoring, rehabilitating, maintenance, the use of new technology, substitute resources or the application of physical or operational mitigation measures; or
- **significant impact** on the environment such that the activity should not proceed in its present form.

The impact assessment of Cardno NSW (2006) identified one benefit to the local environment as follows.

- Improved accessibility of vehicular access from the Project Site to the F3 Freeway.

Cardno NSW (2006) also identified 11 minor impacts that would be mitigated by the project design features, operational safeguards and management measures as follows.

- A slight increase in traffic and vehicle noise levels which would be mitigated by restricting the number of vehicular movements during the early morning and evening periods and discouraging the use of air compression breaks.

- Vehicle lighting associated with night-time and early morning product transportation.
- A potential slight increase in dust deposition levels associated with the construction of the proposed Project Site intersection and access road. This would be largely mitigated through dust suppression activities and the installation and use of a wheel wash facility.
- There may be a slight increase in the safety hazard to on-site workforce and visitors through conflicts with heavy vehicles. Workforce education and enforcement of requirements to wear appropriate clothing (safety vest etc.) would mitigate this impact.
- A possible minor impact to the convenience of site users as a result of vehicle queuing and congestion would be minimised by the provision of the proposed on-site parking.
- Regular vehicle inspections and the use of a site weighbridge would reduce the potential for excessive truck wear and tear, which may lead to an increase in vehicle exhaust emissions.
- The 60 to 80 seconds required by laden product trucks to reach the 80km/hr speed limit of Peats Ridge Road would lead to a minor delays to eastbound traffic. This would be mitigated through driver education to be cognizant to merging in a suitable gap in the traffic stream.
- The 60 to 80 seconds required by laden product trucks to reach the 80km/hr speed limit of Peats Ridge Road may also slightly increase the safety risk mid-block on Peats Ridge Road through minor increase to traffic congestion.
- The potential impact on the safety of Somersby Public School children & teachers as well as other road users in the vicinity of Somersby Public School would be mitigated by the restriction of heavy vehicles to left turn entry and right turn exit only at the Project Site.

Four substantial impacts were identified by Cardno NSW (2006) which would be mitigated by the project design features, operational safeguards and management measures as follows.

- A new intersection would be constructed to enhance safe and convenient access from Peats Ridge Road to the Project Site. Section 4.5.5.2 provided an assessment of the construction and functional impacts associated with the proposed intersection.
- The increase in ESA's on Peats Ridge Road would reduce the pavement design life. Cardno NSW (2006) considered the classification of the road and the likely increase in ESA's associated with the project and the impact to be low (reduction in pavement design life of 2.2 years).
- Any increase in dust levels through the tracking of mud and sand onto Peats Ridge Road would be minimised through the sealing of the site access road between an installed wheel wash facility and the site entrance. All loaded trucks would be covered and mechanical road sweeping would be undertaken, if required.

- An increase in vehicle exhaust emissions would be an unavoidable impact of the project as a result of trucks entering and exiting the Project Site, when these vehicles are operating in the lower speed range where vehicle emissions are the highest.

Considering the minor nature of the majority of the (potential) impacts and that the mitigation of potential impacts is deemed to be substantial, the traffic related impacts of the project are considered acceptable.

4.6 FLORA

4.6.1 Introduction

The flora on the Project Site has been extensively studied over the past ten years, particularly since the main part of Mangrove Tower population of the threatened plant species *Prostanthera junonis* (Somersby Mintbush) is located along the northern side of the Project Site.

This report draws together and presents the results of the various flora studies and the comprehensive studies undertaken on *P. junonis* on the Project Site.

The flora assessment involved a search of all relevant flora databases, a literature review, field studies, and a series of analyses using recognised programs and models. A set of design and operational safeguards were then developed, and following acceptance by the Proponent, the project's impacts were subsequently assessed.

For the purposes of the flora study, the vegetation on the Project Site was assessed in its context for flora on a number of surrounding properties covering approximately 1.2km^2 - collectively referred to as the Study Area.

The description and assessment of flora on the Project Site was undertaken by Robert Payne - Ecological Surveys & Management (ES&M) whose report is included as Part 5 of the *Specialist Consultant Studies Compendium* for the project. This section focuses on the key issues relating to flora without duplicating extensive species lists etc. which can be found in Robert Payne – ES&M (2006).

4.6.2 Study Methodology

4.6.2.1 Database Search

A search of seven publicly available databases established that two databases (PlantNet and Atlas of NSW Wildlife) contained details of eight threatened plant species identified as potentially occurring on the Project Site. Three of the eight species have been identified on the Project Site, namely:

- *Prostanthera junonis;*
- *Hibbertia procumbens;* and
- *Tetratheca glandulosa*.

Payne (2006) records the reasons why the remaining five species are unlikely to be located within the Project Site.

4.6.2.2 Relevant Literature

The various ecological studies undertaken across the Project Site and surrounds over the past ten years are recorded in a number of unpublished and published reports. Those reports pertaining to the 1996 CSR Readymix proposal remain unpublished but contain a range of background information which has been incorporated in Robert Payne – ES&M (2006). Four published documents relate to the vegetation on the Project Site, namely:

1. Vegetation of the Gosford – Lake Macquarie 1:100 000 Map Sheet (Benson, 1986);
2. Vegetation Survey, Classification and Mapping, Lower Hunter Central Coast Region (NPWS, 2000a);
3. The Recovery Plan for *Prostanthera junonis* (Somersby Mintbush) (NPWS, 2000); and
4. The Natural Vegetation of the Gosford Local Government Area, Central Coast (Bell, 2004).

The Recovery Plan for *P. junonis* identifies the Mangrove Tower site as Population 6, ie. one of nine populations of *P. junonis* known in 2000. This population comprises subpopulations at the Tower itself, on the Somersby Fields Project Site, Peats Ridge Road reserve and a site north of Peats Ridge Road. Since that time, at least seven additional populations of *P. junonis* have been identified on the Somersby Plateau. Invariably, as further surveys are conducted, further populations are being identified. For example, in 2006, Robert Payne – ES&M identified an additional population within nine sites (up to 1 500 plants) within or close to the Brisbane Water National Park. It is noted from the Recovery Plan that the following objectives are relevant to the Somersby Fields Project, ie. to:

- "ensure the *P. junonis* populations are not destroyed as a consequence of habitat loss, and that an increased level of security is provided over lands which support *Prostanthera junonis* populations (Reservation / conservation Status of Populations);
- minimise the risk of *P. junonis* populations from declining in the long term through encouraging the implementation of appropriate threat and habitat management practices (Threat and Habitat Management);
- establish the full extent of the distribution of *P. junonis* (survey);
- ensure the management of *P. junonis* habitat;
- ensure the management of *P. junonis* habitat is informed by essential aspects of the species' biology and ecology (Biological Research);
- determine whether a declaration of critical habitat for *P. junonis* will provide greater protection for the species than which currently exists (critical habitat);
- understand the requirement for safeguarding genetic diversity of *P. junonis* for the purpose of reintroduction, following the extinction or irreversible decline of natural populations (Ex situ Conservation); and

- raise awareness among the broader community of the conservation status of *P. junonis* and to involve the community in the species' recovery program (Education / Awareness and Involvement)."

The inventory and plan of natural vegetation (Bell, 2004) identifies approximately 70 vegetation communities throughout the Gosford Local Government Area. It is noted that a number of the individual communities cover a comparatively small area, but in reality, have many similarities with other communities throughout the Gosford and adjoining local government areas. It is noted that the names assigned to vegetation communities are very localised.

The mapping of Bell (2004) records two main native vegetation communities on the Project Site, namely:

1. Somersby Plateau Forest (SP); and
2. Hawkesbury Banksia Scrub-Woodland (HBS).

A small area ($800m^2$) of Sandstone Hanging Swamp was mapped near the southern boundary of the Project Site in an area known to experience some localised seepage. Robert Payne – ES&M has suggested this small area could be a variant of the Hawkesbury Banksia Scrub-Woodland community.

4.6.3 Existing Vegetation

Figure 4.27 displays the vegetation map of the project based upon mapping by Bell (2004) and reproduced by Robert Payne – ES&M (2006). Robert Payne – ES&M (2006) originally undertook some additional mapping of the vegetation communities on the Project Site, which refined to some extent the mapping by Bell (2004). However, it was determined to rely on the Bell (2004) mapping given its consistency across Gosford Shire and Bell's previous knowledge of the previous detailed mapping on the Project Site in 1996. As discussed above, the main two native vegetation communities on the Project Site are namely:

(i) Somersby Plateau Forest (SP); and

(ii) Hawkesbury Banksia Scrub-Woodland (HBS).

The Somersby Plateau Forest community has trees ranging in height from 4m to 18m and a tree cover abundance of 10% to 30%. There is generally a lower layer of shrubs between 2m and 5m high and a third layer of undershrubs. Occasionally a fern and grass cover is present.

It is noted that a number of the isolated trees remain on "pedestals" at original ground level in the area typically 1m to 1.5m above the area previously extracted for ridge gravel for the F3 Freeway.

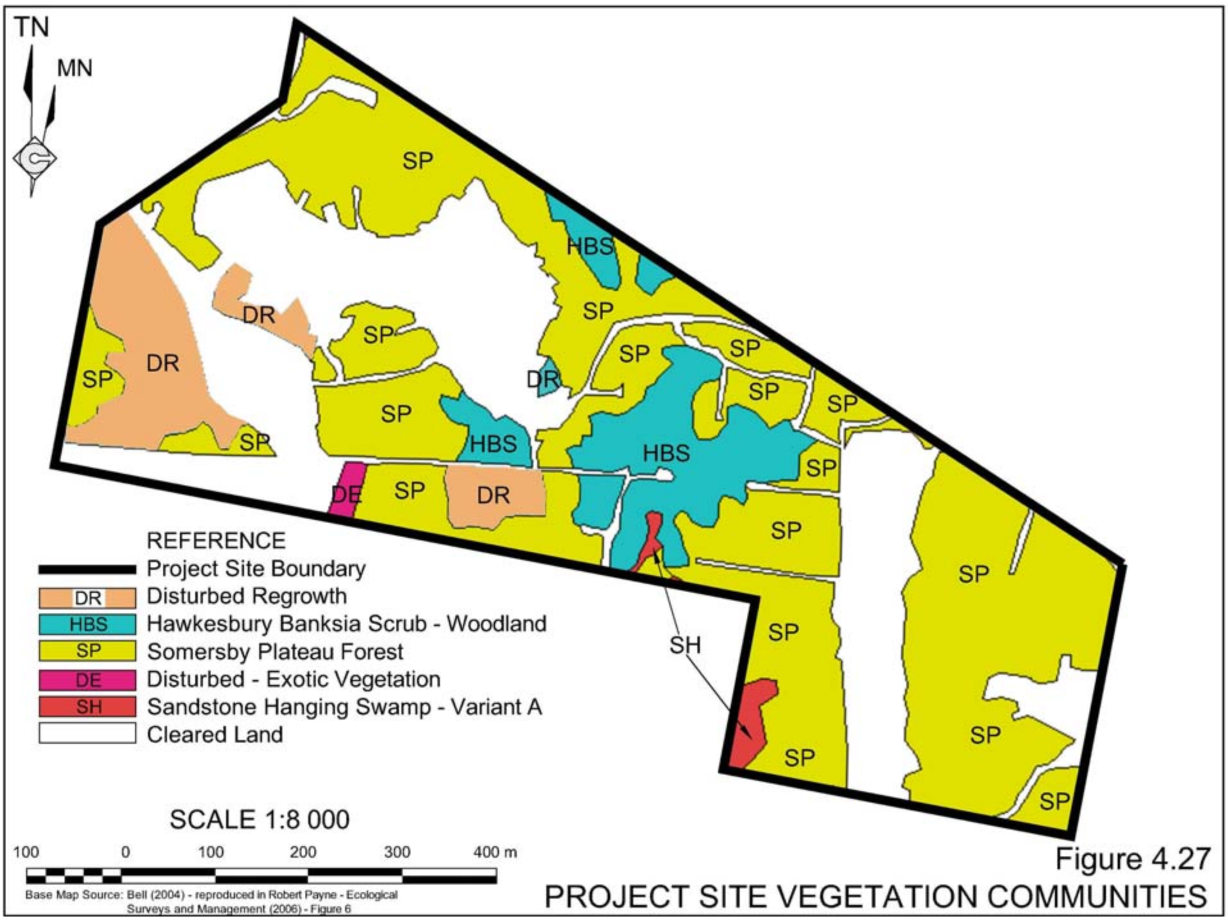


Figure 4.27
PROJECT SITE VEGETATION COMMUNITIES

The species within the Hawkesbury Banksia Scrub-Woodland recorded by Bell (2004) reflect the presence of moist soils, as is the case near the southern boundary of the Project Site where localised seepage occurs. This community comprises a tall, open shrub layer ranging in height from 6m to 8m. Occasional trees occur throughout the community. A distinct layer of fern, principally *Gleichenia dicarpa* (Coral Fern) between 1m to 2m high is present across the community.

The remainder of the Project Site, not covered by mature or regenerating native vegetation and isolated trees, comprises either exotic grassland or exotic grassland with pines. There are no noxious weeds on the Project Site. *Andropogon virqinicus* (Whisky Grass*)* was recorded. It was included in the list of other perennial grass that invade small areas of native vegetation "Key Threatening Processes" in the *Threatened Species Conservation Act 1995*.

The area of each of the native vegetation communities and exotic grassland areas as recorded on **Figure 4.27** are as follows.

- Somersby Plateau Forest (SP) 21.4ha
- Hawkesbury Banksia Scrub-Woodland (HBS)
  (including Sandstone Hanging Swamp) 4.1ha
- Exotic Grassland 12.9ha
- Exotic Grassland with Pines 3.5ha
- Dam / Aquatic Habitat 0.4ha

Total 42.3ha

4.6.4 Conservation Significance

4.6.4.1 Vegetation Communities

Bell (2004) records that Somersby Plateau Forest has a Category 3 conservation status and Hawkesbury Banksia Scrub-Woodland has a Category 5 conservation status although no definitions of the conservation categories are given in Bell 2004. Neither of the two vegetation communities on the Project Site are listed under the *Threatened Species Conservation Act 1995* as an "endangered ecological community" or an "endangered population".

4.6.4.2 Threatened Species

Figure 4.28 displays the locations of the three threatened plant species across the Project Site.

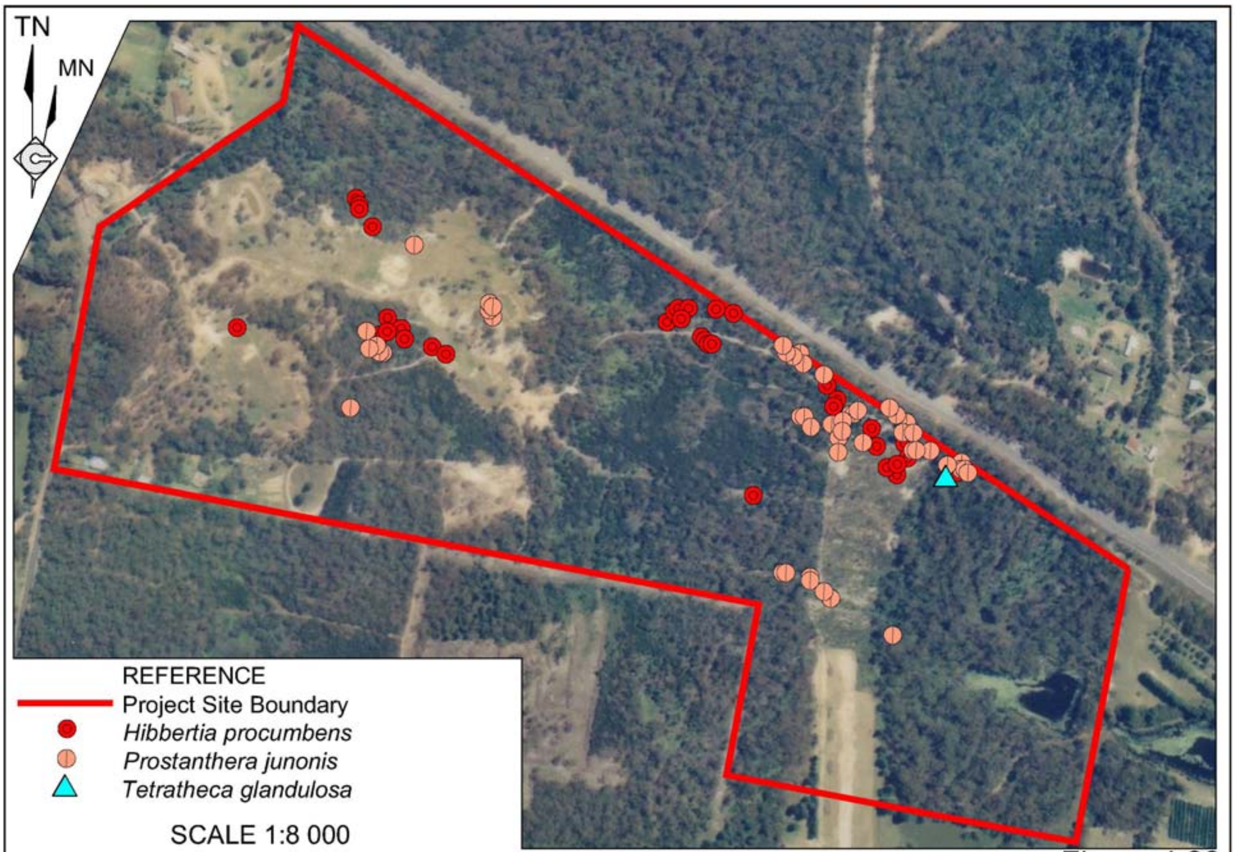


Figure 4.28
THREATENED SPECIES - PROJECT SITE

***Prostanthera junonis* (Somersby Mintbush)**

The population of *P. junonis* on and surrounding the Project Site comprises approximately 280 plants. The detailed investigations by Robert Payne – ES&M between 2000 and 2005 established that the occurrence / growth / health of this species is erratic, however, the main part of the Mangrove Tower Population, occurs near the northern boundary of the Project Site, remains robust. The population of *P. junonis* on the Project Site is part of Population 6 (NPWS, 2000b). Robert Payne – ES&M (2006) subdivides Population 6 into three subpopulations, namely 6A, 6B and 6C.

Figure 4.29 displays the locations of the *P. junonis* plants recorded over the past ten years on and surrounding the Project Site. The plants are commonly located on the edges of clearings such as tracks and on the edge of the former ridge gravel extraction area. The main part of Subpopulation 6A straddles a section of the northern boundary of the Project Site. As many as 68 plants have been identified in the adjoining Peats Ridge Road reserve adjacent to the Project Site.

Apart from the subpopulation within and adjoining road reserve (Subpopulation 6A), the Mangrove Tower Population 6 includes plants at the nearby transmission towers (Mangrove Tower – referred to as Subpopulation 6B) and an area of native vegetation north of Peats Ridge Road (referred to by Robert Payne – ES&M as Subpopulation 6C.

A detailed study of the species undertaken on the Project Site during 2000/2001 established that approximately 25% of plants failed to set fruit and that flowering tended to occur in blocks throughout the flowering season.

Tetratheca glandulosa – Black Eyed Susan

Two plants of *Tetratheca glandulosa* (Black Eyed Susan) were identified within the eastern area of *P. junonis* plants approximately 10m from the northern boundary of the Project Site.

Hibbertia procumbens

This species has previously been thought to be comparatively rare across the Somersby Plateau. Two plants were first identified on site in 2004 and a further 39 plants found in 2005 on the Project Site. This level of occurrence is consistent with numerous other observations of this plant across the Somersby Plateau in 2004 / 2005. It is understood that seasonal conditions favoured the substantial re-emergence of this species and it has since been found that the species is common and abundant on the Somersby Plateau.

4.6.5 Design and Operational Safeguards

The Proponent would adopt a range of design and operational safeguards recommended by Robert Payne – ES&M to manage the flora values of the Project Site, particularly with respect to threatened species and the fauna / flora corridors.

The design safeguards relate to the following.

(i) The areas of native vegetation not required for site-related activities would be conserved. This would be achieved either through fencing and/or signage. Particular emphasis would be placed upon fencing the Voluntary Conservation Area which has been discussed with the NSW Department of Environment and Conservation for the long term protection of Subpopulation 6A of *P. junonis*.

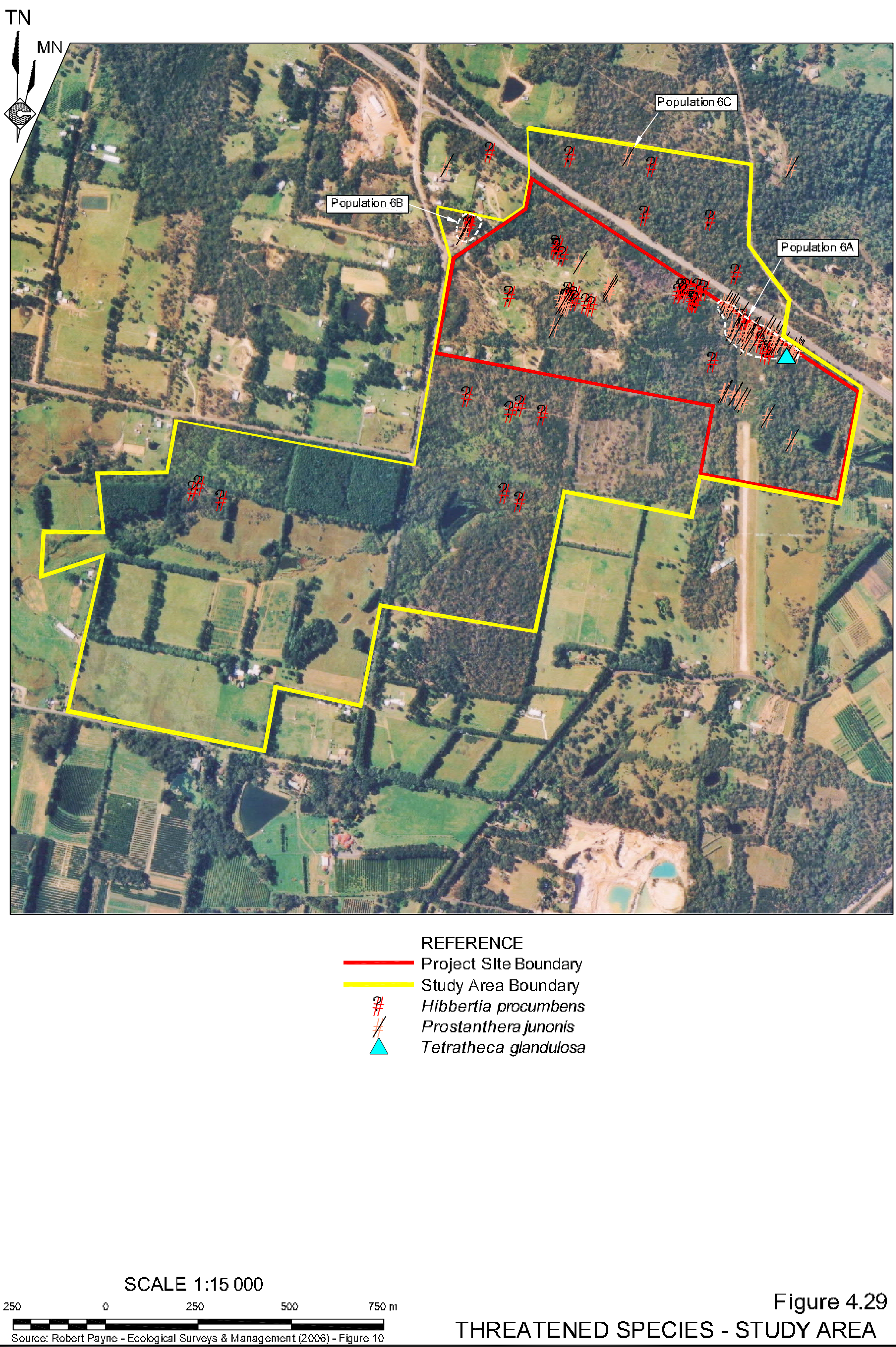


Figure 4.29
THREATENED SPECIES - STUDY AREA

(ii) The vegetation buffer retained on the northern side of the Project Site has been designed at a width of 25m to achieve an overall 50m wide corridor of vegetation between the limit of sand removal and Peats Ridge Road.

(iii) Dams D and E have been located to avoid mature native vegetation. The dams would be within the northern approach to the airstrip which is regularly slashed for safety reasons.

The revegetation of the final landform has been designed to provide for the re-introduction of the existing two native vegetation communities onto the Project Site in the areas best suited for the respective species in those communities. The drier parts of the final landform would be re-vegetated with species typically found in the Somersby Plateau Forest.

The proposed operational safeguards relate to the following.

(i) Throughout the life of the project, vegetation would only be cleared as required with the area of vegetation clearing linked to the area required for each 12 months of activity.

(ii) Topsoil would be directly transferred onto rehabilitation areas as often as possible to maximise the opportunity for retention of the natural seed stock.

(iii) During each vegetation clearing program, seed would be collected from felled vegetation for use in future re-vegetation programs.

(iv) Re-vegetation activities would focus on the re-introduction of the species currently observed within the two main native vegetation communities on the Project Site providing habitat for the three threatened plant species.

(v) A program of weed control would be undertaken, firstly to remove/reduce weeds in soils prior to soil stripping activities and secondly following re-vegetation to ensure native plants are not overgrown during their early periods of growth.

(vi) All pine trees on the Project Site would be progressively removed throughout the life of the project. Those areas of exotic grasses and pines outside the proposed limit of sand removal would be progressively replaced with Somersby Plateau Forest species.

It is noted that the Proponent is committed to commission appropriate monitoring research projects consistent with the Recovery Plan for *P. junonis*. For example, the Proponent would support research to better understand the direct seeding, translocation and tubestock of the plants to be removed from within the area of sand removal (to the area of the Voluntary Conservation Agreement and western fauna / flora corridor) discussed in Section 2.12.2.

All of the design and operational safeguards and proposed monitoring / research would be addressed in a Vegetation and Threatened Species Management Plan. This document would be prepared prior to the commencement of operations and would focus upon the activities required throughout the first two years of operations. The document would be updated biennially thereafter. An important section of the Vegetation and Threatened Species Management Plan would cover the management of the Voluntary Conservation Area. The Proponent believes a coordinated approach would be appropriate with the management of the *P. junonis* in the Voluntary Conservation Area particularly since the population also occurs within the Peats Ridge Road Reserve (owned by Gosford City Council) and the Mangrove Tower site managed by the Department of Natural Resources.

4.6.6 Assessment of Impacts

4.6.6.1 Vegetation Communities

In order to evaluate the impacts of the Somersby Fields Project upon the two main vegetation communities on the Project Site, **Table 4.47** was prepared to record the areas of extant vegetation and the areas of each vegetation community following sand removal and in the longer term following rehabilitation.

Table 4.47
Vegetation Removed and Retained on the Project Site

Vegetation Community	Existing Area (ha)	Proposed Area Removed (ha)	Area Not Disturbed by Sand Removal (ha)	Proposed Area Following Rehabilitation (ha)
Somersby Plateau Forest	21.4	9.2	12.2	30.2 [1 2]
Hawkesbury Banksia Scrub-Woodland[4]	4.1	3.6	0.5	
Exotic Grassland	12.9	8.0	4.9 [3]	10.6
Exotic Grassland with Pines	3.5	1.2	2.3 [3]	-
Dams / Aquatic Habitat	0.4	-	0.4	1.5
TOTAL (ha)	Exotic = 16.4. Dam = 0.4 Native = 25.5 **42.3**	Exotic = 9.2 Dam = 0 Native = 12.8 **22.0**	Exotic = 7.2 Dam = 0.4 Native = 12.7 **20.3**	Exotic = 10.6 Dam = 1.5 Native = 30.2 **42.3**

[1] Incorporates 4.1ha of regenerated woodland on the final landform.
[2] Incorporates 4.3ha of regenerated scrub-woodland on the final landform.
[3] Area to be progressively revegetated with Somersby Plateau Forest species
[4] Incorporates Sandstone Hanging Swamp
Source: Robert Payne – Ecological Surveys & Management (2006) – Table 8

The changes in areas of vegetation communities recorded in **Table 4.47** reveal the following.

1. The area of mature native vegetation removed (12.8ha) represent approximately 50% of the 25.5ha of mature native vegetation on the Project Site.
2. The proposed long term area under native vegetation would be approximately 30.2ha which is almost 5ha larger than the area currently covered by native vegetation.

A further comparison on a regional level was made to assess the proportion of the mature vegetation communities removed during the life of the project. **Table 4.48** records the area of both vegetation communities (and their equivalents) recorded by Bell (2004) throughout the Gosford LGA and proposed to be removed from the Project Site.

Table 4.48
Comparative Areas of Vegetation Communities on the Project Site and throughout the Gosford LGA

Project Site Vegetation Community	Gosford LGA Mapping Equivalent (Bell, 2004)	Extant LGA (ha)	Extant Project Site (ha)	Area within Sand Removal Area (ha)
Somersby Plateau Forest	Somersby Plateau Forest	491	21.4	9.2
Hawkesbury Banksia Scrub - Woodland	Hawkesbury Rock Pavement Heath E26A Somersby Plateau Fernland Woodland E26F Hawkesbury Banksia Scrub - Woodland E29 Hawkesbury Banksia Wet Scrub E29B Sandstone Hanging Swamps E54A, B & C	4 341	4.1	3.6
Source: Robert Payne – Ecological Surveys & Management (2006) – Table 7				

Bell (2004) records there is a total of 491ha of Somersby Plateau Forest in the Gosford LGA and the sand removal operation is likely to cause the direct removal of 9.2ha of this community. In addition to this, an indirect loss of a further 10% may occur from edge effects giving a total of 10.4ha. Of the total area of the Somersby Plateau Forest within the Gosford LGA, the overall loss would be approximately 2% which is not considered to be significant.

Given that the Hawkesbury Banksia Scrub-Woodland vegetation occurs with the upland swamp vegetation complex, and there is 4 341ha of this vegetation throughout the Gosford LGA (Bell, 2004), the loss of 3.65ha of this community (plus 10% indirect loss for edge effects) is equal to a reduction of approximately 0.1% of this plant community in the Gosford LGA. It is noted that the reduction in areas of native vegetation throughout the life of the project would be offset by the Proponent as a result of a comprehensive revegetation program to re-establish and enhance the two main native vegetation communities on the Project Site.

The vegetation communities on and surrounding the Project Site do not appear to be related to high water tables (RCA Australia, 2006). The moist areas appear to reflect the presence of clayey subsoils and profiles which are moistened by overland flow, derived from rainfall. Only in localised areas, eg. on the southern side of the Project Site where there is significant seepage from bedrock outcrop would the sand removal operation remove the seepage in that area.

4.6.6.2 Threatened Plants

Prostanthera junonis

The Somersby Fields Project would potentially result in the removal and relocation of approximately 30 to 40 previously identified *P. junonis* plants throughout its operational life. These plants are isolated and removed from the main population occurring as scattered individuals mainly in previously disturbed areas of the Project Site often around the lowered landforms with islands of trees. The removal of this number of plants would represent approximately 11% to 16% of the overall Population 6. It is assessed that the impact of the removal of these plants is not likely to be significant given these plants are isolated from the main population. The Proponent intends to conduct a tubestock planting and translocation program for these plants, where practicable.

The Proponent has designed the proposed area of sand removal to avoid the main population of *P. junonis*. Furthermore, the Proponent has proposed that the main population of *P. junonis* is incorporated within a Voluntary Conservation Area (with a 20m buffer). This outcome would achieve the long term protection and security for the population as sought in one of the objectives of the Recovery Plan for *P. junonis* (NPWS, 2000). Other relevant objectives discussed in Section 4.6.2 would also be satisfied by the creation and ongoing management of the Voluntary Conservation Area. These include:

- improved habitat management including the fencing of the entire area (to reduce deliberate and inadvertent access); and
- a commitment by the Proponent to fund ongoing research into the population on and adjacent to the Project Site.

Hibbertia procumbens

The Somersby Fields Project would potentially result in the removal and relocation of approximately 25% of the identified *H. procumbens* plants on the Project Site. The bulk of the plants would, however, be retained within the Voluntary Conservation Area for the main *P. junonis* population.

Robert Payne – ES&M (2006) concluded that the impact of the removal of these plants is not likely to be significant as:

- the remainder of the plants would be within the Voluntary Conservation Area; and
- the occurrence of this species across the Somersby Plateau has been recognised to have increased substantially during 2004/2005 as a result of seasonal conditions. As a result, the loss of approximately 10 plants would be comparatively minor.

The Proponent intends to conduct a tubestock planting and translocation program for these plants, where practicable.

Tetratheca glandulosa

The Somersby Fields Project would have no impact on the two *T. glandulosa* plants recorded given both plants are located within the area designated for protection under the Voluntary Conservation Agreement.

4.6.7 Conclusion

Given the assessment of the Somersby Fields Project in the context of the vegetation communities and threatened species on and surrounding the Project Site and the proposed safeguards and mitigation measures, the following conclusions are applicable.

- The removal of the 12.8ha of native vegetation would not significantly affect the proportion of these vegetation communities throughout the Gosford LGA.
- The retention and protection of 12.7ha of native vegetation on the Project Site and the progressive regeneration of 17.8ha of native vegetation would provide increased conservation certainty for both the vegetation communities and threatened species, particularly since the bulk of the threatened species would be protected within a Voluntary Conservation Area.
- The planned vegetation enhancement program and long-term rehabilitation program would assist to improve ecological values of the Somersby area.
- The proposed Voluntary Conservation Area and protection of the *P. junonis* population would effectively satisfy the principal objectives of the Recovery Plan for *P. junonis*.

4.7 FAUNA

4.7.1 Introduction

The following sub-sections describe the existing fauna habitats within the Project Site, the sampling undertaken to identify fauna species occurring, or likely to occur, and the conservation significance of the existing fauna. The potential impacts the project may or would have on the native fauna are described together with the design and operational safeguards and management procedures to be employed to ameliorate any impacts upon native fauna and their habitats.

The information presented in this section is drawn from the fauna assessment undertaken by Countrywide Ecological Service (CES, 2006) whose full report is included in the *Specialist Consultant Studies Compendium* (Volume 1, Part 6). This sub-section presents a summary of the contents of the fauna assessment report. Where appropriate, reference is made to relevant flora matters documented by Robert Payne – ES&M (2006).

4.7.2 Fauna Habitats

The Project Site has previously been disturbed by topsoil and ridge gravel removal activities and use by the Department of Main Roads to supply construction materials during construction of the F3 Freeway in the mid to late 1970s. Based on the existing vegetation communities and the areas regenerating from previous disturbance, five structural habitat types were identified for the fauna sampling (see **Plates 4.1** to **4.5**).

- Habitat Type 1 – Woodland on ridge line and slopes (**Plate 4.1)**.
- Habitat Type 2 – Cleared Lands with Exotic Pine (**Plate 4.2)**.

Plate 4.2 Woodland

Plate 4.1 Cleared Lands with Exotic Pines

Plate 4.4 Banksia Heath

Plate 4.3 Watercourse community with thick understorey

Plate 4.5 Wetlands (dams)

- Habitat Type 3 – Banksia Heath (**Plate 4.3**).
- Habitat Type 4 – Watercourse Community with thick fern understorey (**Plate 4.4)**.
- Habitat Type 5 – Wetlands (dams) (**Plate 4.5)**.

4.7.3 Fauna Sampling

4.7.3.1 Introduction

The bulk of the fauna surveys were carried out on the Project Site during summer between 18 and 21 December 2000. A brief winter bird census was also conducted on 6 August 2003 to detect the presence of listed threatened winter migrant birds. Supplementary sampling was undertaken on 29 March 2004 to include the additional 8ha of land on the southeastern corner of the Project Site encompassing Dam A. Further surveys to detect the presence of listed threatened owls were conducted on 8, 9 and 30 September, 3 October 2005 and a follow-up inspection on 5 May 2006.

Figure 4.30 displays the locations of the fauna sampling across the Project Site which is discussed below.

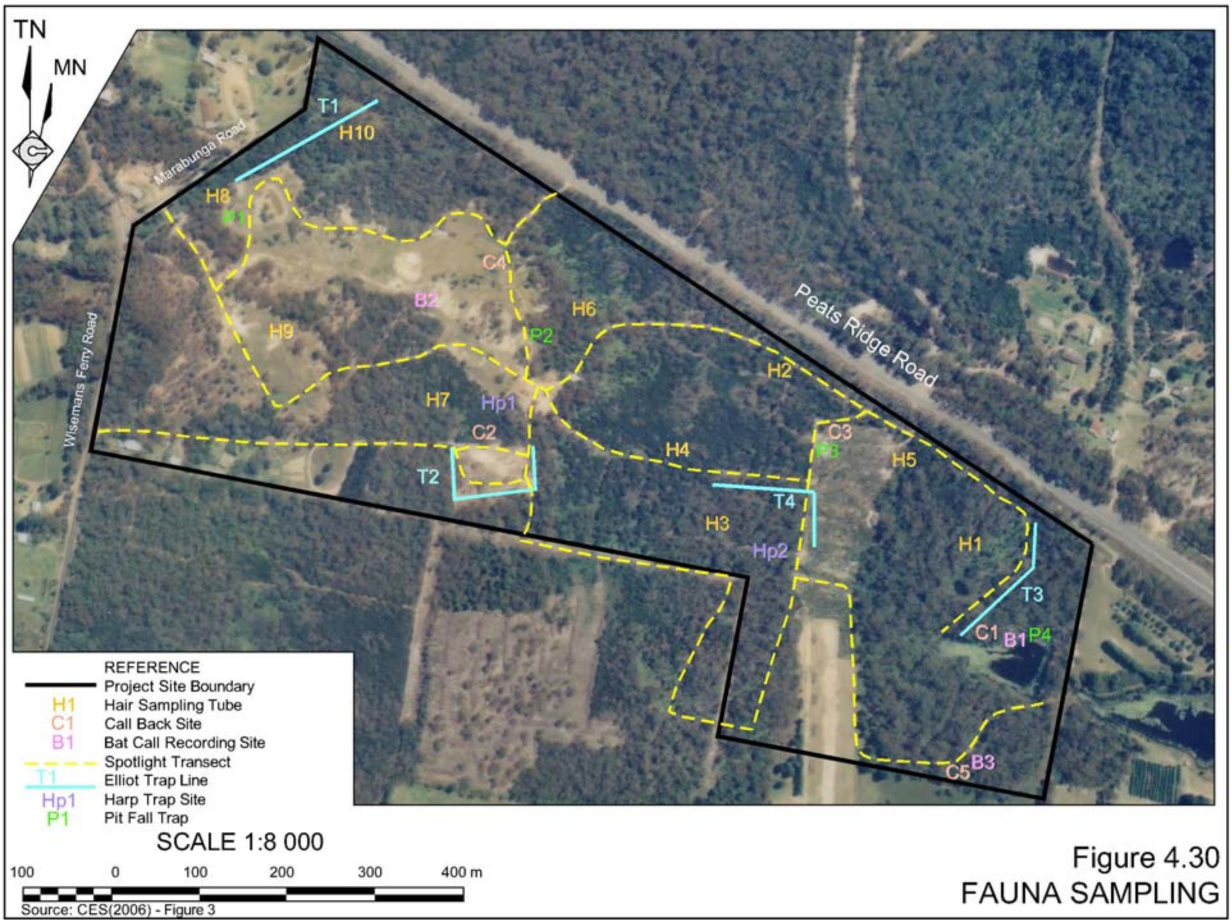


Figure 4.30
FAUNA SAMPLING

4.7.3.2 Amphibians

Four pitfall trap lines (P1-P4) consisting of two x 10-litre buckets and two tube traps along a 30cm high and 12m long drift fence were used to sample frogs. The drift fence extended across two buckets dug into the ground, each about 2m from each end of the drift fence. These sites were set for four successive nights. It should be noted that these pitfall traps will also trap small mammals and reptiles.

Call recognition and opportunistic hand capture techniques were also used during general survey activities.

4.7.3.3 Birds

Birds were sampled by visual observation and call recognition as well as location of roosting sites and recording of other signs ("white wash", feathers, skeletal remains, etc.). A bird census was conducted during each of the four mornings along the Elliot trap lines T1-T4 and opportunistically throughout the Project Site and environs.

Nocturnal birds were sampled during spotlight surveys and from responses to broadcasts of taped calls as well as opportunistic encounters.

A brief targeted sample for winter migrants as well as supplementary samples for owls were also conducted.

4.7.3.4 Mammals

A variety of methods were deployed to sample this fauna group.

Small Mammals	-	One hundred Elliott traps (Type A), laid in 4 lines each with 25 traps spaced about 10m apart, were set over 4 successive nights (100x4 = 400 trapnights).
	-	Twenty hair sampling tubes were set at 10 suitable locations (both within trees and on the ground).
Large Terrestrial and Arboreal Mammals	-	Daytime observations and spotlighting at night were used to sample large terrestrial mammals. Nocturnal arboreal mammals were sampled by spotlighting and by their responses to taped calls.
Insectivorous Bats	-	Ultrasonic calls were recorded using an ANABAT-CF detectors system (Titley Electronics, Ballina, N.S.W.) mounted on a vehicle and analysed using ANALOOK 6 software. A harp trap was also deployed.
Other Signs	-	All other signs of mammals including diggings, footprints, faecal material, hard and soft tissues of body remains, etc. were noted.

4.7.3.5 Reptiles

Systematic hand searching along the tree lines, under logs, bark and leaf litter, pitfall traps, general observation, and chance capture in Elliott traps were techniques used to sample reptiles.

4.7.4 Fauna Species

Table 4.49 presents a summary of fauna species identified during the survey whilst the complete list is presented in CES (2006).

Table 4.49
Fauna Species Recorded

Fauna Group	Number of Species	Native	Exotic	Threatened species
Amphibians	7	7	0	0
Birds	31	30	1	0
Mammals	23	16	7	2 - Eastern Freetail-bat - Little Bentwing-bat
Reptiles	7	7	0	0
Source: Modified after CES (2006) – Tables 4 to 7				

Of the exotic species identified during the fauna survey, three are listed as Key Threatening Processes under the EPBC Act and the TSC Act namely the European Red Fox, Feral Cat and the European Rabbit.

In addition to the species identified during the fauna survey, a checklist of fauna recorded in the Gosford LGA was compiled from the NSW Wildlife database and an online query of the Department of Environment and Heritage database was conducted to identify fauna species of conservation significance that have previously occurred on or within 10km of the Project Site. The following threatened species were identified as being likely to occur on or within the environs of the Projects Site.

- Green-thighed Frog (V)
- Eastern Bentwing Bat (V)
- Gang Gang Cockatoo (V)
- The Long-nosed Potoroo (V)
- Fork-tailed Swift (LM)
- Black-faced Monarch (MT)
- White-breasted Sea Eagle (MT)
- Rufous Fantail (MT)
- Grey-headed Flying Fox (V)
- Large-eared Pied Bat (V)
- Yellow-bellied Sheathtail-bat (V)
- Glossy Black Cockatoo (V)
- Rosenberg's Goanna (V)
- Latham's Snipe (MW)
- Satin Flycatcher (MT)
- White-throated Needletail (MT)

V – Vulnerable, MT – Migratory Terrestrial, MW – Migratory Wetland, LM – Listed Marine

No endangered fauna population, ecological community or critical fauna habitat has been listed in the Gosford LGA or was identified within the Project Site.

4.7.5 Conservation Significance

In addition to the identification of threatened species described in Section 4.7.4, the conservation significance of the Project Site was also considered against SEPP No 44 – Koala Habitat Protection and the *Native Vegetation Conservation Act 1997* (NVC Act).

SEPP No. 44 - Koala Habitat Protection

State Environmental Planning Policy No. 44 - Koala Habitat Protection (SEPP 44) aims to identify potential Koala habitat in the form of native vegetation where the trees of the types listed in Schedule 2 of SEPP 44 constitute at least 15% of the trees in the area.

A Koala feed tree species is listed under Schedule 2 of SEPP 44, the Broad Leafed Scribbly Gum, *Eucalyptus haemastoma,* was recorded in the Project Site (Robert Payne – ES&M, 2006). Most of these trees occur in the area that will be preserved as buffer zones or where the trees will remain unaffected. Additionally, the vegetation in the area that will be cleared or directly affected by the project does not contain any area that is occupied by more than 15% cover (canopy or understorey) of these feed trees.

Furthermore, there are no historical records of Koalas inhabiting the top ridges and plateau areas in the Gosford LGA and there are few records of this species west of the F3 Freeway. Thus, it can be concluded that no prime or potential Koala habitat exists on the Project Site.

Clearing of Native Vegetation and Cumulative Impact (NV Act)

With the ameliorative measures proposed, no significant area of native vegetation would be removed and there are no matters arising from the NV Act in relation to cumulative impact and wildlife corridor connectivity and conductivity that are relevant to the Somersby Fields Project.

4.7.6 Operational Safeguards

A number of listed threatened fauna species were recorded or have been recorded in areas near the Project Site. The following recommended safeguards would be adopted to minimise or ameliorate any adverse impact on the fauna.

1. Sand removal and related activities would preferably be carried out from the least sensitive areas (cleared areas) to the more environmentally sensitive areas (areas with remnant native vegetation).
2. Clearing of native vegetation would be kept to a minimum and clearing of additional native vegetation outside the sand removal area would be avoided, as much as possible.
3. Where possible, felled and fallen native timber would be placed on the ground in suitable places as ground cover habitats and refuges for native fauna.

4. Felled and fallen native trees would not be disposed of by burning.

5. The clearing of vegetation especially the felling of hollow-bearing trees would be conducted in late summer (from February) and early autumn (to April) to avoid winter breeding mammals, spring nesting birds and over-wintering bats.

6. A supplementary re-vegetation program would be formulated and implemented early in the project life as part of the proposed management plan for the site to augment tree recruitment and habitat strata covering the areas affected by the project and in the remaining areas within the Project Site, where appropriate. Particular emphasis would be placed upon re-instating the Somersby Plateau Forest (SP) between the far-western earth mound and the western boundary of the Project Site. This area would effectively create the western fauna / flora corridor shown on **Figure 4.31**. Likewise, the vegetation within the eastern section of the Project Site would be enhanced to also create the eastern fauna / flora corridor (see **Figure 4.31**). Both corridors would assist to promote north-south fauna movement between areas of adjacent native vegetation.

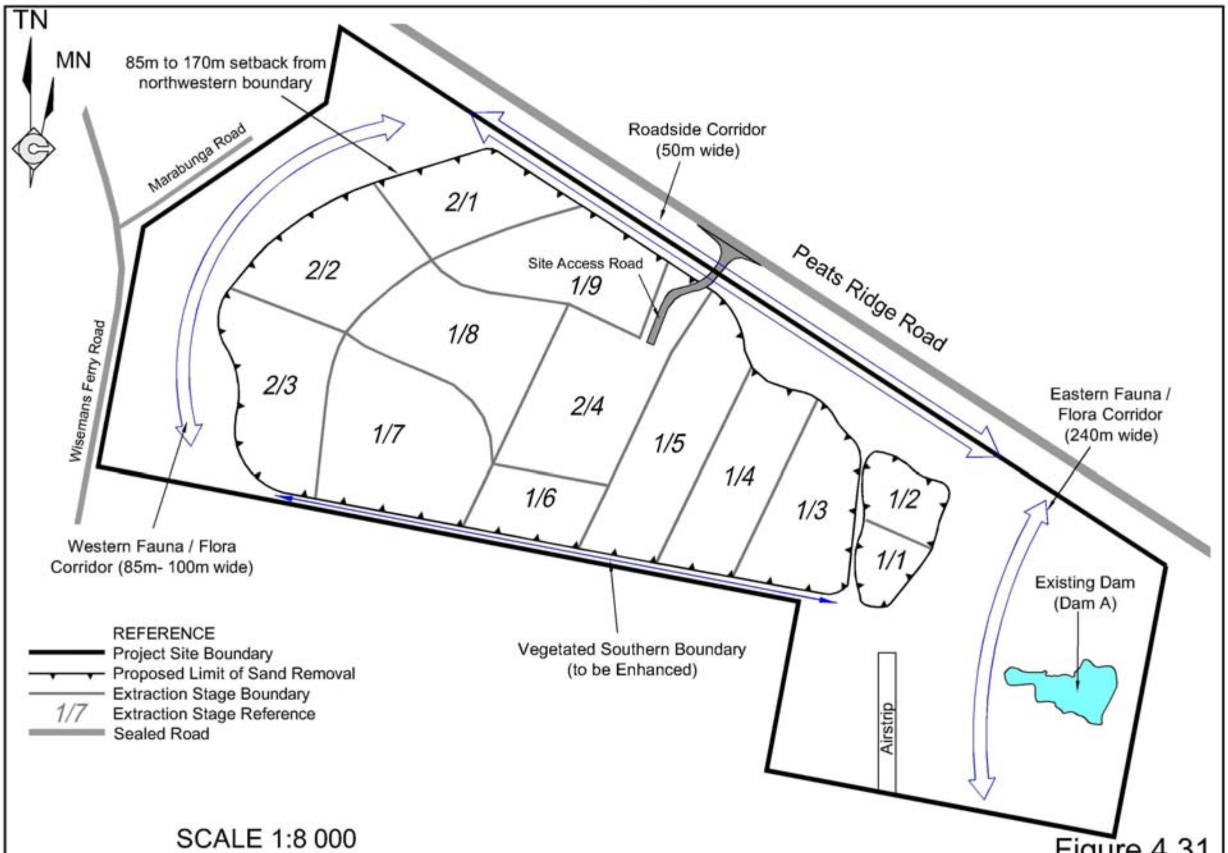


Figure 4.31
FAUNA / FLORA CORRIDORS

7. Any post-extraction revegetation would be carried out with stock from local trees and would be consistent with the composition of the original local vegetation community, where possible.

8. Vegetation adjoining the southern boundary of the Project Site would be enhanced to improve screening and habitat patch quality.

9. The Honey Bee hives would be removed from the entire Project Site for the duration of the project.
10. *Gambusia holbrooki* would not be used to control the breeding of mosquitoes in any of the storage dams or any of the water management facilities on the Project Site.
11. The exotic pines beyond the proposed area of sand removal would be progressively removed to allow better regeneration of native plant communities to improve the fauna habitat quality on the Project Site.

4.7.7 Assessment of Impacts

The Project Site is not considered to contain important habitat which would have implications to the long-term survival of any of the listed threatened fauna or migratory species in the locality nor has any endangered fauna population, ecological community or critical fauna habitat been identified within the Project Site.

Regardless, less than half of the fauna habitat on the Project Site would be modified or removed as a result of this project. Less than one third of the hollow-bearing trees would be removed and the larger, potential roosting and foraging trees, would be retained. Furthermore, as the Project Site is essentially cut off from any direct connections to extensive areas of State Forests and National Parks by Peats Ridge Road and the F3 Freeway, and as a buffer strip would be left along Peats Ridge Road and the eastern section of the site would retain the natural habitat, it is unlikely that the project would fragment or isolate any of the surrounding areas of fauna habitat. The proposed fauna / flora corridors, particularly the western fauna / flora corridor, would provide an improved connection between native vegetation both north and south of the Project Site.

Additionally, the project does not involve waste water discharge or disturbance to surrounding creeks or waterways.

In summary, the project is unlikely to have any significant impact on any threatened, migratory or marine species or matters that would constitute or be construed to be a controlled action under the EPBC Act.

Furthermore, the project would not be inconsistent with the Threat Abatement Plans for the Feral Cat, European Red Fox and European Rabbit populations.

4.7.8 Conclusion

Based on the results of the surveys undertaken, the ameliorative measures proposed, the condition of the existing habitats and the nature of the proposed activity it is concluded that the Somersby Fields Project is:

1. unlikely to significantly affect any of the listed threatened species, fauna populations or communities;

2. unlikely to augment or significantly contribute to any of the Federal or State listed key threatening processes;
3. unlikely to significantly affect any Ramsar wetland or any Bonn, CAMBA or JAMBA listed species;
4. unlikely to significantly affect Narara Creek or Ourimbah Creek if adequate water runoff safeguards are adopted;
5. unlikely to affect any core or potential Koala habitat; and
6. consistent with ESD principles with regards to fauna and would not adversely affect the local biodiversity.

Thus, the project would not be considered to constitute a controlled action, is unlikely to significantly affect any listed threatened species, no issue of cumulative impact and fragmentation of fauna habitat or wildlife corridor arises from the project and no Koala Habitat Management Plan would be required pursuant to SEPP 44.

4.8 SOCIAL ISSUES

4.8.1 Introduction

In light of the perceived social impacts of the project recognised amongst members of the Somersby and district community, Key Insights Pty Ltd was commissioned by the Proponent to identify what potential social impacts may occur as a consequence of the Somersby Fields Project and how such impacts would best be ameliorated. This section provides a summary of the social impact assessment completed by Key Insights (Key Insights, 2006) which is reproduced in full as Part 9 in Volume 2 of the *Specialist Consultant Studies Compendium*.

4.8.2 The Existing Social Setting and Community Position

The social impact of the Somersby Fields Project has been assessed against two primary groups.

Somersby Public School and School Community

This group comprises the school children, parents, teachers, members of the Parents & Citizens association (P&C) and other local residents with a particular interest at or with the Somersby Public School.

Due to its location, facilities, eg. school hall, and widespread influence on the local community, many consider the school to be the geographic and social hub of the Somersby area (pers. comm., Sean Andrews – School Principal to Ellen Davis-Meehan). The Somersby Public School and school community have, since the inception of the initial CSR Readymix proposal in 1996, expressed major concerns and reservations over the development of the project. Their major concerns revolve around the impact on learning of increased noise in the local area, potential health impacts related to dust and "silica", the safety of school children in relation to local truck movements and access to the school's groundwater supply. It has been noted that a number of parents have indicated that should the project be approved, they would remove their children from the school (presumably due to one or more of the previously mentioned concerns). As noted by the school's principal, Mr Sean Andrews, this may be the 'tip of the iceberg' with many other parents following suit. Major reductions in enrolments would ultimately impact on the school's viability (Frank Potter, Schools Education Director of the Department of Education and Training indicated that a 25% reduction in school numbers would result in the loss of one class and teacher which may in turn lead to further enrolment withdrawals).

The Proponent has been pro-active in consulting with the school community through information displays, newsletters and attendance at P&C meetings, however, it is noted that there still remains a general feeling of powerlessness over the possible approval of the project and a genuine (although largely unfounded) fear over health and safety risks.

The Somersby Community

People residing in the immediate Somersby neighbourhood are referred to collectively as the "Somersby community". Given the scattered nature of the Somersby community and therefore the vastly different social and other impacts the project is likely to have on individuals, it is quite difficult to accurately report on the impacts on the Somersby community. The Somersby community has therefore been categorised as those members of the Somersby area who have actively participated in debate and discussion over the project since the initial proposal by CSR Readymix was presented in 1996.

Within the Somersby community, there has been considerable opposition to the project at local meetings, within submissions sent to the Department of Planning, Council, local politicians and local media and in general dealings with representatives of the Proponent and their consultants. However, the Proponent notes that as more accurate information on the project and description of the potential impacts have become available through the Proponent's consultation program, the level of opposition / resistance has decreased. During a consultation program with individual members of the Somersby community, Key Insights noted the following comments.

- The community was originally up in arms about the Somersby Fields Project but as it is finding out more facts, there has been a shift to accepting the project.
- Those who support or are accepting the Somersby Fields Project are not outspoken or visible.
- Those opposing the Somersby Fields Project are not reflecting the entire community. This split is probably 40% for Somersby Fields Project and 60% against but against is larger mainly because of misinformation. Moving toward 50-50 split.

It is considered by the Proponent that there is a growing and now quite good local knowledge on the project and the various steps in the project evaluation and approval process. Information has also been provided covering the various State government agencies and local government involvement in the approval / evaluation process and the issues which need to be addressed.

4.8.3 Methodology to Assess the Social Impact of the Project

Key Insights considered the current social climate and the description of the proposal and commenced a four staged social impact assessment. The four stages are described as follows.

(i) Key Insights reviewed existing literature on the local area and undertook a comprehensive program of consultation with key stakeholders and stakeholder groups. Those consulted included:

- Mr Sean Andrews, Principal of the Somersby Public School;
- Mr Frank Potter, Schools Education Director, Department of Education Area Representative;
- Ms Lesley Greenwood, Demographer, Department of Education;
- Mr Peter Lipscombe, President, Central Coast Plateau Chamber of Commerce;
- Mr Andrew Docking, Agricultural Environmental Officer, Department of Primary Industries (Agriculture);
- Mr Paul Andersen, Site Manager, Somersby Field Station, Department of Primary Industries (Agriculture);
- Mr Duncan Gilchrist, General Manager, Business Central Coast;
- Ms Kim Radford, Recreation Officer, Gosford City Council;
- Mr Pat Riley, Executive Officer, Central Coast Cricket Club;
- Mr David Carraro, Vice President, Mangrove Mountain Pony Club; and
- Individual members of the local community.

The relevant local interests of each consulted stakeholder were recorded along with their comments and/or concerns regarding the project.

(ii) A community focus group, comprising mainly members of the Somersby Public School P&C Somersby Action Group, was chaired by Key Insights to gauge the level of concern / opposition of this group to the project. The discussions held were based on a series of questions relating to the existing social setting, current issues and the anticipated project-related impact(s) on these.

(iii) The recent experience at Maroota (68km by road northwest of Sydney) where the sand extraction operation of Dixon Sands (Penrith) Pty Ltd was approved in close proximity to the Maroota Public School was examined as a case study. Similar to the current situation, there was considerable local community angst and opposition to the Dixon Sands' operation prior to approval and operation.

(iv) The results of the consultation program and Maroota case study were reviewed along with the safeguards and mitigation measures proposed by the Proponent to minimise impacts. Conclusions on the potential impact of the project on the social setting in short, medium and long term were then drawn based on this review.

4.8.4 The Social Impact Assessment

4.8.4.1 Results of Consultation with Key Local Stakeholders

The overwhelming conclusion from the stakeholder consultation was that irrespective of how specific individual environmental aspects of the project are to be managed, there was a general view that the project was not welcome. A summary of comments received from various stakeholder groups is as follows.

Somersby Public School / Department of Education and Training

- The project would result in a decrease in school enrolments, as parents take their children to other schools, which are at the second lowest level in the decade.
- Given the centrality of the Somersby Public School to the local community, a possible fall in enrolments due to the approval of the project was regarded as serious by the Somersby community.
- Specific school issues raised were dust (health of pupils); noise (negative effect on teaching); trucks (safety of pupils); groundwater (reduction in water availability at the School).
- The general stress on the community from the project was thought to reduce the ability of pupils to concentrate on their studies.
- There is a general feeling of powerlessness and dislocation amongst the school community at present.

Regional Business and Agriculture

No consistent viewpoint emerged from discussions with the business and agriculture stakeholders. Support for the project (and industry) by stakeholders such as the Central Coast Plateau Chamber of Commerce was offset by those generally opposing the project (and industry), eg. Business Central Coast. Views varied from those who considered the employment offered by the project to be good for the local economy to those who felt extractive industry was not the way forward for the region.

Recreational Organisations

Of those organisations contacted, the need for sporting facilities in the local area was identified. Both the Central Coast Cricket Club and Mangrove Mountain Pony Club indicated they would be interested in using any facilities created by the project. It is noted that these views were not shared by the general community who generally expressed that if they supported either of the sporting or recreational proposals that they were seen to be supporting the project – which they were not. The Somersby Action Group has stated that 'there is not a need for the sports field'.

Individual Members of the Somersby community

The comments of those individuals of the local community consulted by Key Insights mirrored the general sentiments outlined in Section 4.8.2. Concerns over the project included:

- land value depreciation and destruction of rural amenity;
- reduced availability of groundwater;
- noise and additional truck traffic;
- dust;
- visual impact;
- unsatisfactory end use of the site;
- cumulative impacts when combined with other land uses on the Somersby Plateau.

As noted in Section 4.8.2, despite these concerns, a number of individuals contacted indicated that as more information on the project was provided, their level of concern was decreasing.

4.8.4.2 Somersby Community Focus Group

Results of the focus group discussion are presented in Key Insights (2006), however, it was evident that amongst this section of the Somersby and school Community considerable opposition to the project remains. Major concerns over health, noise and amenity issues were raised with no know benefits of the project identified.

4.8.4.3 The Maroota Case Study

There is an approved sand extraction project at Maroota with some similarities with that proposed at Somersby, providing an insight into the possible impact of the Somersby Fields Project compared to the concerns expressed by locals at present.

Maroota Public School is situated in the Hawkesbury region of NSW. The Maroota community has a population of approximately 520 persons and in September 2002, Dixon Sands (Penrith) Pty Ltd was granted approval to extract sand up to 250m from the school boundary. The

Maroota Public School community expressed strong objections to the sand extraction with their concerns similar to those now being expressed by the Somersby Public School P&C. A major difference between the two projects was that the product trucks now travel past Maroota Public School whereas this is not part of the Somersby Fields Project.

Key findings of the Maroota case study are as follows.

- The Maroota Public School Principal regards the quarry as having impacted minimally on the school over the last year and is no longer regarded as an issue.
- The movement of trucks past the school (a situation which would not occur for the Somersby Fields Project) is considered the main ongoing issue due to safety and noise concerns.
- Both Dixon Sands and the Maroota Public School have reported an improving relationship.
- The school reports satisfaction with dust levels and confidence in monitoring technology.
- The school has expressed a marked decrease in enrolments over the past five years, however, it was acknowledged the school's enrolments have always peaked and troughed.

It is evident that relationships and communication between the Dixon Sands and the Maroota Public School, and school P&C are obviously improving. From a situation where there was considerable concern and opposition to the operations, nobody in the Maroota P&C is reported to be currently making an issue about the sand extraction operation. Many of the initiatives which have been taken by Dixon Sands to work constructively with the Maroota Public School and the community have been studied by the Somersby Fields Partnership and would be implemented should approval be granted for the Somersby Fields Project (see Section 4.8.5).

4.8.5 Mitigation Measures and Commitments to the Somersby Community

The Proponent has carefully reviewed the Maroota Public School / Dixon Sands case study and the recommendations of Key Insights (2006). If approved, the Proponent would commit to the following safeguards, mitigation measures and monitoring programs to minimise any impacts on the Somersby and school communities and expedite harmonious relations between the Proponent and these communities.

- The Proponent would provide a means for the local residents to have confidence the operations are meeting the required environmental standards by:
  - establishing a community consultative committee (CCC);
  - reporting quarterly to the CCC and in the local newspaper on environmental results; and
  - providing ways for the CCC to have access to specialist consultants to establish credibility in the ongoing monitoring programs.
  - establishing a website to enable up-to-date information about the project to be made available to the local community.

- The Proponent would work with residents to become a good contributing member of the local community by:
  - undertaking an annual community, as well as a school, survey and reporting the findings to the CCC;
  - developing, circulating and publicising a Community Plan and updating it each year;
  - establishing a direct email / telephone / postal address so that any resident has easy access for queries / complaints / response feedback on the project;
  - undertaking that there will be no hard rock quarrying on site and that the site will not be used ever as a waste facility; and
  - supporting local community events.
- The Proponent would be a supporter of the educational program at the Somersby Public School by:
  - being prepared to support study programs by pupils of the voluntary conservation area at Somersby Fields as well as the geology and any other educational aspects of the operation; and
  - working with TAFE and other providers to encourage local take-up of traineeships and apprenticeships and support local employees to gain higher trade skills.
- The Proponent would regularly liaise with the local community as the project progresses to develop ways of operating which best meet the requests of the community through:
  - the use of the CCC forums to find ways to improve the relationship between the project and the local community;
  - working with Gosford City Council's Cumulative Impact Consultative Committee for extractive industries on the Somersby Plateau; and
  - establishing dust and noise monitoring at 200m from operations (in addition to those at the Somersby Public School and the baseline sites) to confirm that Stage 2 will be able to meet approved standards.

4.8.6 Social Study Conclusion

Based on the review of stakeholder concerns (Sections 4.8.4.1 and 4.8.4.2), the Maroota Public School / Dixon Sands case study and their own experience, Key Insights considered the social impacts of the Somersby Fields Project to be as follows.

Noise

- If, throughout Stage 1, noise levels are stringently monitored at a distance of 200m from operations (not just at baseline monitoring sites) and found to be acceptable, then based on comparisons with Maroota there is likely to be no significant adverse social impact associated with noise at the Somersby Public School. Some background noise affecting rural ambience may be expected, but this is unlikely to significantly impact upon normal school operations or impact unduly on the Somersby community.
- In the event truck movements are reduced during early morning and evening periods as noted in Section 4.3.6.6, the degree of acceptability of the project would be likely to increase.

Road Safety

- Trucks transporting sand would not pass the Somersby Public School or along Wisemans Ferry Road. Trucks should not present a safety or noise issue for school children as is the case at Maroota.

Air Quality

- Although the community has yet to review an assessment of health-related impacts undertaken by the consultant of the Proponent (Heggies, 2006c), there is skepticism within the school community regarding the accuracy and/or applicability of this study. There is also considerable skepticism regarding the accuracy of base-line dust monitoring and the accountability of the company to enforce air quality requirements regardless of sophistication of monitoring technology.
- Currently, the fears and concerns of the Somersby and school communities have not been allayed by assurances provided by the Proponent regarding dust-related health issues. These fears (while largely unfounded) may result in a number of withdrawals from Somersby Public School, which may lead to further student withdrawal and reduction in teacher numbers, should the project proceed. Should the project proceed however, and follow the trend evidenced at Maroota, the negative impact on numbers is unlikely to be sustained.

Visual Impacts

- Through retention of existing vegetation and construction of vegetated visual barriers, the sand removal operation would not be visible from off-site vantage points and would not affect the immediate amenity of Somersby Public School.

Reduced School Numbers

- A consequence of the initial commencement of the project may be the choice of some parents to withdraw their children from the Somersby Public School. This would impact on school viability as a 25% drop in numbers would probably require the loss of one class and teacher.

- Ultimately the number of student withdrawals would be dependent upon individual choices made by parents upon approval of the project. However, the social nature of the school community and previous trends indicate that initial withdrawals from a school may be sufficient to undermine confidence and influence wider decisions to enrol children. Cumulative concerns as a school becomes 'smaller' may increase 'loss of confidence' and contribute to the gradual erosion of the school. Key Insights (2006) conclude there is a chance of this process occurring in the short term should Somersby parents initiate withdrawals upon project approval. Over the medium to long term, the experience at Maroota would suggest student withdrawals would decrease, with any short term decrease in numbers ultimately indicative of the history of fluctuating enrolments at Somersby Public School.
- In addition, as the Somersby Public School is located in an area that is earmarked for future residential growth – viability of school is not necessarily dependent upon the current cohort of parents. If, as appears to be the case in Maroota, future actual impacts and the community perceptions of these are less pronounced than anticipated, the school should continue to function along its typical fluctuating trajectory of growth, namely peak and trough.

Final Land Use

- Whilst Key Insights (2006) conclude that community and recreational uses of the site would be of social benefit to the community, there has been no Council or community support for the Proponent's sporting fields or "village green" proposals as a long term land use. As such, the long term land use has been designated as rural-residential consistent with Council's zoning requirements.

Cumulative Impacts

- Concerns about the cumulative impacts of this and other sand removal operations on the Somersby Plateau may warrant the setting up of a Cumulative Impacts Committee should the project go ahead. The site does not appear suitable for tourism, aged care or new information technologies which are preferred by the Gosford Wyong Regional Development organisations.

The research undertaken by Key Insights suggests that the Somersby Fields Project would have primarily adverse social impacts on the Somersby Public School community and on some people in the Somersby community in the immediate term, lessening to neutral in the mid-term and potentially producing positive long-term impacts dependent upon the final use of the site. The Maroota Public School / Dixon Sands case study indicates that in a similar circumstance (long-term struggle, community fears, small school) the community's worst fears were not realised and in fact there is now a reasonably harmonious relationship between the operator and the school community.

The potential negative social impacts identified can be mitigated by adopting and implementing sound social strategies and it was the opinion of Key Insights (2006) that the Proponent was highly likely to strive to meet their responsibility to the local community.

4.9 VISIBILITY

4.9.1 Introduction

An important attribute of the Project Site recognised by the Proponent at the time of purchase was its low visibility from Peats Ridge Road and adjoining properties. **Plates 4.6, 4.7** and **4.8** display the presence of wide belts of vegetation around the eastern, northern and western side of the Project Site which currently limits virtually all visibility onto the property. By necessity, the vegetation on the southeastern side of the Project Site has been cleared for an airstrip, however, a few observation points are available from the southern side of the Project Site. The closest residence south of the Project Site with obscure views is approximately 0.8km from the southern boundary.

4.9.2 Mitigation Measures and Management Procedures

The focus of the planned mitigation measures and management procedures would be upon the retention / enhancement of the excellent vegetation screen around the boundary of the Project Site. The following measures are proposed to retain the visual protection of the activities on the Project Site.

1. A vegetation buffer at least 25m wide would be retained along the northern boundary of the Project Site. This buffer, together with a 25m strip of native vegetation along the Peats Ridge Road reserve, would provide a 50m wide vegetation barrier which would continue to totally restrict views onto the Project Site from Peats Ridge Road.
2. The alignment of the site access road has been designed in a curved manner to prevent visual access from Peats Ridge Road onto the Project Site.
3. The planned vegetation enhancement on the western side of the Project Site would assist in the long term, to widen the existing good vegetation barrier between the sand removal area and properties to the west which includes Somersby Public School.
4. The planned vegetation enhancement on the southern side of the Project Site would assist to reduce visual access from the few residence to the south that currently have an obscured view of the Project Site.
5. The Proponent intends to adopt a high standard of housekeeping to achieve a visually attractive site.

4.9.3 Residual Impacts

The effectiveness of the perimeter vegetation and the above mitigation measures would ensure that there would be negligible visual impact from the Somersby Fields Project.

Plate 4.6:
Oblique aerial view to the east showing vegetation corridor adjacent to Peats Ridge Road and tree screen at the western edge of the Project Site
(Ref: 521F/8)

Plate 4.7:
Oblique aerial view to the west across the vegetation screen along the western boundary of the Project Site
(Ref: 521F/29)

Plate 4.8:
View to the south across Peats Ridge Road towards the substantial vegetation barrier on the northern side of the Project Site
(Ref: 521D/3)

4.10 ABORIGINAL CULTURAL HERITAGE

4.10.1 Introduction

The following section presents a summary of the Aboriginal heritage assessment conducted for the Somersby Fields Project by Archaeological Surveys and Reports Pty Ltd (ASR) (ASR, 2006) with the assistance of representatives of the local Darkinjung Local Aboriginal Land Council (LALC). ASR was commissioned to identify any Aboriginal sites and relics that may be present and make recommendations both to the Darkinjung LALC and also to the Proponent. The full report of ASR (2006) is presented as Part 10 Volume 2 of the *Specialist Consultant Studies Compendium*.

4.10.2 Archaeological Investigations and Aboriginal Sites Register Search

4.10.2.1 Introduction

A number of Aboriginal heritage surveys have been carried out over the Project Site and surrounding properties over the last decade. On the Project Site, these surveys have included an archaeological survey of the majority of the Project Site by Rex Silcox in July 1995 (Silcox, 1995) and a sub-surface investigation of an archaeological sensitive area close to the eastern boundary in 1996 (Silcox, 1996).

Prior to the 2005 field investigation, a search was undertaken using the Aboriginal Sites Register. The following subsections provide a summary of the previous investigations on the Project Site, previous investigations close by to the Project Site, the results of the search of the Aboriginal Sites Register and the findings of ASR (2006).

4.10.2.2 1995/1996 Surveys of Somersby Fields Project Site

In July 1995, Rex Silcox, an archaeological consultant, surveyed a large proportion of the Somersby Fields Project Site and recommended that a subsurface investigation should be undertaken close to the eastern boundary. Subsequently, in early 1996, a test excavation program was undertaken at 75 locations in that area on the Project Site. All excavated material was hand-sieved and few items were found that could be diagnostically identified as artefacts (none of which are recorded on the Aboriginal Sites Register).

It was concluded that "the results of the investigation did not indicate that more detailed excavations of the area would be likely to recover a large enough sample for useful analysis (Silcox, 1996).

4.10.2.3 1995/1996 Survey Work Surrounding the Project Site

In December 1995, ASR undertook a survey of the site of a proposed quarry extension at Somersby, 3.5km southwest of the Project Site. No Aboriginal sites were identified during the survey.

In October 1996, ASR undertook an additional survey of the site of a proposed clay / shale mine at Peats Ridge, approximately 4.5km south of the Project Site. Similarly, no Aboriginal sites were found during this survey.

4.10.2.4 Aboriginal Sites Register

A search of the Aboriginal Sites Register identified 80 sites within an 8km by 7km area centred on the Project Site. **Figure 4.32** displays the heritage sites recorded within the vicinity of the Project Site. No sites were recorded within the Project Site boundaries. The closest recorded site is approximately 500m northeast of the Project Site. The identified sites typically comprise either rock engravings or axe grinding grooves, both of which require exposed sandstone rock structures.

4.10.2.5 2005 Survey of the Somersby Fields Project Site

In 2005, a comprehensive survey was carried out of the whole Somersby Fields Project Site by ASR accompanied by Jodi Cameron representing the Darkinjung Local Aboriginal Land Council (LALC). The survey strategy entailed examining areas on or adjacent to all walking tracks, targeting soil exposures and erosion features, drainage lines as well as any tree that appeared to be old growth.

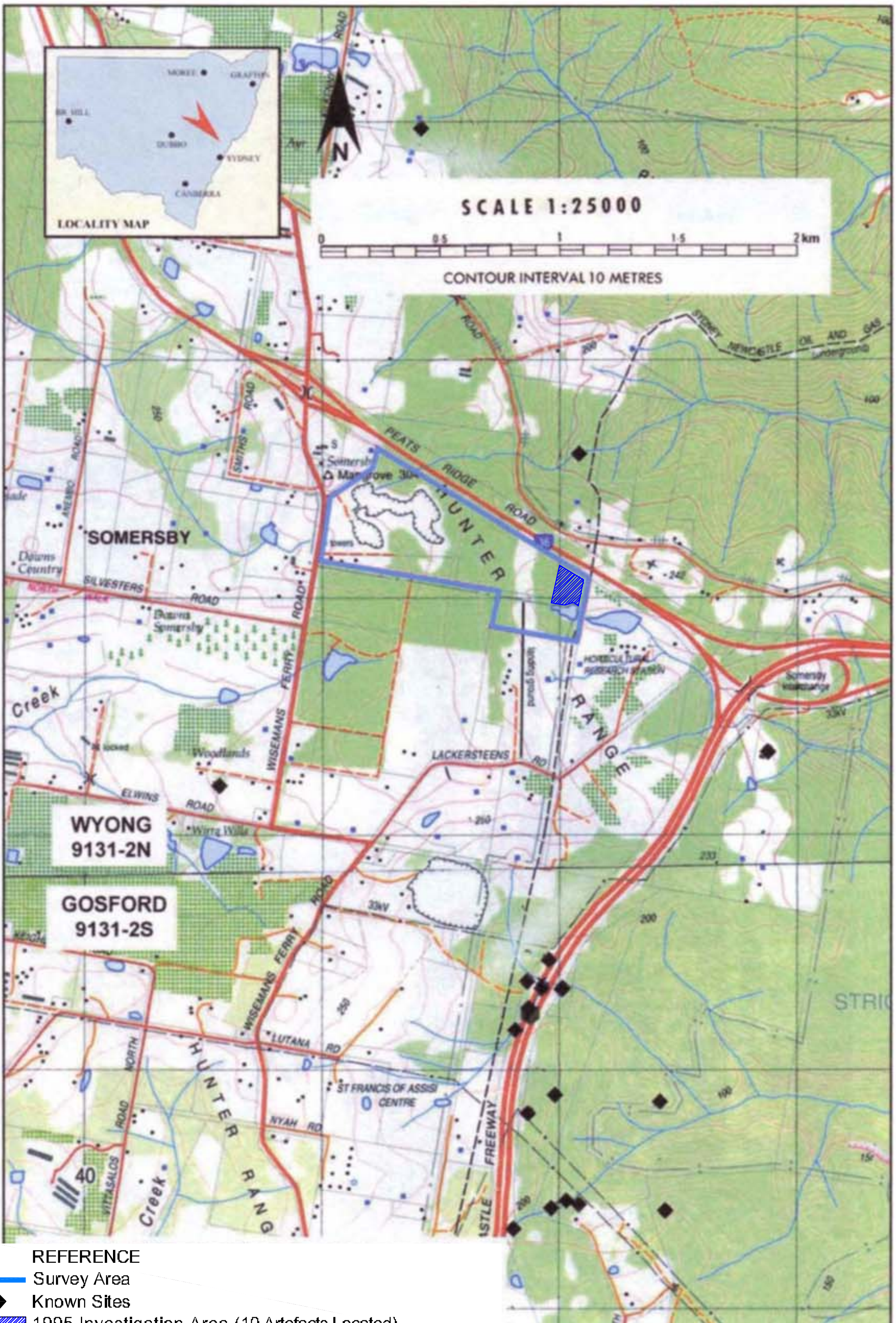
The survey technique was concluded to be the most appropriate and the results are believed to be generally representative of the archaeological record of the Project Site.

No sites of indigenous origin were found in this survey. Although the Project Site is in a region in which there is a potential for Aboriginal heritage sites to occur, there was, in the opinion of ASR (2006), only a very low potential for the Project Site to contain observable archaeological material. If any such material was on the site, it could possibly consist of very small isolated artefacts or isolated stone axes.

4.10.3 Recommendations of the Darkinjung Local Aboriginal Land Council

The results of ASR (2006) and previous surveys on the Project Site and the advice from ASR was presented in written form to the Darkinjung LALC. The Darkinjung LALC confirm that the recommendations provided by the land council in relation to the 1995/1996 surveys undertaken by Silcox remain valid. The recommendations were that:

- there should be a buffer zone of at least 30m wide retained along the eastern boundary to protect the archaeologically sensitive area identified in the 1996 Survey;
- no further archaeological investigation is warranted at the location where the 1996 survey work undertook the subsurface investigation; and
- with the exception of the provision of the buffer zone, that there are no archaeological (or cultural) constraints on the removal of sand on the Somersby Fields Project Site.



REFERENCE
Survey Area
Known Sites
1995 Investigation Area (10 Artefacts Located)

Figure 4.32
ABORIGINAL HERITAGE SITES ON AND SURROUNDING THE PROJECT SITE

Source: Modified After ASR (2006) - Figure 1

4.10.4 Mitigation and Management Procedures

The Proponent accepts the results of these surveys and the recommendations made by the consultants and the decisions of the Darkinjung LALC. Consequently, a 30m wide buffer zone would be provided along the eastern boundary of the Project Site and would remain undisturbed during the period of the sand removal operation.

All employees of the Somersby Fields Project including all contractors would be informed of the location of the buffer zone and the legal requirement to avoid direct or indirect disturbance of the buffer zone. The Proponent has in fact proposed to include the 30m wide buffer zone with the Voluntary Conservation Area adjacent to the northeastern and eastern boundary of the Project Site, therefore providing further protection to this area.

All employees and contractors would be made aware of their responsibility under the *National Parks and Wildlife Act 1974* to notify the operations manager should any additional Aboriginal heritage sites be identified and that work to should cease immediately in the area of the find. In the event that any Aboriginal heritage sites are discovered, the Darkinjung LALC and staff of the DEC (NPWS) would be informed of the discovery and work would not recommence in that area until permission to proceed has been given.

The incorporation of the buffer zone would avoid the necessity to apply for either Section 87 or Section 90 Consents, or the need to consult further with the Aboriginal community in accordance with the Interim Guidelines for Consultation with the Aboriginal community (DEC, 2004). No other mitigation or management procedures are deemed necessary.

4.10.5 Assessment of Impacts

It is assessed that with the implementation of the mitigation and management procedures described in Section 4.10.4, it is unlikely that the project would result in impacts to Aboriginal heritage sites.

4.11 SOILS AND LAND CAPABILITY

4.11.1 Introduction

An assessment of the soils, land capability and agricultural land suitability of the Project Site has been prepared to ensure that the project includes an environmentally sound approach to rehabilitation and re-establishment of the final landform. A detailed soils and land capability / agricultural land suitability assessment of the Project Site was conducted by Geoff Cunningham Natural Resource Consultants Pty Ltd between August 2005 and January 2006 (GCNRC, 2006). A full copy of GCNRC (2006) is presented as Part 11 in Volume 2 of the *Specialist Consultant Studies Compendium* and draws upon a review of previous soil studies on the Project Site, published land capability and soil maps, stereoscopic aerial photo interpretation, field assessment and sampling, and laboratory analyses of sampled soils.

This sub-section, which provides a summary of GCNRC (2006), has been structured to:

- place the Project Site within its regional soil landscape setting (Section 4.11.2.1);
- describe the soils identified on the Project Site, including their physical and chemical attributes, erosion potential and value for rehabilitation (Section 4.11.2.2);
- identify the different land capability and agricultural land suitability classes present on the Project Site (Section 4.11.3); and
- present the management controls proposed by the Proponent to minimise the impact of the project (Section 4.11.4).

For the purpose of the soils, land capability and agricultural land suitability assessments, a study area incorporating an area marginally larger than the footprint of the proposed area of disturbance for the project (26ha) was defined. Details of soil sampling locations and laboratory analyses of all soil samples are presented in full in GCNRC (2006).

4.11.2 Soils

4.11.2.1 Regional Setting

The Project Site is located within the Gosford - Lake Macquarie 1: 100 000 scale Soil Landscapes map sheet area (Murphy, 1993a; 1993b). On this map sheet area, the Project Site is mapped by Murphy (1993b) as the Somersby Soil Landscape, which is described as follows.

> *"gently undulating to rolling rises on deeply weathered Hawkesbury Sandstone plateaux; local relief to 40m; slopes < 15%; Rock outcrop is absent; crests are broad and convex; slopes are long and drainage lines are narrow."*

Section 3 of GCNRC (2006) provides a further summary of this soil landscape.

4.11.2.2 Project Site Soils

4.11.2.2.1 Soil Mapping Units

Following the sampling of eight test pits over the Project Site, a single Soil Mapping Unit (SMU 1) was identified. **Table 4.50** presents a summary of the soil profiles and characteristics of SMU1.

4.11.2.2.2 Physical Attributes

Eight soil samples from two representative test pits were analysed to further characterise the physical properties of SMU 1. Three tests, namely Particle Size Analysis, Dispersion Percentage and Emerson Aggregate Test, were carried out to provide an indication of the soils' likely response to erosive forces.

Table 4.50
Summary of Soil Mapping Unit 1

General	Topsoil	Subsoil
SMU 1		
Soil depth: 35cm to 173cm. *Surface:* soft/loose and rarely hard setting. *Stones:* surface stone and gravel usually absent.	*Horizons:* up to 3 A1 horizons A1.1 Usually present, 14cm-35cm. A1.2 Usually present, 24cm-89cm. A1.3 Rarely present, recorded to 15cm. *Texture:* A1.1 Sandy loam, loamy sand or clayey sand. A1.2 Sand / loamy sand, clayey sand; clayey sand / sandy loam, sandy loam. A1.3 Sand / loamy sand. *pH:* 4.5 to 6.0. *Colour:* light grey and various shades of brown (yellowish brown to strong brown).	*Horizons:* up to three B horizons B1 Usually present, 13cm-83cm. B2.1 Sometimes present, 2cm-24cm. B2.2 Rarely present, recorded to 52cm. B3 Usually present, 26cm-63cm. *Texture:* B1 Clayey sand, sandy loam, sandy clay loam to sandy clay, sandy clay. B2 Sandy clay, sandy light clay, sandy clay loam. B3 Sandy loam, sandy clay, sandy light clay, light clay. *pH:* 4.0 to 5.5 *Colour:* shades of white, pink, light red, yellow and brown.
Source: Modified after GCNRC (2006) – Section 5.		

Particle Size

Particle Size Analyses (PSA) indicate the proportions of gravel, coarse sand, fine sand, silt and clay contained within each soil sample. Although it is evident that the topsoil layer of the profile may contain relatively high concentrations of gravel, this is not sufficient to cause the material to be unsuitable for use in rehabilitation works.

Dispersion

The Dispersion Percentage (D%) test indicates the proportion of the soil material less than 0.05mm in size, ie. clay and some of the silt fraction, that may disperse on wetting. The percentage values recorded indicate that the topsoils on the Project Site have negligible dispersibility. With the exception of the deepest layer of the test pit 4 profile, which displayed a very high dispersibility, the subsoil dispersibility values were also generally negligible to slight.

Soil Coherence

The Emerson Aggregate Test (EAT) provides a measure of coherence of soil aggregates when immersed in water. The results of the EAT tests indicate that all layers display negligible to slight dispersibility.

4.11.2.2.3 Chemical Attributes

The representative samples used for physical characterisation were also subject to laboratory chemical analyses to evaluate the likely salinity hazard.

Soil pH

The pH testing established that all soil layers display a pH within the acceptable range for agronomic purposes (pH 4.0 to pH 8.5), although the pH ranges towards the more acidic end of the scale. This indicates that the pH values of the soil layers that would be stripped for use in rehabilitation are within acceptable limits.

Electrical Conductivity

Electrical conductivity (EC) is a measure of the presence of water-soluble salts, mainly of sodium, calcium and magnesium, in the soil solution. The results obtained indicate that all soil layers are non-saline and suitable for use in rehabilitation of the Project Site.

4.11.2.2.4 Soil Erodibility and Erosion Potential

Visual observations of the soils within the Project Site indicate that, in their current state, they are generally stable except for some minor areas of sheet erosion on the slopes and some gully erosion in the main drainage lines.

Data from the representative soil samples of SMU 1 were analysed using the SOILOSS computer program to determine erosion hazard. The program indicated that the soils have a low to moderate erodibility and, therefore, would require careful management during the stripping and rehabilitation stages to ensure that soil structure damage is minimal, and that they are suitably protected by vegetation or some other medium at all times.

4.11.3 Land Capability and Agricultural Suitability

4.11.3.1 Introduction

"Land capability" was defined by Houghton and Charman (1986) as "the ability of land to accept a type and intensity of use permanently, or for specified periods under specific management, without permanent damage". Land used beyond its capability ultimately loses its productive capacity.

"Agricultural land suitability" is based on land capability, but with the incorporation of other factors, such as closeness to markets and availability of water or processing facilities, in order to provide an indication of its suitability with respect to agriculture (Cunningham *et al.,* undated).

The Gosford land capability map prepared by the former NSW Soil Conservation Service (now DNR) and the regional agricultural land suitability map prepared for the Hunter Plateau by NSW Agriculture (now DPI (Agriculture)) were examined by GCNRC (2006) to determine the land capability and agricultural land suitability of the different areas of the Project Site. These maps provide a broad overview of the land capability and agricultural land suitability of the Project Site.

4.11.3.2 Land Capability

The 1:100 000 scale Gosford Land Capability map sheet shows the Project Site as incorporating mainly Class VI land with some Class IV and in the central section and a small area of Class IVc land in the eastern section near the Department of Primary Industries – Agriculture Research Station. A stereoscopic interpretation of aerial photographs and field assessments of the Project Site study area determined that the bulk of this area should be classed as Class VI land. The eastern area mapped as Class IVc land would be better classified as Class VIc land given its proximity to the adjacent horticultural research facility. **Figure 4.33** presents the Project Site land capability classification as defined by GCNRC (2006), descriptions of which are provided by GCNRC (2006). The Project Site is therefore generally only suitable for grazing with no cultivation and would require soil conservation practices.

4.11.3.3 Agricultural Land Suitability

GCNRC (2006) notes DPI (Agriculture) has classified the agricultural suitability of the Project Site as a combination of Class 2, Class 3, Class 3-4, Class 3-4, 5 and Class 8. Land within the Project Site ranges in suitability from land suitable for regular cultivation for crops to land unsuitable for agriculture and at best suited to light grazing. Further descriptions of each agricultural land suitability class are provided by GCNRC (2006).

After a field inspection and detailed soil sampling of the Project Site, as well as the consideration of the information provided by a previous soils study of the Project Site (Wildthing, 1996; 2002), GCNRC (2006) determined the following agricultural suitability land classifications for the Project Site.

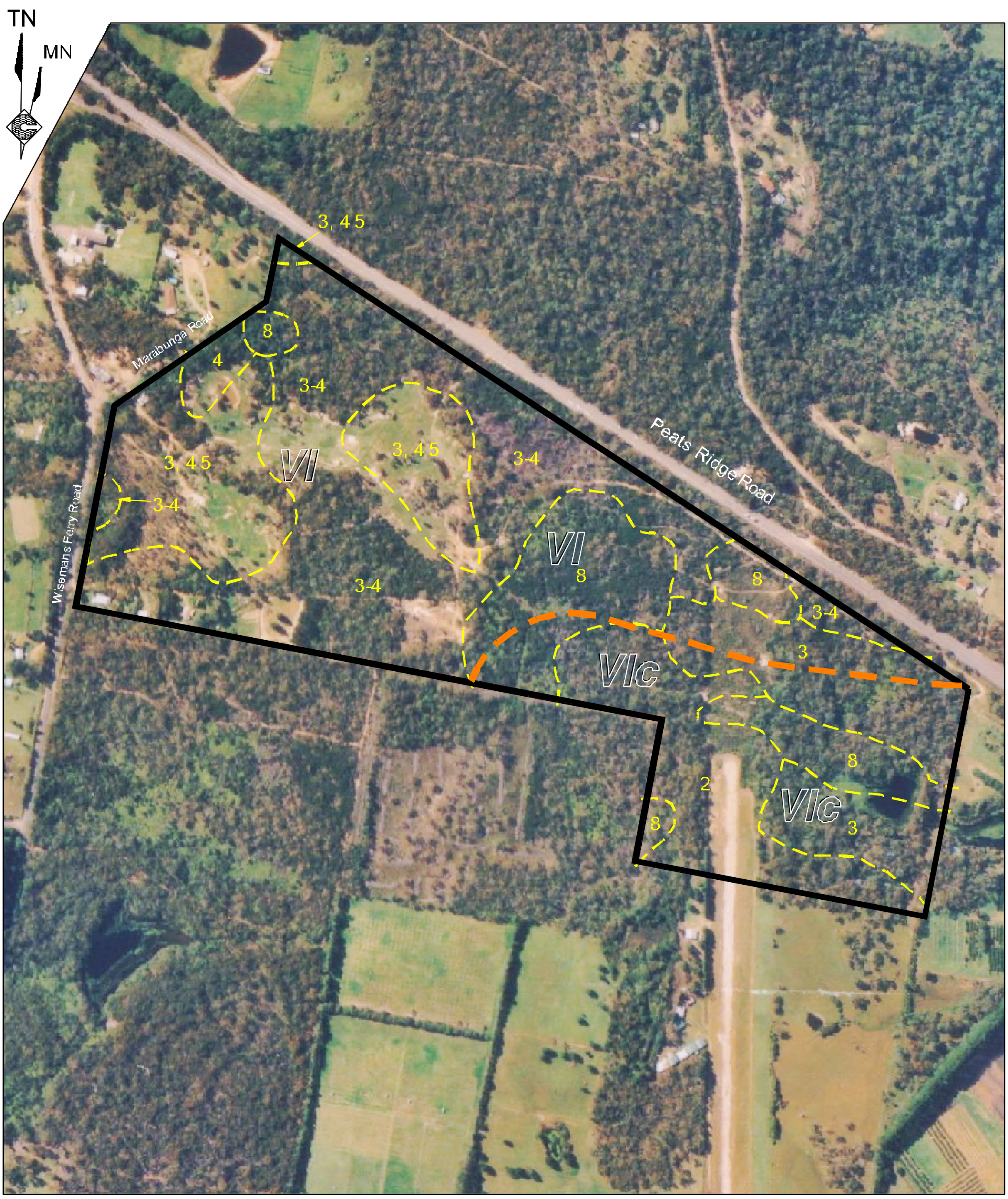
- The lands currently mapped as Class 2 should remain mapped as Class 2 land.
- The lands currently mapped as Class 3 should remain mapped as Class 3 land.
- The lands currently mapped as Class 3-4, 5 should be mapped as Class 5 land.
- The lands currently mapped as Class 3-4 should be mapped as Class 4 land.
- The lands currently mapped as Class 8 should be mapped as Class 5 land.

Figure 4.33 presents the Project Site agricultural land suitability classification as defined by GCNRC (2006).

4.11.4 Soil Management Controls

Management controls for the soil resource to be stripped and replaced are summarised as follows.

- The topsoil layer would be stripped to a depth of 15cm.
- Subsoil would be stripped to a depth of 50cm (below the topsoil layer) unless lateritic gravel or mottled horizons are encountered at lesser depths at which the stripping would cease.



REFERENCE
Project Site Boundary
Agricultural Land Suitability Boundary
3 Agricultural Land Suitability Reference
Land Capability Boundary
VI Land Capability Reference

Figure 4.33
PROJECT SITE LAND CAPABILITY AND AGRICULTURAL LAND SUITABILITY

- Excessive handling of the materials during the stripping and stockpiling operation and handling when the soils are wet would be avoided to protect any structure that may have developed. This would be accomplished, where possible, through the preferential direct transfer of the soils from stripping location to the rehabilitation area.
- Topsoil stockpiles, when required, would not exceed 2m in height and, where practical, be maintained as windrows in preference to larger structures. The placement of these stockpiles would reflect the likely destination of the soil on the final landform. Any stockpiles retained for over three months would be seeded with a non-persistent cover crop to reduce erosion potential and assist in the maintenance of the biological viability of the soil.
- Subsoil stockpiles, when required, would generally not exceed 3m in height and would typically be placed in larger stockpiles than the topsoil.
- Soils to be stockpiled for extended periods of time would form the top section of the Project Site earth mounds and acoustic bunds. This would allow the maximum recommended stockpile heights to be adhered to and minimise the requirement to clear additional areas for their storage.
- The formed stockpile surfaces would be left with a generally even surface that is as 'rough' as possible, in a micro-sense, to assist in runoff control and seed retention and germination.
- Driving of machinery on the topsoil and subsoil stockpiles, as well as the respread soil, would be kept to an absolute minimum to maximise soil aggregation and prevent compaction, particularly when the stockpiles are moist.
- Silt-stop fencing or similar would be placed immediately downslope of stockpiles where required, until stable vegetation cover is established.

4.11.5 Impact Assessment

The project would require the removal and relocation of up to 150 000m^3 of topsoil and subsoil from within a 22ha area on the Project Site. Adherence to the recommended soil stripping, handling and storage procedures would result in an appropriate amount of suitable material being available throughout the project life for progressive landform stripping and rehabilitation. Furthermore, the land would be rehabilitated to a similar land capability as currently identified. Hence, from a soils and land capability viewpoint, the project would result in minimal impacts.