STRATFORDCOAL
Part of the Yancoal Australia Group

Stratford Extension Project
Environmental Impact Statement






SECTION 4

ENVIRONMENTAL ASSESSMENT

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4 ENVIRONMENTAL ASSESSMENT

The following sub-sections present the environmental assessment for the Project, including:

- a description of the existing environment, including descriptions of components of the existing Stratford Mining Complex and its environmental management regime, where relevant;
- an assessment of the potential impacts associated with the Project, including potential cumulative impacts;
- a description of the measures that would be implemented to avoid, minimise, mitigate and/or offset the potential impacts of the Project; and
- a description of the ongoing management and monitoring measures that would be implemented by SCPL.

The assessment of the potential impacts of the Project was conducted in accordance with the DGRs (Section 1.2 and Attachment 1), and in consideration of the outcomes of consultation with key stakeholders, including the community (Section 3) and the results of the Environmental Risk Assessment (ERA) (Section 4.1 and Appendix R).

A summary of other major projects that may interact with the Project and potentially give rise to cumulative impacts is provided in Section 2.5. Potential cumulative impacts have been considered, where relevant, in the specialist studies and in the sub-sections below.

It is considered unlikely that any significant or sustained cumulative environmental impacts would arise from exploration activities by AGL, GRL or Yancoal as exploration activities are generally short-term, of limited extent and are closely regulated (Sections 2.5.1 to 2.5.3). Potential cumulative exploration impacts are therefore not specifically discussed in the following sub-sections.

SCPL's summary of management, mitigation, monitoring and reporting for the Project was developed as a result of the environmental assessment and is provided in Section 7.

4.1 ENVIRONMENTAL RISK ASSESSMENT

As a component of the environmental assessment of the Project, an ERA was undertaken to identify key potential environmental issues for further assessment in the EIS. The ERA was conducted in January 2012, and was facilitated by a risk assessment specialist (Safe Production Solutions, 2012).

The risk assessment team consisted of representatives from:

- SCPL;
- SLR Consulting Australia Pty Ltd;
- PAE Holmes;
- Gilbert & Associates Pty Ltd;
- Heritage Computing; and
- Resource Strategies.

The key potential environmental issues identified during the ERA workshop are summarised in Table 4-1 and addressed in Sections 4.2 to 4.18, and the relevant appendices to this EIS.

The risks associated with the potential environmental issues shown in Table 4-1 were ranked in accordance with the frameworks detailed in Australian Standard/New Zealand Standard ISO 31000:2009 *Risk Management – Principles and Guidelines*, *MDG 1010 Minerals Industry Safety and Health Risk Management Guideline* (NSW Department of Industry and Investment, 2011) and Handbook 203: 2006 *Environmental Risk Management – Principles and Process* (Standards Australia/Standards New Zealand, 2006).

All of the potential issues were ranked within the "Medium – As Low as Reasonably Practicable" or "Low" range by the risk assessment team. The ERA is provided in full as Appendix R.

4.2 CLIMATE

4.2.1 Existing Environment

Meteorology

Long-term meteorological data for the region are available from a range of the Commonwealth Bureau of Meteorology (BoM) meteorological stations (Table 4-2).

Table 4-1
Key Potential Environmental Issues

Environmental Issue Subject Area	Description of Issue	EIS Appendix/Section
Groundwater	Potential cumulative groundwater impacts as a result of the AGL Gloucester Gas Project, proposed Rocky Hill Coal Project and the Project.	Appendix A and Section 4.4
	Final void water management and development of groundwater sinks in the long-term.	
	Potential groundwater related impacts (e.g. baseflow loss) on Dog Trap Creek, Avondale Creek and associated alluvium.	
	Potential reduction in yield in surrounding landholder bores (e.g. Stratford) resulting from the Project.	
	Potential leakage of stored mine water in the Stratford East Dam through underlying coal seams to Stratford East Open Cut – resulting in higher groundwater inflows requiring management.	
Surface Water	Potential for long-term spill of water with elevated salinity from final voids.	Appendix B and Section 4.5
	Design of post-mine landform water management to be stable in the long-term, including up-catchment diversions.	
	Long-term stability of the tributary of Avondale Creek.	
	Long-term stability of up-catchment permanent diversions.	
	Site water balance and management of surplus mine water on-site to achieve zero discharge of mine water.	
Noise	Potential for intrusive noise and sleep disturbance impacts on some receivers including dwellings, schools, a church and recreational areas resulting from Project operations.	Appendix C and Section 4.6
	Noise amenity and sleep disturbance impacts on nearby receivers from Project road and rail operations during daytime, evening and night-time.	
	Operational requirement for additional fixed and mobile plant - leading to additional noise impacts.	
	Noise performance and non-compliance with noise criteria during Project operations.	
Air Quality	Increased emissions of PM_{10}/$PM_{2.5}$/total suspended particulate (TSP)/dust deposition from the Project resulting in the potential for increase in predicted impact (health and amenity) at residential receivers.	Appendix D and Section 4.7
	Potential for increase in cumulative impact associated with the Project, proposed Rocky Hill Coal Project and the AGL Gloucester Gas Project.	
	Heightened community concern regarding health related air quality issues, including cumulative impacts.	
	Potential for an increase in dust and aerial contaminants on Stratford homes resulting in contamination of their tank water supplies.	
	Changes in the air quality effects between modelled and actual levels experienced (due to conservative assumptions in modelling).	
Flora and Fauna	Potential for loss of terrestrial flora and fauna and their habitat - other species (non-threatened).	Appendices E and F and Sections 4.9 and 4.10
	Fragmentation of habitats impacting movement of fauna.	Appendix F and Section 4.10
	Potential impacts on threatened fauna species (Squirrel Glider, Glossy Black-Cockatoo and New Holland Mouse).	
	Failure of revegetation and/or habitat enhancement in the biodiversity offset areas or biodiversity enhancement areas.	Appendices E and F and Sections 4.9 and 4.10

Table 4-1 (Continued)
Key Potential Environmental Issues

Environmental Issue Subject Area	Description of Issue	EIS Appendix/Section
Flora and Fauna (Aquatic Ecology)	Potential change in flow persistence in Avondale Creek, Dog Trap Creek and/or Avon River leading to adverse aquatic ecology impacts.	Appendix G and Section 4.11
Aboriginal/Non-Aboriginal Heritage	Potential indirect impacts on potential cultural site CTS-1.	Appendix I and Section 4.12
Socio-Economic	Potential impacts on amenity (effects on tourism, loss of farming land, proximity to Stratford), water quality (environmental), noise, air quality, health and transport.	Appendices C, D, N and P and Sections 4.6, 4.7, 4.14 and 4.17
Rehabilitation/Closure	Potential for failure of revegetation and/or habitat enhancement on post-mine landforms.	Section 5
	Geotechnical issues related to the Roseville West Pit Extension (where excavating through reject material).	
	Long-term stability and rehabilitation of CHPP rejects deposited in the co-disposal areas.	

Source: Appendix R.

Short-term local records are available from the on-site weather station located at the Stratford Mining Complex (Figure 4-1), which is operated in accordance with the Development Consents (DA 23-98/99 and DA 39-02-01) and EPLs (5161 and 11745).

The on-site weather station monitors a number of meteorological parameters, including daily rainfall and temperature, solar radiation, wind speed and wind direction.

Short-term data records are also available from the on-site weather station located at the DCM, approximately 20 km south of the Stratford Mining Complex (Figure 4-1). The DCM weather station is operated in accordance with Project Approval 08_0203 and EPL 11701.

Meteorological data were also made available by GRL from a new meteorological station installed some 5 km to the north of the Stratford Mining Complex (Figure 4-1).

A summary of meteorological parameters in the vicinity of the Project relevant to the environmental studies in this EIS are provided below.

Temperature

The closest BoM meteorological stations to the Project with recorded temperature data are located at Chichester Dam and at the Dungog Post Office (BoM, 2011) (Figure 4-1).

Long-term, monthly-average daily maximum and minimum temperatures from Chichester Dam and Dungog Post Office meteorological stations show that temperatures are warmest from November to February and coolest in the winter months of June, July and August (Table 4-2).

Monthly-average daily maximum temperatures and daily minimum temperatures for the Dungog Post Office and Chichester Dam meteorological stations are provided in Table 4-2.

Evening and night-time temperature inversions occur in the Stratford Mining Complex area. Weak, moderate and strong temperature inversions (i.e. class E, F and G, respectively) occur during the evening and night-time, with moderate temperature inversions of 1.5 to 4 degrees Celsius (ºC)/100 m occurring most frequently (Appendix C). Further detail regarding the occurrence of temperature inversions is provided in the Noise and Blasting Assessment (Appendix C).

Rainfall

The long-term average annual rainfall recorded at the Gloucester Post Office (60015), located approximately 14 km north of the Project (Figure 4-1), is 983 mm based on records dating back to 1888 (Table 4-2).

Closer to the Project, rainfall records at Craven (Longview [60042]) since 1961 and Gloucester (Hiawatha [60112]) since 1976 indicate the average annual rainfall since these stations were commissioned is 1,057 mm and 1,021 mm, respectively (Table 4-2).

Table 4-2
Meteorological Summary - Average Temperature, Rainfall and Evaporation

Period of Record	Average Daily Temperature (ºC) [1] [Minimum-Maximum]		Average Monthly Rainfall (mm) [2]					Average Monthly Evaporation (mm) [3]			
	Chichester Dam (61151)	Dungog Post Office (61017)	Data Drill Sequence[4]	Gloucester Post Office (60015)[1]	Craven (Longview) (60042)[1]	Gloucester (Hiawatha) (60112)[1]	Stratford Mining Complex AWS[2,5]	Data Drill Sequence[4]	Chichester Dam (61151)[1]	Taree Airport AWS (60141)[1]	Paterson [Tocal] AWS (61250)[1]
	1938 to 1956	1966 to 1975	1889 to 2011	1888 to 2011	1961 to 2011	1976 to 2011	1996 to 2011	1970 to 2011	1942 to 2011	1999 to 2011	1967 to 2011
January	13.7-30.1	15.7-34.0	121.6	114.8	125.3	113.3	99.6	171.5	139.5	201.5	192.2
February	13.8-29.8	15.5-31.1	129.3	121.7	136.8	131.7	111.1	135.2	110.2	155.4	149.7
March	13.1-26.2	13.1-29.3	134.6	127.9	133.9	124.1	107.9	120.7	93.0	148.8	130.2
April	2.8-23.3	7.6-27.4	88.3	77.3	85.2	83.8	71.1	88.3	69.0	105.0	99.0
May	0.8-21.0	6.1-23.6	78.1	68.6	88.3	81.4	72.1	64.5	46.5	83.7	74.4
June	4.4-17.4	2.6-19.8	79.9	68.4	79.2	60.4	79.2	54.0	33.0	66.0	63.0
July	4.4-15.9	0.3-20.2	58.9	51.4	40.3	39.9	51.0	62.0	40.3	74.4	74.4
August	4.9-20.5	3.7-20.8	53.1	46.6	44.3	36.1	36.6	87.4	58.9	99.2	105.4
September	6.8-21.8	5.9-25.2	55.9	51.2	47.4	44.5	42.8	115.4	87.0	138.0	132.0
October	7.8-23.9	7.5-28.0	73.9	69.2	79.3	68.5	70.6	142.0	108.5	158.1	161.2
November	12.3-28.7	10.8-31.4	85.6	83.9	91.8	102.4	106.1	152.0	123.0	162.0	174.0
December	14.4-30.7	11.2-31.3	108.1	104.4	98.5	101.7	78.7	180.0	151.9	201.5	210.8
Annual Average	***11.0-21.9***	***10.3-24.8***	***1,067 [1,067.3]***	***983 [985.4]***	***1,057 [1,050.3]***	***1,021 [987.8]***	***924 [926.8]***	***1,374 [1,373.0]***	***1,059 [1,060.8]***	***1,607 [1,593.6]***	***1,571 [1,566.3]***

[1] Source: BoM (2011).

[2] Source: After Gilbert & Associates (2012).

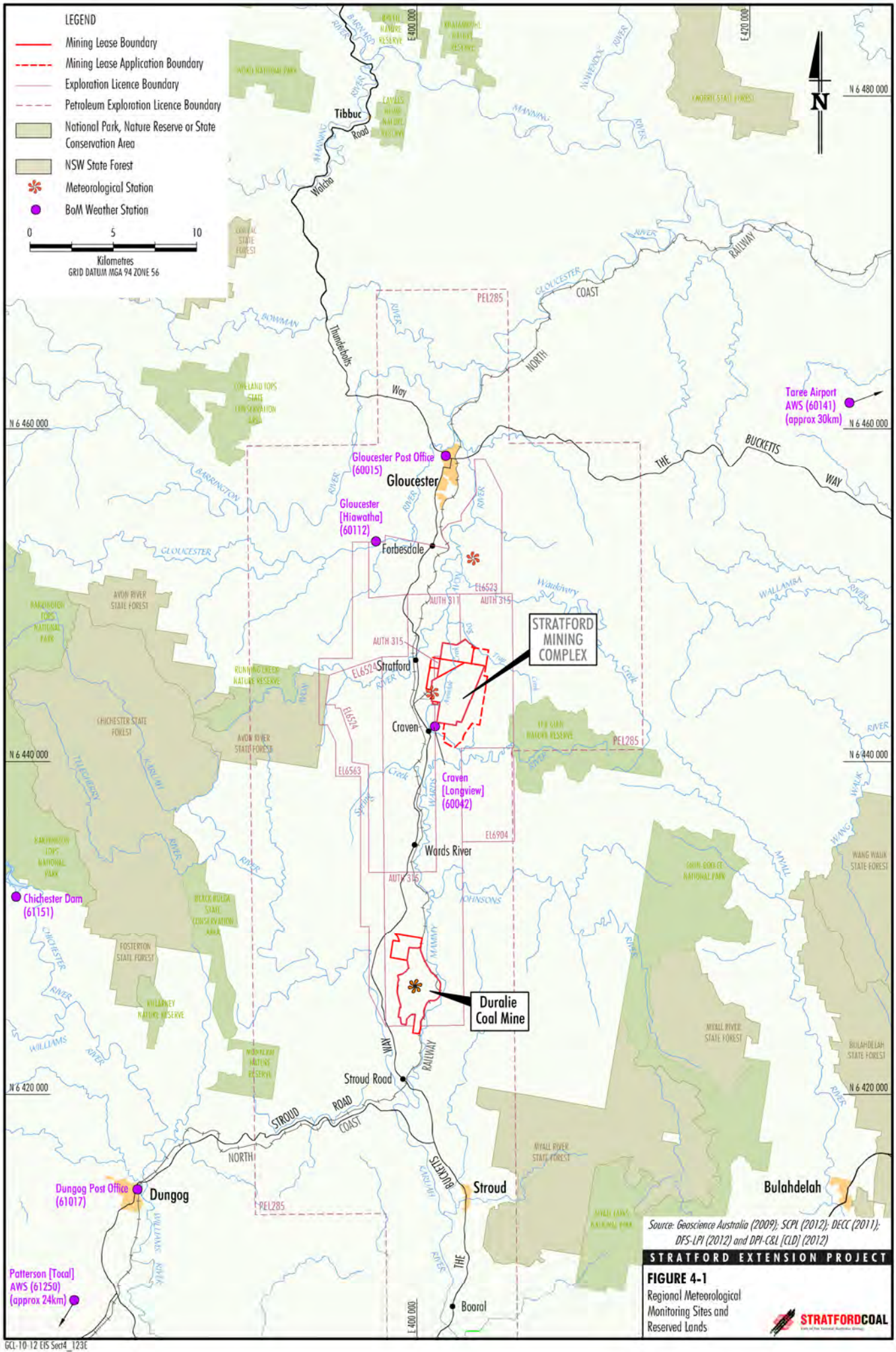
[3] As measured by Class A Evaporation Pan.

[4] Data Drill located at 32.15ºS, 151.95ºE – located to the south-west of ML 1360 at the Stratford Mining Complex. The Data Drill sequence is a continuous, synthetic record based on interpolation of data from nearby sites.

[5] Records missing for periods: 12 March 2001 to 31 December 2001; 10 February 2005 to 25 March 2005; 7 November 2005 to 30 November 2005; and 17 January 2008 to 13 February 2008.

AWS = Automatic Weather Station

[ ] Sum of average monthly records.



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Rainfall records are also available at several other meteorological stations in the region with varying periods of records as follows (Appendix B):

- Stroud Post Office (61071) – since 1889.
- Paterson (Tocal) (61250) – since 1967.
- DCM AWS - since 2002.
- Waukivory (60115) - since 2008.

The months with the highest monthly-average rainfalls at the Gloucester Post Office , Craven (Longview) and Gloucester (Hiawatha) meteorological stations are February and March (121.7 mm and 127.9 mm, 136.8 mm and 133.9 mm, and 131.7 and 124.1 mm, respectively) (Table 4-2).

The distribution of annual average precipitation across the Project is highest in elevated areas to the south and east. Average annual rainfall is relatively lower in areas to the north of the Project along the Avon River (Appendix B).

For the period 1996 to 2011, the average annual rainfall recorded by the Stratford Mining Complex meteorological station is 924 mm, with maximum monthly rainfall typically occurring during the warmer months from November to March (Table 4-2).

The average annual rainfall as predicted by the BoM Data Drill Application[1] at the Stratford Mining Complex is 1,067 mm (Table 4-2).

Evaporation

Evaporation records are available from the Chichester Dam (61151), Taree Airport AWS (60141) and Paterson (Tocal) (61250) meteorological stations (Figure 4-1), which have recorded average annual evaporation of approximately 1,059 mm, 1,607 mm and 1,571 mm, respectively (Table 4-2). The highest monthly-average evaporation is in December (151.9 mm, 201.5 mm and 210.8 mm, respectively) and the lowest monthly-average evaporation is in June (33 mm, 66 mm and 63 mm, respectively) (Table 4-2).

Based on the available datasets, measured monthly-average evaporation exceeds the measured monthly-average rainfall for most of the year (Table 4-2).

The average annual evaporation as predicted by the BoM Data Drill Application at the Stratford Mining Complex is 1,374 mm (Table 4-2).

Wind Speed and Direction

As part of the Air Quality and Greenhouse Gas Assessment (Appendix D), annual and seasonal wind speeds and directions were determined using available 15-minute averages of wind speed and direction data between November 2010 and October 2011 from the Stratford Mining Complex weather station. The annual and seasonal windroses are presented on Figure 4-2.

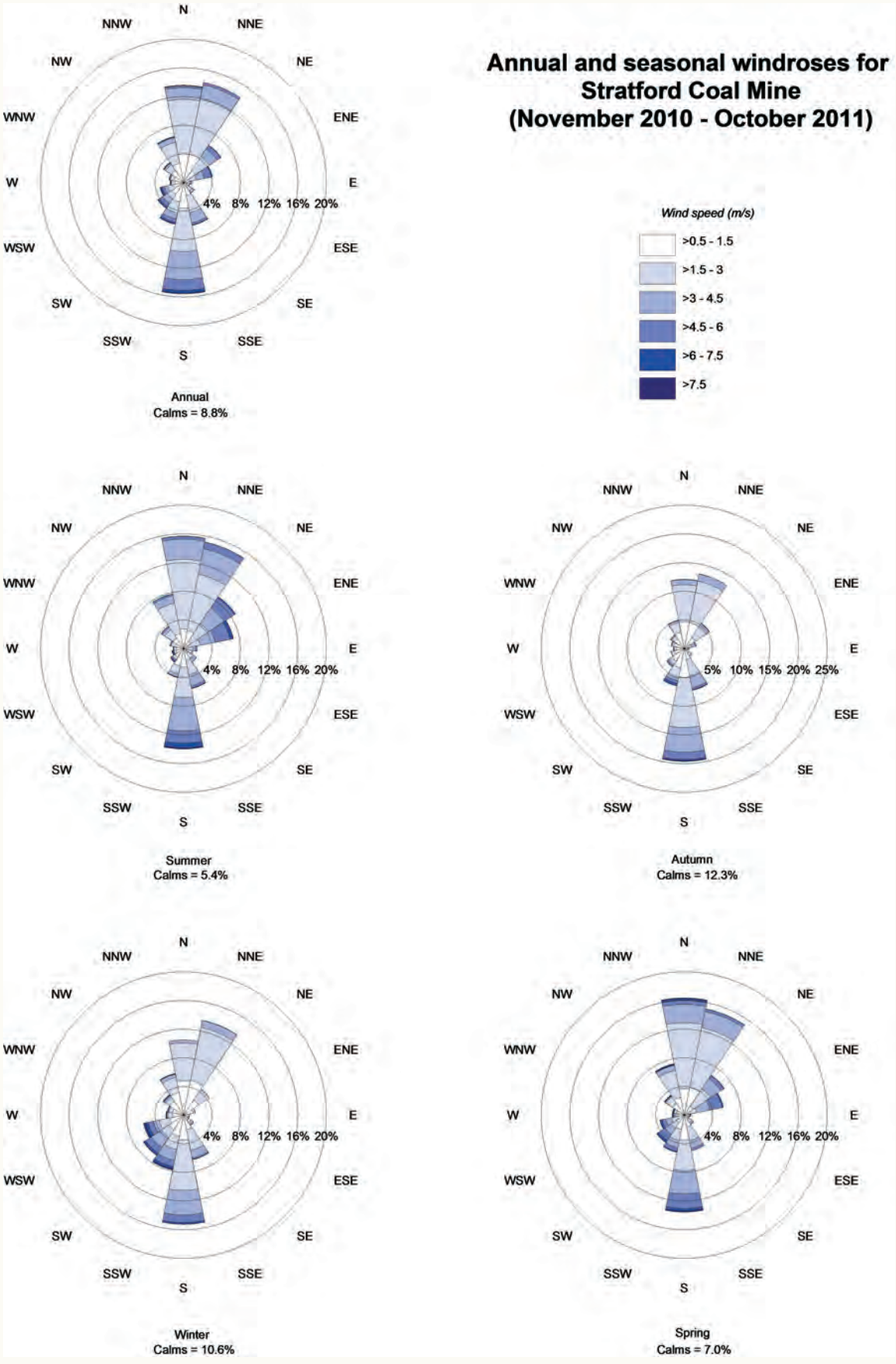
The annual windrose indicates that the prevailing wind direction was from the northern quadrant with wind speeds generally between 0.5 and 4.5 metres per second (m/s). Winds from the south are also a feature of the area (Figure 4-2). Calm periods (i.e. wind speed less than 0.5 m/s) were recorded for approximately 8.8% of the time between November 2010 and October 2011.

Appendix D also compared wind speed and direction from data from the Stratford Mining Complex and the GRL meteorological station located some 5 km to the north. The comparison indicates that the annual windroses are very similar, with some minor differences in wind direction explained by variations in local topography at the two sites (Appendix D). In addition, Appendix D provides windroses developed (using the meteorological model CALMET) from a synthesis of data from the Stratford Mining Complex, DCM, the GRL meteorological station and the BoM AWS located at Murrurundi Gap (located some 110 km west-northwest of the Stratford Mining Complex). This synthesised dataset was prepared for use in air quality modelling.

4.2.2 Monitoring

The Stratford Mining Complex meteorological station would continue to operate for the Project. The data recorded would continue to be used as part of the noise (Section 4.6) and air quality (Section 4.7) management regimes, and to assist in the interpretation of surface water and groundwater monitoring results.

[1] The Data Drill Application is a system which provides continuous, synthetic daily data sets for a specified point by interpolation between surrounding point records held by the BoM.



Source: PAEHolmes (2012)

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FIGURE 4-2
Stratford Coal Mine
Annual and Seasonal
Wind Roses 2010/2011

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4.3 LAND RESOURCES AND AGRICULTURAL PRODUCTION

A description of the existing environment relating to land resources and agricultural production is provided in Section 4.3.1. Section 4.3.2 describes the potential impacts of the Project on land resources and agricultural production, and Section 4.3.3 describes applicable mitigation measures, management and monitoring.

An Agricultural Assessment for the Project was undertaken by SCPL and is presented in Appendix K. The Agricultural Assessment has been prepared in consideration of the DP&I *Guideline for Agricultural Impact Statements* (DP&I, 2012a) and the *Strategic Regional Land Use Plan – Upper Hunter* (Upper Hunter SRLUP) (DP&I, 2012b).

4.3.1 Existing Environment

Landforms and Topography

The Project is situated in the Gloucester Basin which is a linear valley extending approximately 40 km in length and 13 km in width (SCPL, 1998). The Gloucester Bucketts (546 m AHD) and Mograni Range (480 m AHD) flank the western and eastern sides of Gloucester respectively. Other elevated topographic features include Cut Hill (359 m AHD) (some 7 km north-west of the Project) and Banks Rocks (460 m AHD) (located some 3 km north-east of the Project).

The topography of the area within and immediately surrounding the Project is characterised by a north-south oriented linear ridgeline to the east, transitioning to undulating lowlands and valley floor floodplains towards the west.

The ridgeline to the east of the Project area rises to approximately 470 m AHD and is moderately to steeply sloping. The elevation of the valley floor within the Project area ranges from approximately 140 m AHD to approximately 115 m AHD.

The development of the Stratford Mining Complex and associated open cut mining and waste rock emplacements has resulted in alteration to the site's pre-mining topography. Modified landforms include the Roseville, Northern, Southern and Stratford Waste Emplacements, western co-disposal area, water management infrastructure and the open cut pits (Figure 2-1).

Land Use

The Project area is located on lands which include the border of the Birpai (or Birripai) tribe and the Worimi tribe (Tindale, 1974).

The Project area was part of a very large land grant held from the early 19th Century by the Australian Agricultural Company that extended from Port Stephens to the Manning River (Appendix J). Historically, the valley in the Project area appears to have been largely wooded during the Australian Agricultural Company period and was cleared for dairying in the early 20th Century (Appendix J).

Contemporary land use in the vicinity of the Project is dominated by the Stratford Mining Complex, agricultural production (primarily grazing for beef production) and remnant vegetation generally located along ridgelines, along watercourses and in isolated patches within the cleared landscape.

A number of reserved areas are located in the general vicinity of the Project including the Glen Nature Reserve (located approximately 2 km to the south-east), Barrington Tops National Park located to the west and south-west, and the Avon River State Forest located to the west (Figure 4-1).

Settlements located in the vicinity of the Project site include Stratford and Craven (Figure 4-1).

Soils

An Agricultural Resource Assessment was undertaken for the Project by McKenzie Soil Management (2012) and is included as an attachment to Appendix K.

The main soil types mapped in the Project area comprise Kurosols (38%), Kandosols (22%) and Anthroposols (disturbed lands) (16%), while lesser areas of Sodosols, Tenosols, Chromosols and Dermosols were also observed (Appendix K).

Soil landscape units containing groupings of the above soil types identified during the soil survey are listed below:

- Disturbed lands with a broad range of slopes: Anthroposols.
- Alluvial/Colluvial Plains, <3% slope: dominated by Kandosols; sub-dominant Kurosols, Sodosols and Chromosols.
- Alluvial/Colluvial Plains, flat and swampy: dominated by Kandosols; sub-dominant Kurosols, Sodosols and Chromosols.

- Lower slopes, 3% to 10% slope: dominated by Kurosols; sub-dominant Kandosols, Sodosols and Chromosols.
- Mid-slopes, 10% to 25% slope on sedimentary rock: mosaic of Tenosols, Kurosols, Kandosols and Sodosols.
- Mid-slopes, 10% to 25% slope on basalt: Dermosol.
- Upper slopes, >25% slope: Tenosols and Rudosols.

The soil types and associated soil landscapes are mapped in Appendix K.

Soil Condition

A broad range of soil physical and chemical constraints for agricultural land use were identified on the Project site including (Appendix K):

- subsoil acidity and associated aluminium (Al) toxicity;
- a lack of water holding capacity;
- dispersive subsoil;
- subsoil salinity; and
- nutrient deficiencies.

The soil testing pits located in the existing Stratford Mining Complex rehabilitated areas had a wide range of soil conditions for plant growth, ranging from areas with low water holding capacity associated with rock close to the surface, to areas with much higher water storage capacity and favourable subsoil pH associated with excellent deep root growth (Appendix K).

Rural Land Capability

The Rural Land Capability classification system is used to determine the various classes of rural land on the basis of the capability of the land to remain stable under particular uses. Land is allocated to one of eight classes, with emphasis on the erosion hazards in the use of the land.

Rural Land Capability mapping for the Project area has been completed by McKenzie Soil Management (2012) and is documented in Appendix K. Mapped Rural Land Capability ranged from Class IV to Class VIII, with the major factors in determining the classes being slope and soil stability in water (Appendix K).

Definitions for these classes are provided below (Emery, 1986; Sonter and Lawrie, 2007):

Land Suitable Mainly for Grazing

Class IV: *Soil conservation practices such as pasture improvement, stock control, application of fertiliser, minimal cultivation for the establishment or re-establishment of permanent pasture and maintenance of good ground cover.*

Class V: *Soil conservation works such as diversion banks and contour ripping, in addition to the practices in Class IV.*

Land Suitable for Grazing

Class VI: *Not capable of cultivation. Soil conservation practices include limitation of stock, broadcasting of seed and fertiliser, promotion of native pasture regeneration, prevention of fire, destruction of vermin, maintenance of good ground cover and possibly some structural works.*

Land Suitable for Tree Cover

Class VII: *Land best protected by trees.*

Land Unsuitable for Agriculture

Class VIII: *Cliffs, lakes or swamps where it is impractical to grow crops or graze pasture.*

The rehabilitated flat areas on the Stratford Waste Emplacement were allocated Class IV. Other rehabilitated areas (e.g. batters) on the Stratford Waste Emplacement and the Northern Waste Emplacement were allocated to Class V due to slope (Appendix K). The flat areas on the Stratford Waste Emplacement were observed to have similar, and in some cases better, soil conditions than that observed in the "natural" soil profiles under pasture on the Project site (Appendix K).

Agricultural Suitability

The Agricultural Suitability system is used to classify land in terms of its suitability for general agricultural use. Agricultural land is classified by evaluating biophysical, social and economic factors that may constrain the use of land for agriculture.

Agricultural Suitability mapping for the Project area has been completed by McKenzie Soil Management (2012) and is documented in Appendix K.

Agricultural Suitability classes identified across the Project site ranged from Class 4 to Class 5. No Class 1, Class 2 or Class 3 agricultural lands have been identified within the Project area. Soil limitations included various combinations of the following factors: erosion hazards associated with steep slopes, shallowness, dispersion, acidity, nutrient deficiencies and compaction (Appendix K).

The rehabilitated areas on the existing Stratford Mining Complex waste rock emplacements were allocated by McKenzie Soil Management (2012) to Class 4.

Class 4 Agricultural Suitability is defined as (NSW Agriculture, 2002):

> *Land suitable for grazing but not for cultivation. Agriculture is based on native pastures and improved pastures established using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.*

Class 5 Agricultural Suitability is defined as (NSW Agriculture, 2002):

> *Land unsuitable for agriculture, or at best suited only to light grazing. Agricultural production is very low or zero as a result of severe constraints, including economic factors which prevent land improvement.*

Agricultural Activities and Productivity

Agricultural activities known to have been conducted in the Project area include cattle grazing for beef and dairy products, and small areas were observed to have been used for cultivation for forage crops. There was, however, no evidence of crop production for grains (irrigated or unirrigated) or intensive horticulture (Appendix K).

Yancoal also owns land adjoining the Project area. This land typically comprises the same agricultural-related land uses as the Project area.

The Project biodiversity offset areas include approximately 380 ha of cleared land outside of the Project MLs and MLAs. This cleared land is typically used for grazing (Appendix K).

Strategic Agricultural Lands

A review of the regional mapping in the Upper Hunter SRLUP indicates that the nearest mapped strategic agricultural land is located on the Avon River approximately 2 km to the west of the Project (Figure 4-3).

It is therefore concluded that based on the limitations identified in the site soil survey, Rural Land Capability mapping, Agricultural Suitability mapping and review of regional mapping of strategic agricultural lands, the Project area does not include highly productive soils, nor does it include areas of high value or strategic agricultural lands (Appendix K) (e.g. as described by the Upper Hunter SRLUP).

Similarly, adjoining Yancoal-owned lands and the proposed Project biodiversity offset areas also do not comprise high value or strategic agricultural lands based on the available mapping information (Appendix K) (e.g. as described by the Upper Hunter SRLUP).

Bushfire Regime

The Project is located in the Gloucester Bush Fire Management Committee (GBFMC) Bush Fire Management Plan area (Gloucester BFMC area). In the Gloucester BFMC area the bushfire season generally runs from October to December, however, when summer rainfall is below average, the season can extend in autumn (GBFMC, 2008).

The main sources of bushfire ignition in the Gloucester BFMC area include (GBFMC, 2008):

- loss of fire control during legal burning-off;
- lightning;
- arson;
- re-ignition following wildfire or hazard reduction burns; and
- illegal burning-off.

Under the Bush Fire Management Plan, the Stratford Mining Complex is designated within an Asset Protection Zone.

SCPL is suitably equipped to respond to any fires on-site and to assist the RFS and emergency services if there is a fire in the area.

The following bushfire management related activities/works are undertaken at the Stratford Mining Complex (SCPL, 2011a):

- access arrangements onto and through the Stratford Mining Complex for local RFS officers to fight fires are in place;
- a number of old fire trails up onto the ridge on the eastern side of the Stratford Mining Complex have been cleared and re-opened;

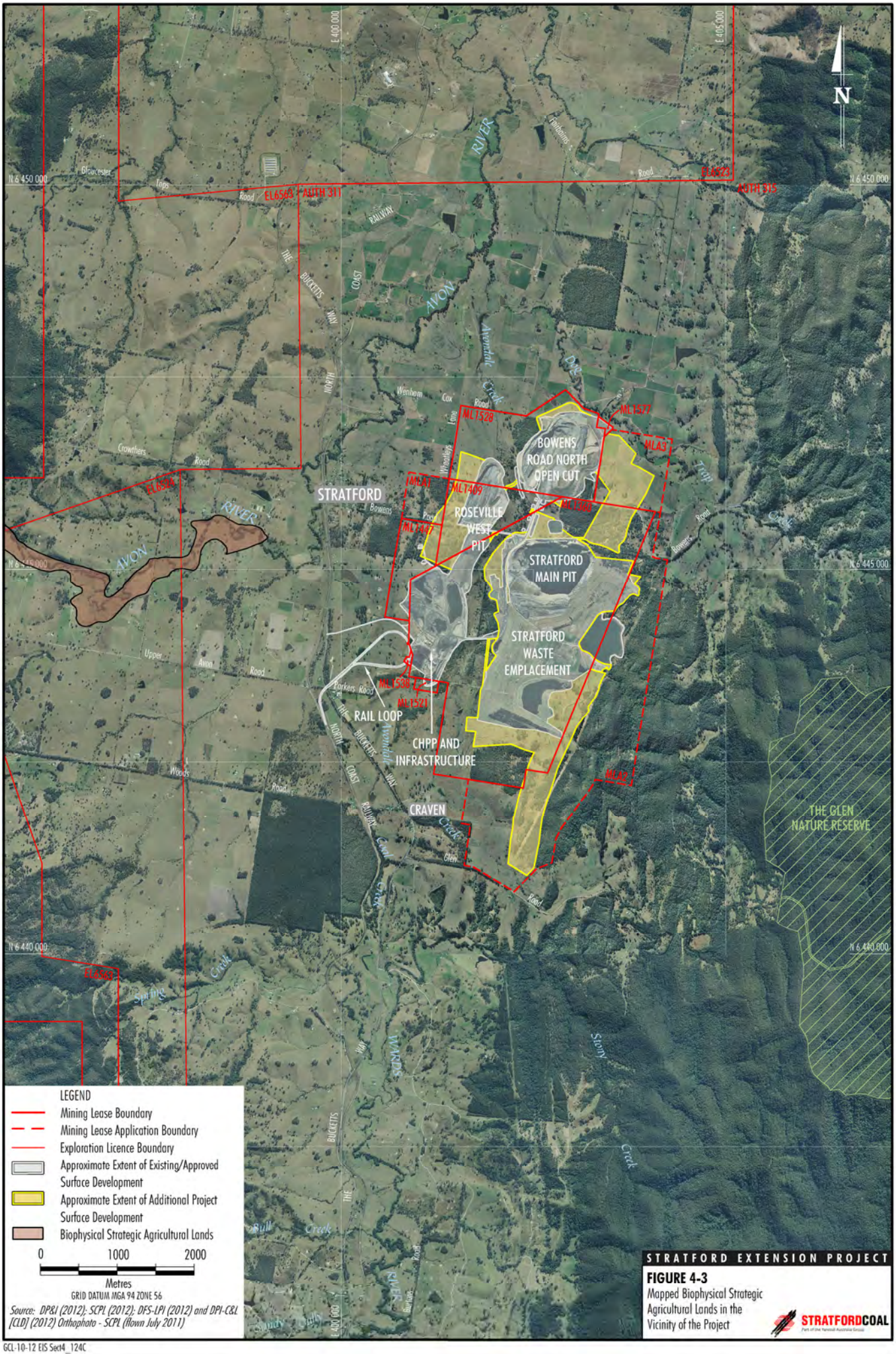

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FIGURE 4-3

Mapped Biophysical Strategic Agricultural Lands in the Vicinity of the Project

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- Stratford Mining Complex water cart(s) are made available for bushfire fighting purposes where suitable access for this machinery is available;
- SCPL undertakes hazard reduction burns as requested, in consultation with the local RFS; and
- fuel loads on cleared pasture areas are reduced by cattle agistment and/or periodic slashing.

4.3.2 Potential Impacts

Landforms and Topography

The Project would alter the landforms and topography within the Project site. Some topographic changes would be temporary (e.g. temporary bunds/drains) and some would be permanent (e.g. final mine landforms).

The extent of the existing open cut mining areas and waste rock emplacements would be increased by the Project (Figures 2-1 and 2-8 to 2-12). The Project would also include development of the new Avon North and Stratford East Open Cuts.

Waste rock mined during the development of the Project would be used to in-fill mine voids, as well as being placed in the out-of-pit waste rock emplacements (i.e. the extensions to the Northern Waste Emplacement and Stratford Waste Emplacement).

The Stratford Waste Emplacement would be lifted to a maximum height of 196 m AHD. The Northern Waste Emplacement would be extended to a maximum height of 165 m AHD.

At the cessation of mining, three final voids would remain (Section 5.3.8).

These changes, while altering the layout and extent of the approved/existing Stratford Mining Complex, are effectively extensions to existing approved mine landforms.

A range of lesser topographic changes would be associated with the construction of roads, hardstands, water management, and erosion and sediment control features over the Project life.

Soils

Potential impacts of the Project on soils would relate primarily to:

- disturbance of *in situ* soil resources within additional disturbance areas (e.g. development of the new open cut mining areas);
- alteration of soil structure beneath infrastructure items, hardstand areas and roads;
- possible soil contamination resulting from spillage of fuels, lubricants and other chemicals;
- increased erosion and sediment movement due to exposure of soils during construction (e.g. road realignments); and
- alteration of physical and chemical soil properties (e.g. structure, fertility, permeability and microbial activity) due to soil stripping and stockpiling operations.

A review of the physical and chemical properties of the soils within the Project site has established that there are soil resources present that would be suitable as a rehabilitation medium for agricultural land uses (grazing) and for native plant revegetation on the Project site post-mining (Appendix K).

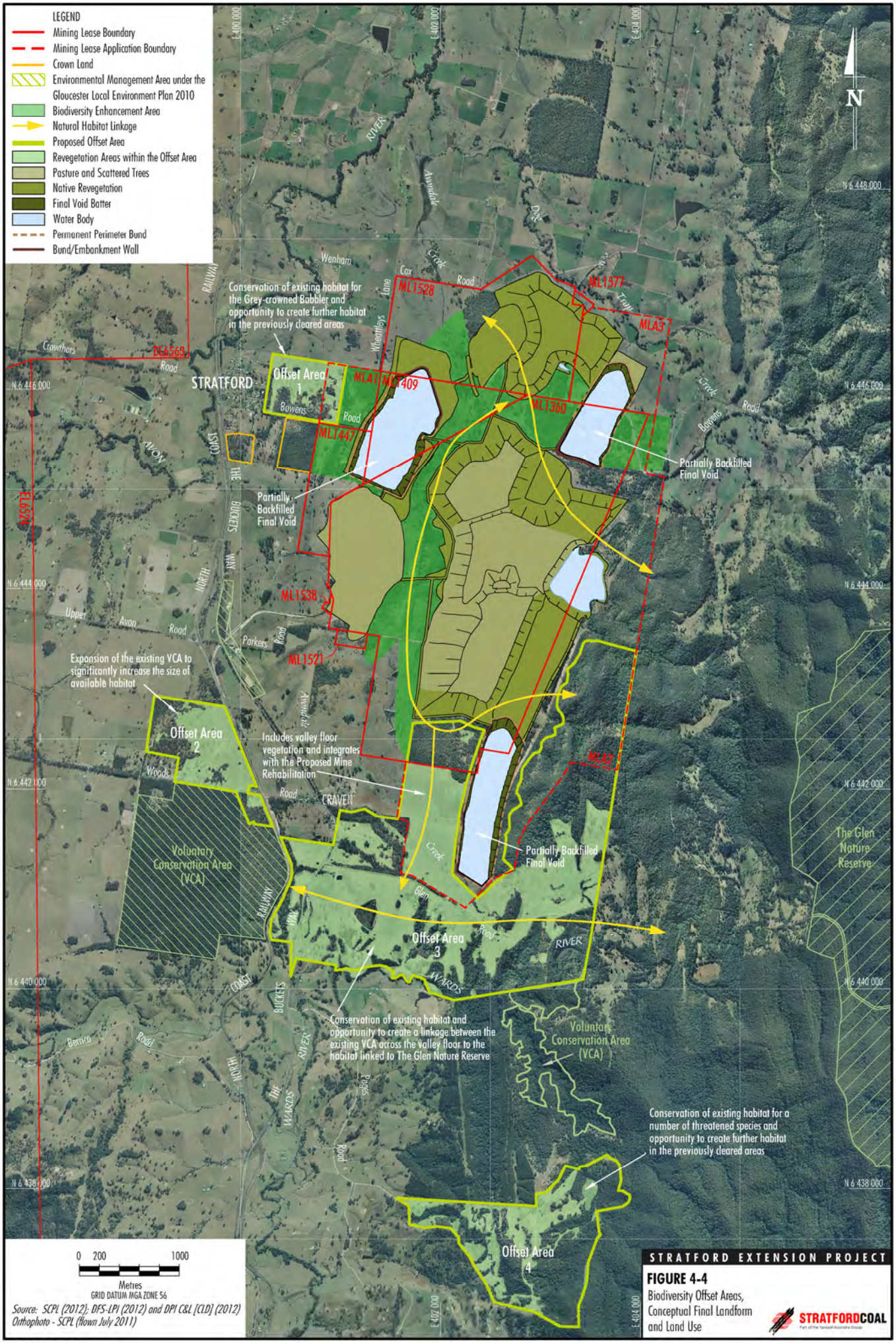
Land Contamination Potential

Potential land contamination risks were identified as part of the Preliminary Hazard Analysis (PHA) (Section 4.18) and include leaks/spills, fires and explosions associated with the transport, storage and use of hydrocarbons and chemicals.

Land Use - Agricultural Activities and Productivity

The Project (plus a portion of the biodiversity offset areas) would result in the long-term disturbance or alteration of existing agricultural lands. The rehabilitation and mine closure strategy for the Project includes restoration of approximately 300 ha of agricultural land suitable for grazing (Figure 4-4). This re-establishment of agricultural lands would be undertaken progressively as a component of the Project rehabilitation programme (Section 5).

As has already been successfully demonstrated at the Stratford Waste Emplacement, SCPL anticipates rehabilitated agricultural lands would be of comparable Agricultural Suitability classification to neighbouring areas.



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A summary of the area of agricultural lands in these areas before, during the Project life and post-mining is provided in Table 4-3.

Table 4-3
Summary of Potential Impacts on Agricultural Lands

Locality	Approximate Area of Agricultural Land (ha)			
	Existing	Project Life	Post-Mining	Net Change
Project Site	830	140	440	-390
Project Biodiversity Offset Areas	380	0	0	-380

Source: After Appendix K.

The Project would result in the sterilisation of approximately 770 ha of agricultural land in the long-term (Table 4-3).

These sterilised agricultural lands are not considered to be highly productive or of strategic importance (Appendix K).

Consideration of the economic value of lost agricultural production on these lands is provided in Appendices K and P. The Project has very little potential to materially affect regional agricultural production or demand for agricultural infrastructure, supplies and services at a local or regional level (Appendix K).

In addition, no significant cumulative impacts on regional agricultural production and associated support industries are anticipated to arise from the co-incident development of the Project, approved DCM and AGL's Gloucester Gas Project (Appendix K). If the proposed Rocky Hill Coal Project or the Stroud to Lansdowne Project are approved in the future, the cumulative impacts of these developments are also considered to be unlikely to result in significant impacts on regional agriculture or associated supporting industries (Appendix K).

Yancoal-owned lands that adjoin the Project area would continue to be used for agricultural uses (e.g. via agistment of stock, leasing or agreements with previous landholders).

The potential impacts of the Project on the local amenity of adjoining privately-owned land, or water resources available for agricultural use, are considered where relevant in the groundwater, surface water, noise and blasting, and air quality studies (Appendices A to D and Sections 4.4 to 4.7).

Bushfire Hazard

Any uncontrolled fires originating from Project activities may present potentially serious impacts to nearby rural properties and the Glen Nature Reserve.

Similarly, fires originating in nearby rural areas could pose a significant risk to Project infrastructure and SCPL staff, contractors and equipment.

The degree of potential impacts of a bushfire would vary with climatic conditions (e.g. temperature and wind) and the quantity of available fuel.

The continuation and expansion of Stratford Mining Complex operations for the Project could increase the potential for fire generation. However, given the range of management measures in place, the overall risk of increased bush fire frequency due to the Project is likely to be low (Appendix E).

An existing fire trail would be re-aligned (Section 2.6.5) and the Project would not prevent access to existing fire trails located to the east of the Stratford Mining Complex.

4.3.3 Mitigation Measures, Management and Monitoring

Soils and Erosion Potential

General soil resource management practices would include the stripping and stockpiling of soil resources for use in rehabilitation. The objectives of soil resource management for the Project site would be to:

- identify and quantify potential soil resources for rehabilitation;
- optimise the recovery of useable soil reserves during soil stripping operations;
- manage soil reserves so as not to degrade the resource when stockpiled; and
- establish effective soil amelioration procedures to maximise the availability of soil reserves for future rehabilitation works.

The following management measures would be implemented during the stripping of soils at the Project:

- areas of disturbance would be stripped progressively, as required, to reduce potential erosion and sediment generation, and to minimise the extent of topsoil stockpiles and the period of soil storage;

- areas of disturbance requiring soil stripping would be clearly defined following vegetation clearing;
- soil stripping during periods of high soil moisture content (i.e. following heavy rain) would be avoided to reduce the likelihood of damage to soil structure; and
- in preference to stockpiling, wherever practicable, stripped soil would be directly replaced on completed sections of the final landforms.

Any long-term soil stockpiles would be managed to maintain long-term soil viability through the implementation of relevant management practices as listed below:

- Soil stockpiles would be retained at a height of 3 m, with slopes no greater than 1:2 (vertical to horizontal [V:H]) and a slightly roughened surface to minimise erosion.
- Soil stockpiles would be constructed to minimise erosion, encourage drainage, and promote revegetation.
- Where additions such as lime, gypsum and fertiliser are needed to improve the condition of stripped soil, they would be applied to the stockpiles in-between the application of separate layers from the scrapers.
- Wherever practicable, soil would not be trafficked, deep ripped or removed in wet conditions to avoid breakdown in soil structure.
- All soil stockpiles would be seeded with a non-persistent cover crop to reduce erosion potential as soon as practicable after completion of stockpiling. Where seasonal conditions preclude adequate development of a cover crop, stockpiles would be treated with a straw/vegetative mulch to improve stability.
- Soil stockpiles would be located in positions to avoid surface water flows. Silt stop fencing would be placed immediately down-slope of stockpiles until stable vegetation cover is established.
- An inventory of soil resources (available and stripped) on the Project site would be maintained and reconciled annually with rehabilitation requirements.
- Weed control programmes would be implemented on soil stockpiles if required.

The Rehabilitation Management Plan would be updated to describe the soil resource management measures that would be used during the Project life.

Land Contamination

A number of existing hazard control and mitigation measures are described in the following Stratford Mining Complex management documents and systems:

- Environmental Management Strategy;
- Contractor Management Plan;
- Emergency Management Plan;
- Fitness for Work Management Plan;
- Explosives Management Plan;
- Inspection Program Scheme;
- Spill Response Procedures; and
- Pollution Incident Response Management Plan.

These documents and systems would be reviewed and revised to incorporate the Project, subject to the conditions of any Development Consent.

General measures to reduce the potential for contamination of land would include the following:

- contractors transporting dangerous goods loads would be appropriately licensed in accordance with the provisions of the Australian Code for the Transport of Dangerous Goods by Road and Rail (ADG Code) (National Transport Commission, 2007);
- on-site consumable storage areas would be designed with appropriate bunding and would be operated, where applicable, in compliance with the requirements of AS 1940 *The Storage and Handling of Flammable and Combustible Liquids* and AS 2187.1 *Explosives – Storage, Transport and Use – Storage*; and
- fuel and explosive storage areas would be regularly inspected and maintained.

In addition, during construction and exploration activities fuels, oils and other hydrocarbons would be managed to minimise the risk of spills which could cause soil contamination.

Land Use - Agricultural Activities and Productivity

Agricultural land resource management at the Project would include the following key components:

- minimisation of disturbance to agricultural lands, where practicable;

- continued use of adjoining Yancoal-owned land for agricultural uses;
- management of soil resources at the Project site so that they can be used for rehabilitation; and
- inclusion of agricultural lands in the Project rehabilitation strategy (Figure 4-4).

Minimisation of Disturbance to Agricultural Lands

The area of agricultural land disturbed by the Project at any one time would be minimised so that beneficial agricultural uses can continue to be undertaken on available Project grazing lands. As demonstrated by SCPL at the existing Stratford Mining Complex, grazing agricultural activities can be readily undertaken in conjunction with the operation of a mine.

Continued Use of Existing Agricultural Areas

Adjoining Yancoal-owned lands would continue to be used for agricultural uses, where practicable.

A Property Management Strategy has been prepared by suitably qualified persons to facilitate the management of agricultural land in the Project area and on adjoining Yancoal-owned lands. The Property Management Strategy includes property and grazing management measures, erosion, weed and pest controls to be applied across all of the lands controlled by Yancoal within the Gloucester Basin.

The implementation of the Property Management Strategy would serve to minimise the potential direct impacts of the Project on agricultural production within the Project area and Yancoal-owned land, and potential indirect impacts (e.g. weeds and pests) on surrounding agricultural lands.

Management of Soil Resources

Soil resource management measures that would be used during the life of the Project are described above.

Re-establishment of Agricultural Lands

The rehabilitation and mine closure strategy for the Project includes restoration of approximately 300 ha of agricultural land. The rehabilitation of this land reduces the area of agricultural land that would otherwise be sterilised by the Project (Figure 4-4).

Bushfire Hazard

SCPL would continue to implement the existing bushfire management measures (Section 4.3.1) and consult with the Gloucester BFMC and the RFS, and provide assistance to these organisations as required. Further bushfire preventative measures are outlined in Section 4.9.3.

4.4 GROUNDWATER

A Groundwater Assessment for the Project was undertaken by Heritage Computing (2012) and is presented in Appendix A. The Groundwater Assessment was peer reviewed by Kalf and Associates (Dr Frans Kalf) and the review report is presented in Attachment 3.

A description of the existing groundwater resources in the Project area and surrounds, including baseline data and the existing monitoring regime and effects of the Stratford Mining Complex is provided in Section 4.4.1. Section 4.4.2 describes the potential impacts of the Project on groundwater resources including cumulative impacts, while Section 4.4.3 outlines mitigation measures, management (including licensing considerations) and monitoring.

The Project groundwater and surface water studies have been undertaken in an integrated manner. For example, the assessment of potential groundwater impacts includes the predicted post-mining water levels of the final voids determined by the Surface Water Assessment (Appendix B).

4.4.1 Existing Environment

Baseline Groundwater Data

Baseline geological and groundwater data was reviewed and compiled from a number of sources as part of the Groundwater Assessment including:

- Gloucester Basin geology mapping;
- Yancoal exploration (geological) data and logs;
- NOW PINNEENA Groundwater Works Database records;
- existing water management (including groundwater licensing) records from the SCM and BRNOC operations;
- previous hydrogeological assessments and reviews undertaken at the Stratford Mining Complex;

- groundwater level and pressure data from groundwater monitoring programs and investigations undertaken at the Stratford Mining Complex and surrounding projects (e.g. AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project);
- groundwater quality data from the above monitoring programs and investigations; and
- other regional topographic mapping data.

The Groundwater Assessment has considered the requirements of the Water Sharing Plan under the NSW *Water Management Act, 2000*.

In addition, the Groundwater Assessment has also considered the mapped biophysical strategic agricultural lands in the region that are defined in the Upper Hunter SRLUP.

The existing baseline groundwater data was augmented with the results of a Project groundwater investigation programme undertaken by RPS Aquaterra in 2011, the results of which are presented in Appendix A.

The Project groundwater investigation programme included (Figure 4-5):

- core testwork (horizontal and vertical permeability, and porosity measurements) on 31 drillcore samples from five drillholes across the Project area and surrounds;
- installation of multi level vibrating wire piezometers;
- installation of standpipe piezometers;
- pumping tests in the vicinity of Dog Trap Creek; and
- slug/aquifer tests.

In addition, to assist in delineating the extent and depth of alluvium in the vicinity of the Avon North Open Cut, a transect of shallow drillholes (DTTR1, DTTR2 and DTTR3) was completed and logged across Dog Trap Creek (Figure 4-6).

To assist with further definition of alluvium in the vicinity of the Project (i.e. comparison with Quaternary alluvium mapped at the regional scale), and to validate and correlate the results from the transect of shallow drill holes, Groundwater Imaging (2011) completed TEM surveys of sections of Dog Trap Creek and Avondale Creek (Figures 4-7 and 4-8, respectively). The TEM survey results are summarised in Appendix A.

Examination of the available baseline groundwater data has enabled an understanding of the existing groundwater systems, and the scale and nature of the effects of the existing operations at the Stratford Mining Complex on local and regional groundwater systems.

Existing Groundwater Regime

A conceptual hydrogeological model of the existing groundwater regime was developed by Heritage Computing (2012) based on the review of the available groundwater data, the Water Sharing Plan and the conceptual hydrogeological model (and its update) for the AGL Gloucester Gas Project (SRK Consulting, 2010; Parsons Brinckerhoff, 2012).

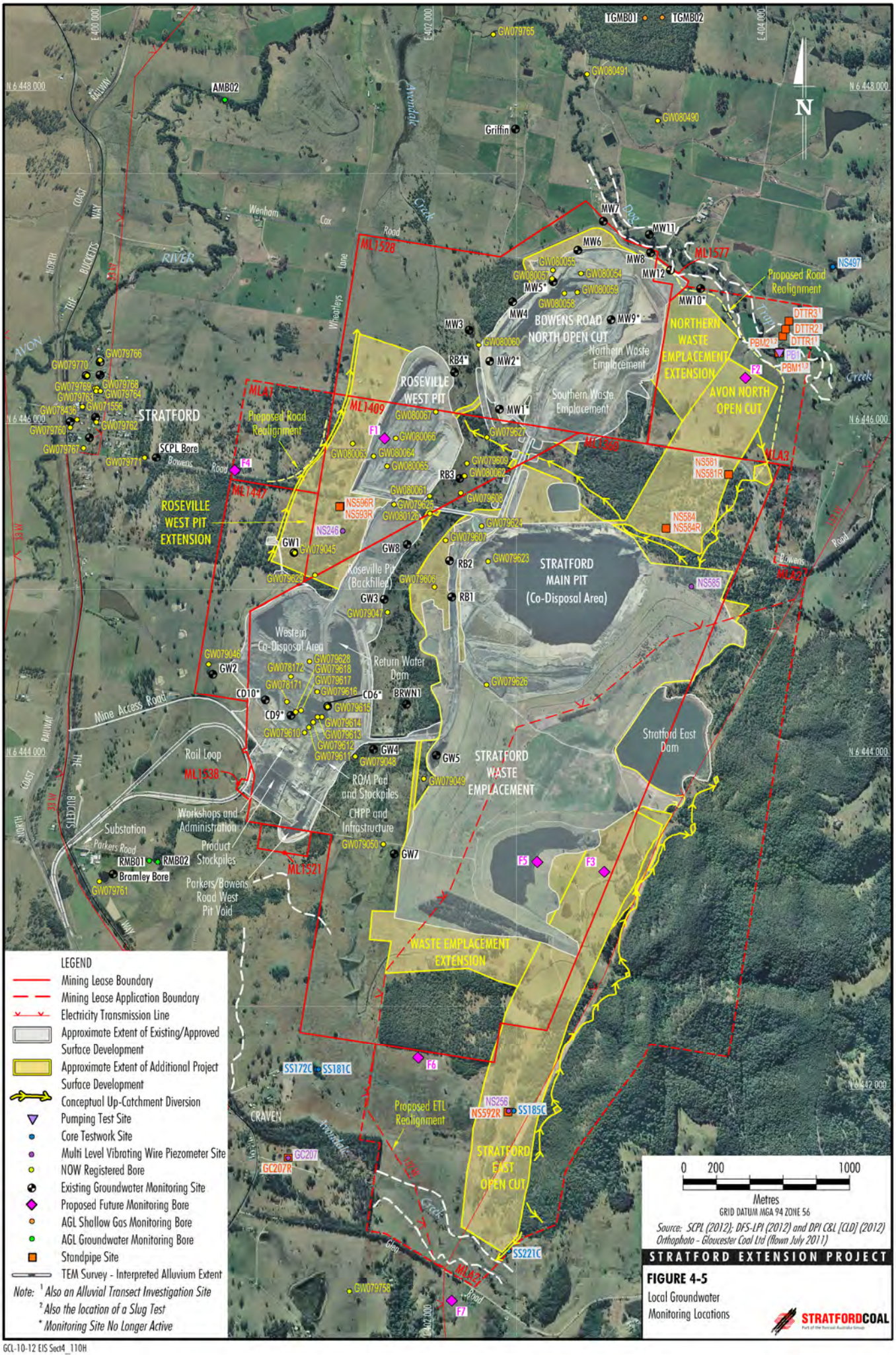
The review of data supports two groundwater systems:

- **Fractured Rock Groundwater System** – including shallow rock aquifer and the Gloucester Coal Measures and underlying Dewrang Group (Figure 2-7); and
- **Alluvial Groundwater System** – including alluvial (narrow channel) sediments associated with Dog Trap Creek, Avondale Creek and the Avon River.

The Project coal resource is located within the Craven and Avon Subgroups of the Gloucester Coal Measures and the underlying Dewrang Group (Section 2.3), which is within the fractured rock groundwater systems of the Gloucester Basin. These fractured rock groundwater systems lie within the boundary defined in the Water Sharing Plan. However, the Water Sharing Plan does not apply to the groundwater contained in the fractured rock aquifers and basement rocks within which the Project coal resource exists.

The Water Sharing Plan does apply to all surface water and groundwater (i.e. water beneath the ground surface in the saturated zone) within alluvial sediments.

Alluvial sediments associated with Dog Trap Creek and Avondale Creek surface drainages exist in the Project area and surrounds. These alluvial sediments are located within the Avon River Water Source in the Manning Extraction Management Unit defined in the Water Sharing Plan.



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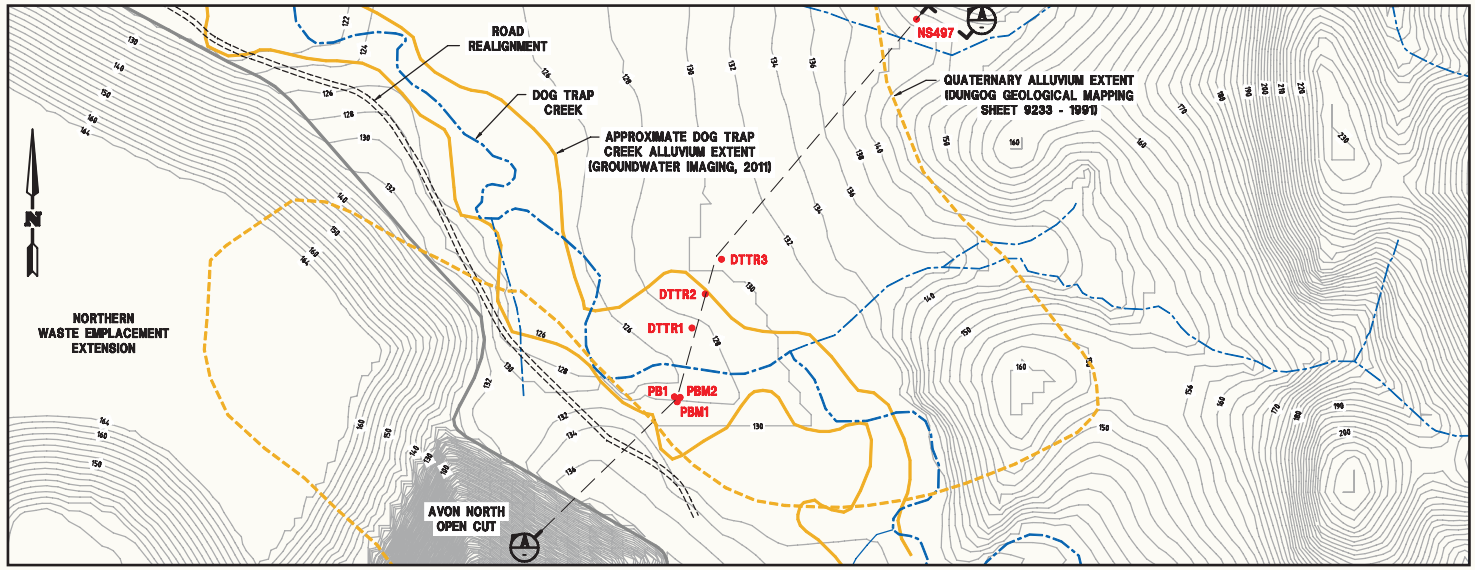
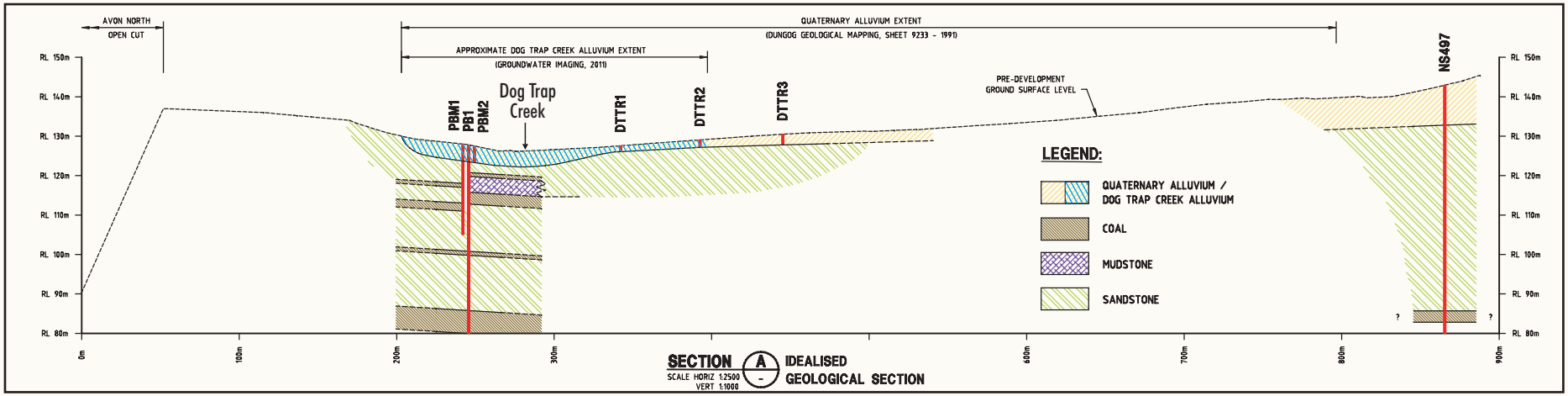


Source: Allan Watson Associates (2011)

Dog Trap Creek Alluvium - Plan View



Source: Allan Watson Associates (2011)

Dog Trap Creek Alluvium - Section

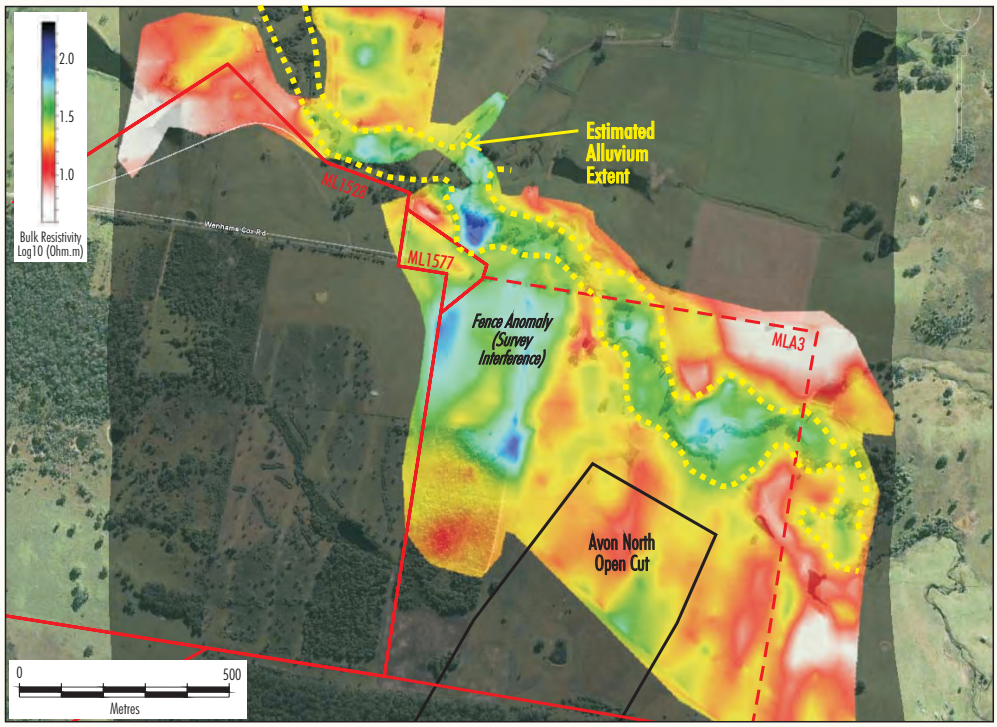
Source: Heritage Computing (2012)

STRATFORD EXTENSION PROJECT

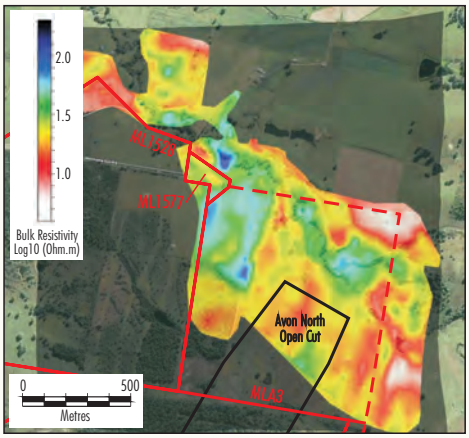
FIGURE 4-6

Transect of Alluvial Bores across Dog Trap Creek

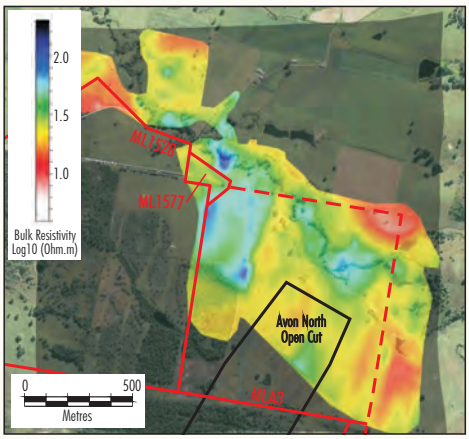
STRATFORDCOAL



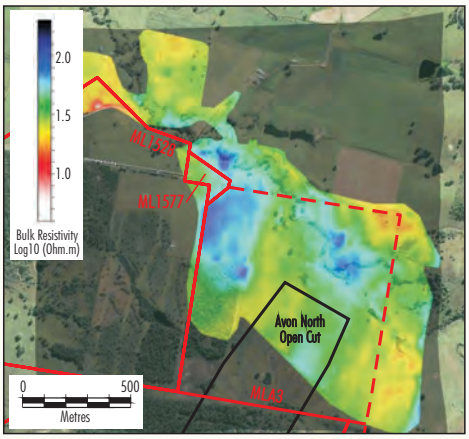
TEM Results @ 1m Depth (Including Estimated Alluvium Extent)



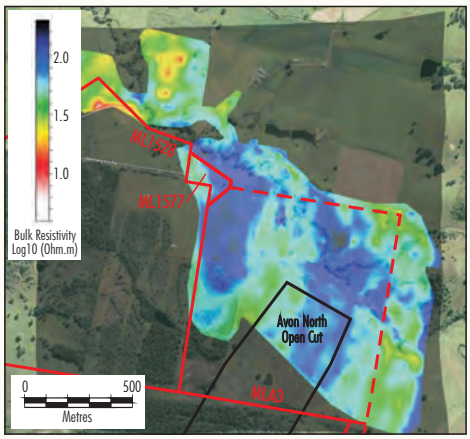
TEM Results @ 3m Depth



TEM Results @ 7m Depth



TEM Results @ 12m Depth



TEM Results @ 20m Depth

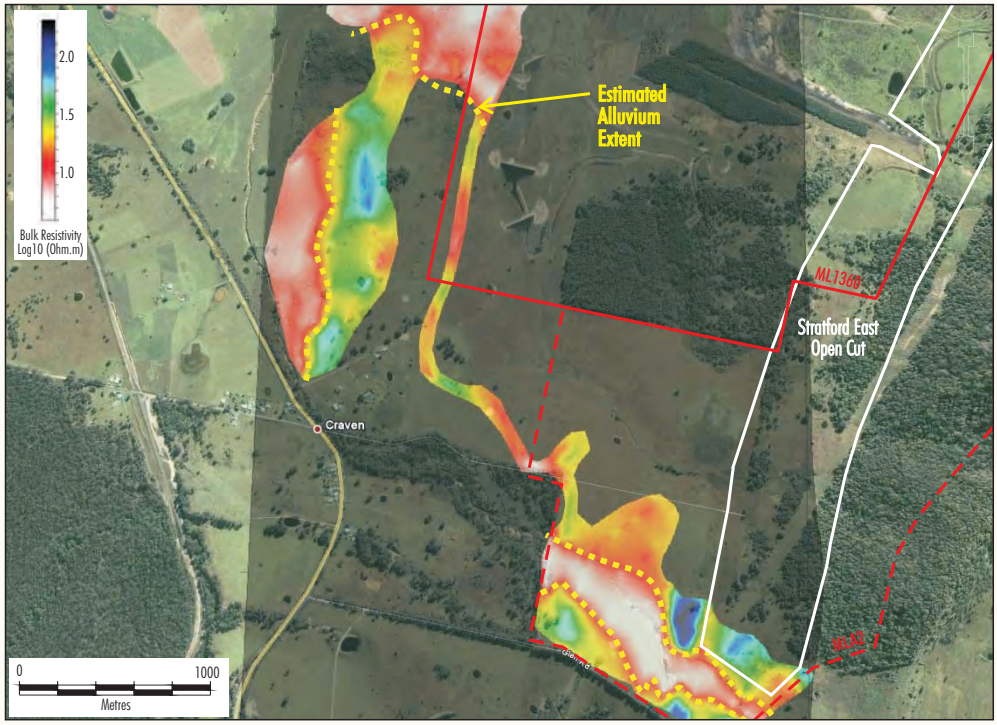
Source: Groundwater Imaging (2012)

Mining Lease Boundary
Mining Lease Application Boundary

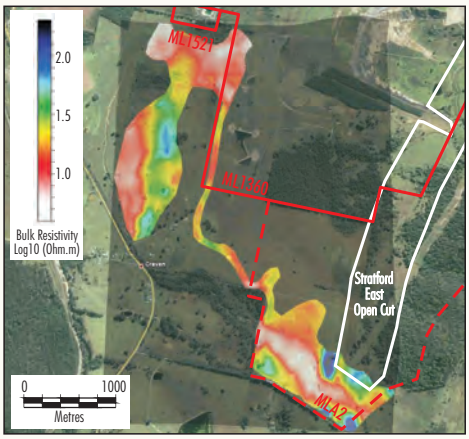
STRATFORD EXTENSION PROJECT

FIGURE 4-7
TEM Survey Results
Dog Trap Creek

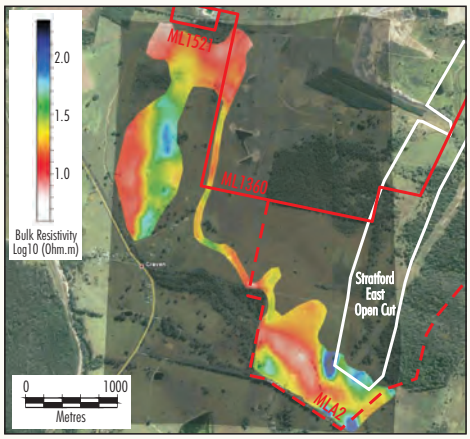
STRATFORDCOAL



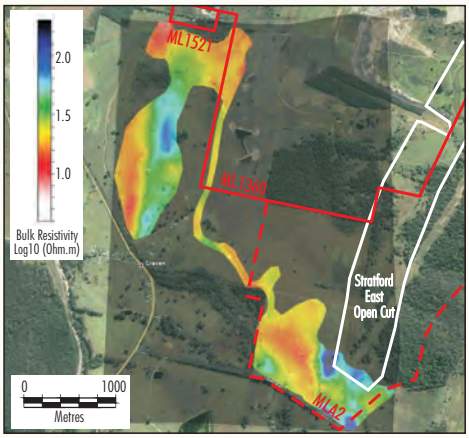
TEM Results @ 1m Depth (Including Estimated Alluvium Extent)



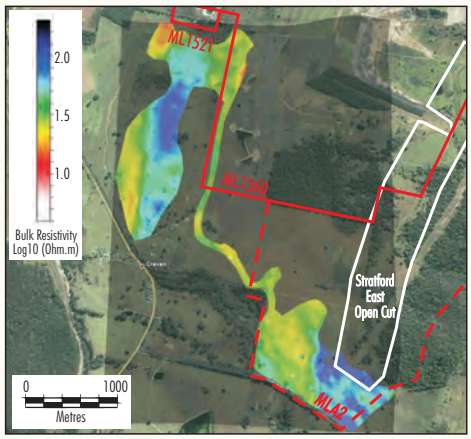
TEM Results @ 3m Depth



TEM Results @ 7m Depth



TEM Results @ 12m Depth



TEM Results @ 20m Depth

Source: Groundwater Imaging (2012)

Mining Lease Boundary
Mining Lease Application Boundary

STRATFORD EXTENSION PROJECT

FIGURE 4-8
TEM Survey Results
Avondale Creek

STRATFORDCOAL

The transect of shallow alluvial drill holes conducted as part of the Project groundwater investigation programme revealed local alluvial thicknesses from 1.5 m to 4 m, with a median thickness of 3 m associated with Dog Trap Creek (Figure 4-6). This was supported by the TEM survey results that concluded the Dog Trap Creek alluvium was resistive, intermittent and scant (Groundwater Imaging, 2011). Groundwater Imaging (2011) also concluded that the Avondale Creek alluvium was conductive and, in places, it is constricted by weather-resistant dipping underlying strata (i.e. fractured rock).

Recharge to the groundwater systems occurs from rainfall and runoff infiltration, lateral groundwater flow and some leakage from surface water storages and streams (e.g. Dog Trap Creek). Although groundwater levels are sustained by rainfall infiltration, they are controlled by topography, geology and surface water levels in local drainages (Appendix A).

Local groundwater tends to mound beneath hills (e.g. to the east of the Stratford Mining Complex), with ultimate discharge to local drainages and loss by evapotranspiration where the watertable is near the ground surface (generally less than 2 to 3 m below ground level) (Appendix A).

The typical depth to groundwater is generally 1 to 10 m in the vicinity of the Stratford Mining Complex tenements (Appendix A). Where groundwater levels occur close to surface elevations (e.g. alluvial sediments associated with Avondale Creek), evapotranspiration is a likely occurrence.

The direction of groundwater flow in the vicinity of the Stratford Mining Complex is from the south-east to the north-west, and the main groundwater discharge zones are Dog Trap Creek, Avondale Creek and the Avon River (Appendix A). A groundwater divide is present in the Craven area which separates the surface catchments and groundwater systems in this part of the Gloucester Basin. South of Craven, groundwater flows generally in a southerly direction and towards Wards River (Appendix A).

Groundwater Dependent Ecosystems

There are currently no high priority groundwater dependent ecosystems identified in the Water Sharing Plan in the Avon River Water Source (Appendix A).

Notwithstanding, NSW State Groundwater Dependent Ecosystems Policy (NSW Department of Land and Water Conservation, 2002) also recognises the four Australian groundwater dependent ecosystem types (Hatton and Evans, 1998) that can be found in NSW, namely:

- terrestrial vegetation;
- baseflows in streams;
- aquifer and cave ecosystems; and
- wetlands.

Groundwater resources in the north and north-west of the Project area are associated with alluvial groundwater of unregulated tributaries in the Avon River Water Source. The flora assessment (Appendix E and Section 4.9) concluded there is no groundwater dependent terrestrial vegetation known to occur within the Project area.

The aquatic ecology assessment (Appendix G and Section 4.11) has considered the potential groundwater impacts of the Project on aquatic ecosystems dependent on baseflows in streams and wetlands.

The potential groundwater impacts on aquifer ecosystems (i.e. stygofauna) are considered in Section 4.11.

Existing Effects of the Stratford Mining Complex

Groundwater Levels

Records of groundwater levels in the vicinity of the Stratford Mining Complex are available from as early as 1994. Monitoring bores have been established in a number of different timeframes and have been generally associated with different stages of development approvals.

An analysis of the available temporal data (including hydrographic plots) to illustrate cause-and-effect relationships with rainfall and mining for groundwater levels at the Stratford Mining Complex and surrounds is provided in Appendix A.

In summary this analysis indicates (Appendix A):

- coal seam bore MW6 (north of BRNOC) showed a pronounced mining effect shortly after commencement in 2003, with a drawdown of about 8 m; from 2007 onwards this bore has responded to climate variations;

- coal seam bores MW3 and MW4 between the BRNOC and the Roseville Extended Pit showed a mild but gradually increasing effect from both the approaching BRNOC and the receding Roseville Extended Pit, and a sharp response at the onset of Roseville West Pit;
- coal seam bores MW1, MW2 and MW3 showed a mild response to Roseville Extended Pit and a sharper response to Roseville West Pit;
- interburden bores close to open cut mining areas have all shown a mining response;
- regolith bores are fairly stable, showing mild responses to climate variation, with bores MW9 and MW8 (adjacent to BRNOC) showing a mining effect with drawdowns of about 5 m, and bore RB4[2] (north of Roseville Extended Pit) responding to mining;
- the Ex Griffin and Ex Bramley bores (1.2 km and 2 km respectively from historical [BRNOC and Stratford Main Pit] mining areas) show no mining effects; and
- no mining effects have been observed in any privately owned bores in Stratford.

Groundwater Pressures

The monitoring results available from the installed vibrating wire piezometers at NS585, NS246, GC207 and SS256 (Figure 4-5) indicate that no significant mining effects (i.e. deviation from the hydrostatic pressure line) have been recorded at these locations at the Stratford Mining Complex (Appendix A).

Groundwater Inflows/Pumping Rates

Records of pumped water volumes from operational open cut mining areas at the Stratford Mining Complex (e.g. BRNOC, Roseville Extended Pit and Roseville West Pit) have been kept for water management and groundwater licensing purposes. The pumped water data is presented in graphic form including trend lines in Appendix A.

The recorded pumped volumes are however a combination of groundwater inflow, rainfall runoff, seepage from waste emplacements and, in some cases, water transfers. Therefore the pumping rates do not represent actual groundwater inflow rates (i.e. groundwater inflow rates would be significantly lower).

The trend lines show that pumping rates at the Stratford Mining Complex have been approximately:

- 1 ML/day at BRNOC, declining with time;
- 0.6 ML/day at Roseville Extended Pit, declining with time; and
- 0.3 ML/day at Roseville West Pit, increasing steadily with time.

Groundwater Use

Locally there is little reliance on groundwater bores as a source of water, as agricultural enterprises predominantly rely on surface water sources which are more abundant and generally better quality. The number of privately held bores in the Project area and surrounds is low due to the generally poorer groundwater quality, high rainfall and subsequent high rates of runoff (Appendix A).

This is confirmed by the fact that there is only one groundwater licence with a total entitlement of 20 ML/annum for the Avon River Water Source (NSW Department of Water and Energy [DWE], 2009).

A search of the NOW PINNEENA Groundwater Works Database identified 62 registered bores and wells within approximately 5 km of the Stratford Mining Complex (Figure 4-5).

The majority (48) of these registered bores identified are on land owned by Yancoal and one is on land owned by AGL. Registered bores not owned by Yancoal in the vicinity of the Project include (Figure 4-5):

- 11 bores in Stratford; and
- one private bore (GW079759) to the south of the Stratford Mining Complex.

One privately owned bore (GW200398) is located more than 5 km from the proposed Project.

The privately owned bores are licensed for stock and domestic use.

Groundwater Quality

An analysis of water quality attributes of groundwater at the Stratford Mining Complex and surrounds is provided in Appendix A. An analysis of surface water quality where groundwaters interact is also provided in Appendix B.

[2] Bore RB4 was removed by mining in 2009.

Baseline groundwater salinity (i.e. measured EC) at the Stratford Mining Complex and surrounds is analysed in Appendix A. In summary, the median recorded values for EC at the Stratford Mining Complex are approximately: 5,000 microSiemens per centimetre (µS/cm) in coal; 4,500 µS/cm in alluvium and regolith; and 3,500 µS/cm in coal measures interburden.

The analysis conducted by Heritage Computing (2012) shows salinity is fairly uniform spatially, with the highest value (11,700 µS/cm) in Avondale Creek alluvium to the south of the Stratford Mining Complex, and generally lower values in Stratford closer to the Avon River.

There is no clear differentiation between the salinity signatures of different lithologies. In particular, the salinity of alluvial/regolith waters is no better than coal groundwaters (Appendix A).

Groundwater samples taken close to Avondale Creek show generally high salinities in the alluvium, and in sub-cropping coal seams. Intermittent seepage of more saline groundwater from sub-cropping coal seams into Avondale Creek has caused gradually increasing salinity of surface water in the downstream direction (Appendix A).

Groundwater in the coal seams is highly mineralised and hard with slightly acidic to neutral pH (range 6.2 to 7), which is unsuitable for domestic consumption and in some cases unsuitable for livestock and irrigation. The total hardness of the coal seam groundwater increases from 300 milligrams per litre (mg/L) to 730 mg/L at depth (Appendix A).

Apart from two private bores in Stratford and bore MW12 (that intercept better quality alluvial waters), most groundwaters are beyond the limit of potable use but on the basis of salinity are suitable for livestock, irrigation and other general uses (Appendix A).

The above conclusions are generally consistent with the findings of the water quality analyses and assessment undertaken by Parsons Brinckerhoff (2012) for the AGL Gloucester Gas Project. That assessment included major ion chemistry, radioactive isotope and stable isotope analyses and concluded:

- alluvial groundwater is fresh to brackish, and is young (less than a few hundred years);
- shallow rock groundwater is brackish, and contains water that is several thousand years old;
- both interburden materials and coal seams contain brackish to slightly saline groundwater, and is much older, in the order of thousands to tens of thousands of years old;
- the brackish nature of most samples indicates minimal aquifer recharge from rainfall;
- the relatively high salinities in alluvium are attributed to high clay content which counters rainfall recharge; and
- the water age differences indicate limited connectivity between the alluvial aquifer and the shallow rock aquifer.

Surface water salinity has also been observed to increase as stream flow reduces and groundwater discharge contributions become more prevalent. However, the near-neutral pH of surface water indicates that baseflow contributions remain small in magnitude (Parsons Brinckerhoff, 2012).

4.4.2 Potential Impacts

Numerical modelling has been undertaken to inform the Groundwater Assessment (Appendix A) for the Project and to quantify the likelihood and magnitude of potential impacts.

The numerical groundwater model covers an active area of approximately 179 km^2 (15 km east-west and 17 km north-south) and incorporates the AGL Gloucester Gas Project wells in the vicinity of the Stratford Mining Complex and the proposed Rocky Hill Coal Project to the north. During the preparation of this EIS, SCPL has consulted with AGL and GRL, and has obtained and incorporated relevant data and information made available to the public for the conceptual groundwater model (AGL) and mine plans (GRL).

Calibration was undertaken for the numerical groundwater model, including (Appendix A):

- *steady-state calibration* (for 39 head targets for average groundwater levels in 2010) of shallow aquifer permeabilities against the inferred groundwater levels; and
- *transient calibration* (for 1,145 head targets for the period between January 2003 to July 2010) of aquifer system properties against hydrographic responses at Project monitoring bores for dynamic rainfall recharge and static stream water levels.

Overall, the calibration of the numerical groundwater model showed good agreement across the whole range of measurements and there is no bias towards overestimation or underestimation (Appendix A). Therefore, the numerical groundwater model was considered suitable to simulate the potential effects of the Project on the local and regional aquifer systems and groundwater users.

Using the calibrated numerical groundwater model, the following model scenarios were undertaken as part of the Groundwater Assessment (Appendix A):

- transient prediction (Project);
- transient prediction (cumulative including AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project);
- transient recovery (Project); and
- steady-state recovery (Project).

A transient simulation was also undertaken for a climate change scenario with rainfall infiltration reduced by 20% for the calibration and prediction periods.

A summary of the modelled potential impacts of the Project on the fractured rock and alluvial groundwater systems, surface water resources, groundwater dependent ecosystems, existing groundwater users and biophysical strategic agricultural land is presented below.

Fractured Rock Groundwater System

During Mining

As mining operations progress, each open cut acts as a localised groundwater sink. This would cause a change in groundwater flow direction and, in some places, a localised reversal of flow direction.

There would also be a change in hydraulic properties where the waste rock is subsequently used to infill the open cut. As waste rock would have a higher permeability than any natural rock material (associated with the fractured rock groundwater system), there would be associated reductions in localised hydraulic gradients (Appendix A).

Numerical modelling conducted as part of the Groundwater Assessment predicts a substantial reduction in potentiometric head in the aquifers of the fractured rock groundwater system in the near vicinity of the Project.

The model predicts maximum watertable drawdown extents from each of the open cut mining areas as follows (Figure 4-9):

- Roseville West Pit Extension – 1.6 km at the end of mining;
- Avon North Open Cut – 1.0 km at the end of mining; and
- Stratford East Open Cut – 0.8 km at the end of mining.

However, the numerical modelling conducted for the Groundwater Assessment predicts negligible impact on groundwater levels or groundwater yield for groundwater users with privately owned bores in the fractured rock groundwater system.

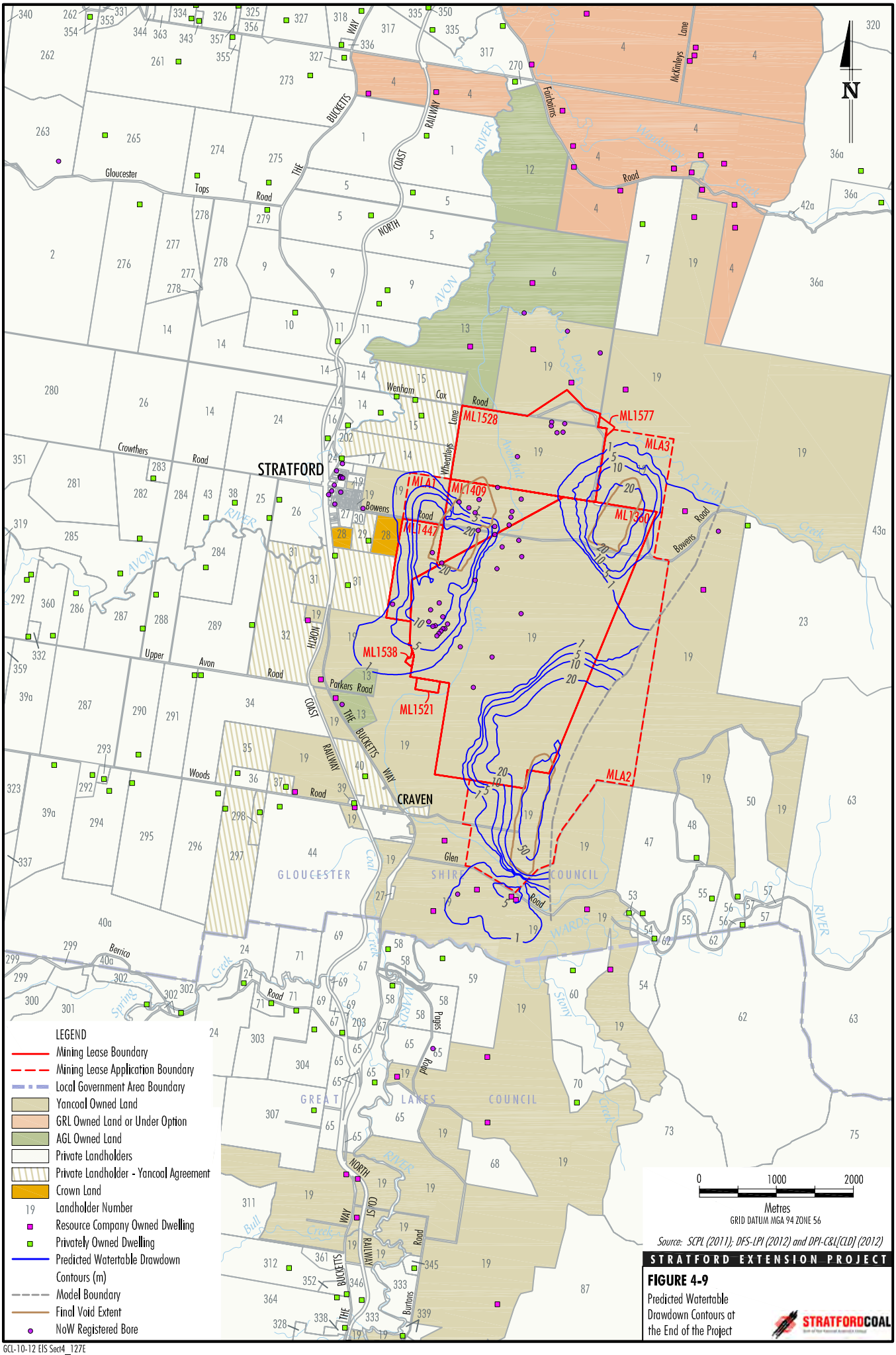
Staged groundwater drawdown contours during the Project life are provided in Appendix A.

The average predicted pit inflows (combined) over the life of the Project are predicted to be about 1.1 ML/day (390 ML/annum), with all but approximately 1.5% derived from the fractured rock groundwater system (Appendix A). Further breakdown for each individual pit and consideration of mine sequencing over time is provided in Section 4.4.3.

Based on the results of the Geochemistry Assessment (Appendix L), and as described in Section 2.10.3, there would be negligible mobilisation of metals/metalloids under near-neutral pH conditions.

It is expected that the use of PAF management procedures for the Project, including segregating and selectively handling PAF material and then placement in either in-pit (below the predicted final watertable recovery level) or out-of-pit engineered PAF waste cells (Section 2.10.4), would be sufficient to maintain adequate control over acid rock drainage risk.

Given the similarity of salinity for the various source waters, no appreciable change in groundwater salinity is expected as a consequence of mining. The Groundwater Assessment concludes that there is expected to be negligible change in groundwater quality as a result of mining in the short-term (Appendix A).



Source: SCPL (2011); DFS-LPI (2012) and DPI-C&L[CLD] (2012)

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FIGURE 4-9

Predicted Watertable Drawdown Contours at the End of the Project

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Post-Mining

Numerical modelling of the post-mining scenario shows that the water levels in the fractured rock groundwater system would recover over time with substantial recovery apparent after about 40 years (Appendix A). The steady-state groundwater simulation shows that each void would remain a permanent and localised groundwater sink.

Comparison of the predicted long-term equilibrium watertable to the existing/simulated regional groundwater table is provided in Appendix A and shows patterns are generally similar.

The Groundwater Assessment concludes that there is expected to be negligible change in groundwater quality as a result of mining in the long-term (Appendix A). In the long-term, the salinity in the final voids would increase through evaporative concentration, but as the final voids would remain groundwater sinks, there would be no deleterious effect on the beneficial uses of any groundwater sources (including the fractured rock groundwater system) (Appendix A).

Alluvial Groundwater System

The numerical modelling conducted for the Groundwater Assessment predicts (Appendix A):

- negligible drawdown in the aquifers of the alluvial groundwater system; and
- negligible impact on groundwater levels or groundwater yield for groundwater users with privately owned bores in the alluvial groundwater system.

Groundwater drawdown contours during and post-mining are provided in Appendix A.

Notwithstanding the above, as mining progresses, water could be lost from the alluvium/regolith groundwater source by three mechanisms (Appendix A):

- enhanced leakage from the Quaternary alluvium/regolith to the underlying fractured rock groundwater system;
- interruption of rainfall recharge to excavated Quaternary alluvium/regolith; and
- direct excavation of Quaternary alluvium/regolith materials as part of the open cut mining areas.

Although the impacts are considered negligible, the numerical model has accounted for each of the above mechanisms for the purposes of licensing (Section 4.4.3).

Given the similarity of salinity for the various source waters (fractured rock and alluvial), no appreciable change in groundwater salinity is expected as a consequence of mining. Further, it is expected that groundwater quality would not be impacted by final void water quality post-mining, and there would be no deleterious effect on the beneficial uses of any groundwater sources (including the alluvial groundwater system), as the final voids would remain groundwater sinks (Appendix A).

Surface Water Resources

The existing surface water resources and their characteristics (i.e. streamflow, water quality and geomorphology) are described in Section 4.5.1.

The Groundwater Assessment (Appendix A) included examination of the stream-aquifer (surface water-groundwater) interaction status of the Avon River, Dog Trap Creek and Avondale Creek.

Project mining is too far away from Avon River for any discernible effect on that stream (Appendix A).

Dog Trap Creek would continue as a gaining stream (i.e. with some baseflow component) and would have an average baseflow reduction of 0.07 ML/day during the Project. The baseflow reduction would peak at approximately 0.08 ML/day and then reduce when the BRNOC is used as a water storage and ultimately backfilled with waste rock (i.e. when the system recovery commences). The reduction in baseflow would have a negligible effect on the natural stream flow of Dog Trap Creek (Appendix A).

Avondale Creek would have a complicated pattern of changes in baseflow during the Project that would vary from a peak reduction of less than 0.2 ML/day to a gain in baseflow of about 0.05 ML/day. Overall, an average net reduction in baseflow of about 0.02 ML/day is expected for Avondale Creek. The predicted changes in baseflow would have a negligible effect on Avondale Creek natural stream flow (Appendix A).

Groundwater Dependent Ecosystems

As described in Section 4.4.1, there are no high priority groundwater dependent ecosystems identified in the Water Sharing Plan in the Avon River Water Source (Appendix A).

The Flora Assessment (Appendix E) concludes that there is no groundwater dependent terrestrial vegetation known to occur within the Project area. The Aquatic Assessment (Appendix G) concludes that there are no aquatic ecosystems in the Project area or surrounds that are dependent on groundwater.

As described above, the predicted changes in baseflow would have a negligible effect on natural stream flow (Appendix A).

As concluded in Section 4.11.2, the additional groundwater drawdown resulting from the Project is not likely to significantly impact stygofauna.

Consistent with these findings, Parsons Brinckerhoff (2012), for the AGL Gloucester Gas Project, noted that there are "no known wetlands, lakes or other surface features that are indicative of shallow groundwater processes and possible groundwater dependent ecosystems". Furthermore, they note that the brackish-saline nature of groundwater baseflow is unlikely to be conducive to the sustenance of groundwater dependent ecosystems.

Groundwater Users

The numerical modelling shows that potential changes in water level in each of the 12 privately owned bores identified in the vicinity of the Project (Section 4.4.1) is expected to be negligible. There is expected to be negligible impact on groundwater levels or groundwater yield for groundwater users with privately owned bores in any groundwater system attributable to the Project (Appendix A).

The Groundwater Assessment also concludes that there would be no deleterious effect on the beneficial uses of any groundwater sources, as the final voids would remain groundwater sinks (Appendix A).

Biophysical Strategic Agricultural Land

Based on the numerical groundwater modelling (Appendix A), there is expected to be no effect on the nearest biophysical strategic agricultural land or any underlying productive aquifers along the Avon River, west of Stratford (Figure 4-3).

Cumulative Impacts

The Groundwater Assessment included consideration of the cumulative impacts of the Project, the approved AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project.

Cumulative groundwater drawdown contours showing the magnitude and water table pattern caused by coincident CSG extraction and mining at the proposed Rocky Hill Coal Project are presented in Appendix A.

Whilst conservative for assessment purposes, the cumulative groundwater modelling results show that the approved AGL Gloucester Gas Project CSG extraction activities would likely cause a pronounced drawdown between the Project and Stratford and create a dominant drawdown effect when compared to the drawdown induced by the Project alone (i.e. effects are expected to be substantially greater than would be produced by the Project alone) (Appendix A).

Climate Change and Groundwater

The potential groundwater impacts of the Project, in the context of global climate change, have been considered and are presented in Appendix A.

4.4.3 Mitigation Measures, Management and Monitoring

Groundwater Licensing

A summary of groundwater licensing requirements for the Project is provided below, with further details provided in Attachment 5 including consideration of the Project against the water management principles and access licence dealing principles under the NSW *Water Management Act, 2000*.

Fractured Rock Groundwater System

As no separate water sharing plan applicable to the fractured rock groundwater system has yet commenced, the *Water Act, 1912* remains the relevant Act for approval of groundwater extraction from aquifers other than the alluvial groundwater system within the Project area.

Notwithstanding, once a relevant water sharing plan is commenced, an appropriate licence for the dewatering activities (i.e. groundwater inflows) for each of the open cut mining areas would be sought and obtained from the NOW pursuant to the *Water Management Act, 2000*.

The predicted annual groundwater volumes required to be licensed over the life of the Project are summarised in Table 4-4.

Post-mining, the groundwater inflows would reduce as the final void water levels in the Roseville West Pit, Avon North Open Cut and Stratford East Open Cut reach equilibrium over many decades. The final voids are further discussed in Section 5.

Table 4-4
Estimated Project Groundwater Licensing Requirements

Groundwater System	Water Sharing Plan	Water Source	Predicted Average and Maximum Annual Inflow Volumes Requiring Licensing (ML/Annum)			
			BRNOC*	Roseville West Pit Extension	Avon North Open Cut	Stratford East Open Cut
Fractured Rock	Not Applicable	Not Applicable	152 (Average) 163 (Maximum)	188 (Average) 261 (Maximum)	92 (Average) 119 (Maximum)	38 (Average) 57 (Maximum)
Alluvial	Lower North Coast Unregulated and Alluvial Sources 2009	Avon River Water Source	6[1] (Maximum)	14[2] (Maximum)	34[3] (Maximum)	Nil

Source: Appendix A.

* Up until backfilled.

1 No more than 6 ML/annum from Dog Trap Creek alluvium; after Project Year 8 would reduce to nil.

2 The regolith/floodplain alluvial veneer would provide about 2 ML/annum from extra leakage to fractured rock, 10 ML/annum from reduced rainfall recharge, and 2.2 ML/annum in excavated sediments.

3 The regolith/floodplain alluvial veneer would provide about 31 ML/annum from extra leakage to fractured rock, 2.8 ML/annum from reduced rainfall recharge, and 0.6 ML/annum in excavated sediments

SCPL currently holds a combined total of 1,021 ML volumetric licence allocation under Part 5 of the *Water Act, 1912* for the operations at the Stratford Mining Complex which is greater than the predicted maximum for all Project open cut mining areas combined (i.e. approximately 600 ML). Copies of the licences are provided in Attachment 5.

Alluvial Groundwater System

The Project open cuts would not be located within 40 m of Avondale Creek or Dog Trap Creek (Section 2.7.2). In addition, no direct pumping of water from alluvial sediments is proposed for the Project.

Predicted annual inflow volumes requiring licensing have been quantified based on the numerical model (Appendix A) (Table 4-4).

The volumetric quantities are however considered overly conservative as the groundwater model has assumed all Quaternary alluvium mapped at the regional scale (Roberts *et al*., 1991) comprises alluvial sediments.

This assertion of conservatism is supported by the Geomorphology Review undertaken by Fluvial Systems (2012) and included as a component of the Surface Water Assessment (Appendix B) which indicates that the Quaternary alluvium extent is inaccurate at a local scale, as evidenced by the mapped boundary occasionally running over hilltops (Figure 4-6).

At a local scale, the TEM survey results and alluvial transect holes cross-section demonstrate that the alluvial sediments are primarily confined to the alignment of the drainage line, for example along Dog Trap Creek (i.e. some areas mapped as quaternary alluvium are more likely to be regolith) (Figure 4-6). Fluvial Systems (2012) concludes that the boundaries mapped by the TEM survey (e.g. Dog Trap Creek and Avondale Creek) correspond with a geomorphologically-defined alluvium boundary.

The above conclusions are also supported by the fact that no deep alluvium with favourable subsoil properties (i.e. with the potential for use as rehabilitation material) was identified within the proposed Project open cut mining areas despite attempts to identify such material in the regionally mapped alluvial/colluvial areas with the use of 3 m deep soil pits (Appendix K).

Further, there is only one groundwater licence with a total entitlement of 20 ML/annum for the Avon River Water Source (DWE, 2009).

Notwithstanding the above, SCPL currently holds a combined total of 140 ML or unit volumetric licence allocations under the *Water Management Act, 2000* for unregulated rivers in the Avon River Water Source which is greater than the predicted maximum inflows from the alluvial groundwater system for all Project open cut mining areas combined (i.e. 54 ML). Copies of the licences are provided in Attachment 5.

Groundwater Monitoring

The existing groundwater monitoring program which is included in the Groundwater Management Plan of the Water Management Plan for the SCM (Figure 2-3), would be updated to include the additional monitoring network augmentation as part of the groundwater investigation programme for the Project.

The groundwater monitoring program would also be progressively extended to detect changes in groundwater levels and quality as a result of mining and improve knowledge of aquifer definition and interactions.

As mining progresses, the existing SCPL network of piezometer installations would be augmented with up to seven additional sites including (Figure 4-5):

- Sites F1 to F3 (to monitor the watertable elevation in waste rock infilling to provide information on recharge rates and waste rock permeabilities and to validate groundwater modelling predictions with respect to the emplacements over the life of the Project):
  - **Site F1** (Roseville West Pit);
  - **Site F2** (Avon North Open Cut); and
  - **Site F3** (Stratford East Open Cut).
- Sites F4 to F7 (to monitor west and south of the open cut mining areas):
  - **Site F4** (screened in the Roseville Seam to provide an early trigger system for effects approaching Stratford);
  - **Site F5** (screened in no higher than the Bowens Road Seam);
  - **Site F6** (vibrating wire installation with piezometers placed in each of the major coal seams screened no higher than the Bowens Road Seam); and
  - **Site F7** (screened in no higher than the Bowens Road Seam).

The timing for installation for Sites F1 to F3 would be upon completion of the final landform and rehabilitation at each of the mining areas.

Sites F4 (Roseville West Pit Extension) and F5 to F7 (Stratford East Open Cut) would be installed as mining progresses.

The final location and timing of piezometers would include consideration of site characteristics, their location relative to the mine plan, access and site inspection. Water level measurements would be automated with daily or more frequent recordings and would continue for at least two years following mining.

The groundwater monitoring network (except vibrating wire installations) would be sampled for water quality on a quarterly basis during mining, and for at least two years following mining. Groundwater quality samples would also be taken during drilling of any new/future piezometer or hydrogeological investigation bores.

Groundwater quality monitoring would include, but not necessarily be limited to, analysis of the following parameters: pH, dissolved oxygen, EC, Total Dissolved Solis (TDS), iron (Fe), Al, arsenic (As), magnesium, molybdenum, selenium, calcium, sodium, chloride and sulphate. Water quality data would be evaluated during the life of the Project to validate the predicted negligible impacts.

The groundwater monitoring program would be designed to comply with the *Murray-Darling Basin Groundwater Quality Sampling Guidelines* (Murray-Darling Basin Commission, 1997). Further information on the proposed groundwater monitoring program is provided in Appendix A.

Where the opportunity arises, and in consultation with the relevant government agencies, SCPL would co-operate with proponents of other projects (e.g. AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project) for the establishment of a regional groundwater monitoring network.

Quarterly independent geotechnical inspections of open cut mining areas would be used in conjunction with groundwater monitoring results and monthly inspections of up-catchment diversions (Section 4.5.3) to monitor the stability of pit walls in the Avon North Open Cut (proximal to Dog Trap Creek), Stratford East Open Cut (proximal to the eastern diversions) and Roseville West Pit Extension (proximal to Avondale Creek and western diversions) during the life of the Project.

Groundwater Users – Management of Complaints

In the event that a complaint is received during the life of the Project in relation to drawdown or depressurisation of a privately-owned bore or well, the results of the groundwater monitoring program would be reviewed by SCPL as part of a preliminary evaluation to determine if further investigation, notification, mitigation (e.g. bore re-conditioning), compensation (e.g. alternative water supply) or other contingency measures (refer below) are required.

Numerical Model and Water Balance Review

The numerical model developed and used for the Groundwater Assessment (Appendix A) would be used as a management tool for the periodic review and calibration of predicted groundwater impacts through the life of the Project.

The results of the groundwater monitoring program would inform progressive refinement of the numerical model as each of the open cut mining areas are developed. Revised outputs from the numerical model would be reported periodically over the life of the Project and used to inform the site water balance review (Section 4.5.3).

Groundwater Management Plan and Adaptive Management

The existing Groundwater Management Plan, which is included in the Water Management Plan for the SCM (Figure 2-3), would be reviewed and revised to describe any additional measures/procedures that would be implemented over the life of the Project to respond to potential exceedances of groundwater-related criteria.

It would also describe the contingent mitigation, compensation, and/or offset options that would be enacted in the event that groundwater users are adversely affected by the Project.

Examples of SCPL's proposed adaptive management approach to manage potential groundwater impacts during the life of the Project may include:

- bore-reconditioning or provision of an alternative water supply (and appropriate licence) in the event that depressurisation of a bore or well privately-owned by local groundwater users is materially greater than that predicted in the EIS and results in loss of supply to the local groundwater user; or
- additional backfilling, or increasing the reporting surface catchment to the final voids, if the groundwater recovery levels post-mining are not being achieved.

4.5 SURFACE WATER

A Surface Water Assessment for the Project was undertaken by Gilbert & Associates (2012). The Surface Water Assessment is presented in Appendix B. The Surface Water Assessment was peer reviewed by Emeritus Professor Tom McMahon and the review report is presented in Attachment 3.

The existing Stratford Mining Complex and proposed Project water management systems are described in Sections 2.12.1 and 2.12.2.

A description of existing local and regional surface water resources, including baseline data and the existing monitoring regime is provided in Section 4.5.1. Section 4.5.2 describes the potential impacts of the Project on surface water resources including cumulative impacts, and Section 4.5.3 outlines mitigation measures, management and monitoring.

4.5.1 Existing Environment

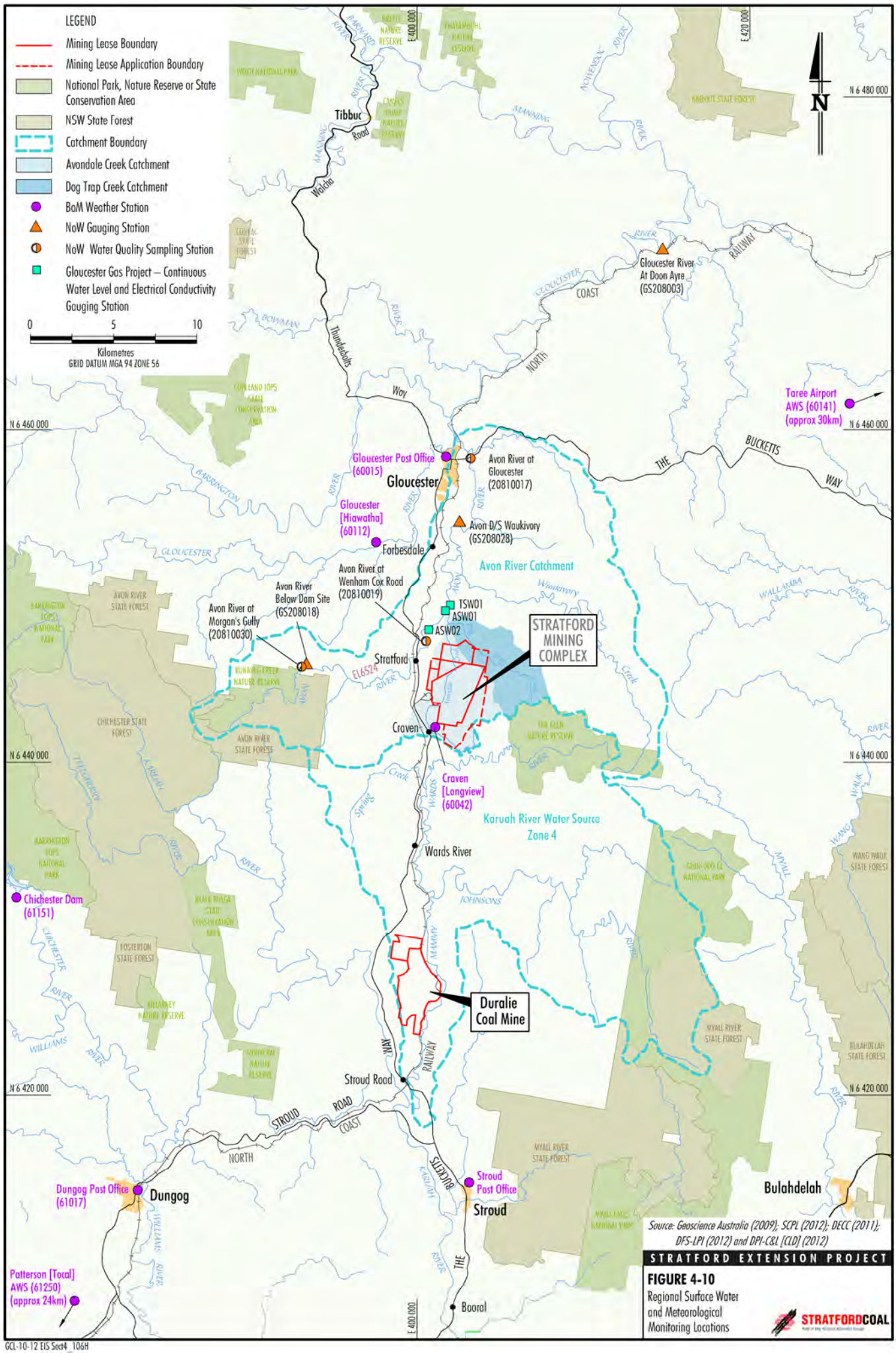
The surface water quality and flow regimes in the Project area reflect the influences of historical extensive clearing for grazing, and existing mining operations at the Stratford Mining Complex (Section 4.3).

The discussion below presents a summary description of the baseline surface water data and the regional and local hydrology. Further detail is provided in Appendix B.

Baseline Surface Water Data

Gilbert & Associates (2012) analysed SCPL databases and data made available by Commonwealth and State government agencies, and surrounding gas/mining projects, including:

- rainfall and evaporation records from the BoM weather stations (Figure 4-10);
- rainfall records from the Stratford Mining Complex and DCM meteorological stations (Figure 4-1);
- NOW gauging station flow data on the Avon River and the Gloucester River (Figure 4-10);
- SCPL monitoring station recording depth and water quality data on Avondale Creek (Figure 4-11);


LEGEND
Mining Lease Boundary
Mining Lease Application Boundary
National Park, Nature Reserve or State Conservation Area
NSW State Forest
Catchment Boundary
Avondale Creek Catchment
Dog Trap Creek Catchment
BoM Weather Station
NoW Gauging Station
NoW Water Quality Sampling Station
Gloucester Gas Project – Continuous Water Level and Electrical Conductivity Gauging Station
0 5 10
Kilometres
GRID DATUM MGA 94 ZONE 56
N
E 400 000
E 420 000
N 6 480 000
N 6 460 000
N 6 440 000
N 6 420 000
Tibbuc
Watcha
Thunderbolts Way
Gloucester River At Doon Ayre (GS208003)
Taree Airport AWS (60141) (approx 30km)
Gloucester Post Office (60015)
Gloucester
Avon River at Gloucester (20810017)
Gloucester [Hiawatha] (60112)
Avon D/S Waukivory (GS208028)
Forbesdale
Avon River Catchment
Avon River at Wenham Cox Road (20810019)
Avon River Below Dam Site (GS208018)
Avon River at Morgan's Gully (20810030)
TSW01
ASW01
ASW02
STRATFORD MINING COMPLEX
Stratford
EL6524
Craven
Craven [Longview] (60042)
Karuah River Water Source Zone 4
Wards River
Chichester Dam (61151)
Duralie Coal Mine
Stroud Road
Dungog Post Office (61017)
Dungog
Stroud Post Office
Stroud
Bulahdelah
Patterson [Tocal] AWS (61250) (approx 24km)
Booral
Source: Geoscience Australia (2009); SCPL (2012); DECC (2011); DFS-LPI (2012) and DPI-C&L [CLD] (2012)
STRATFORD EXTENSION PROJECT
FIGURE 4-10
Regional Surface Water and Meteorological Monitoring Locations
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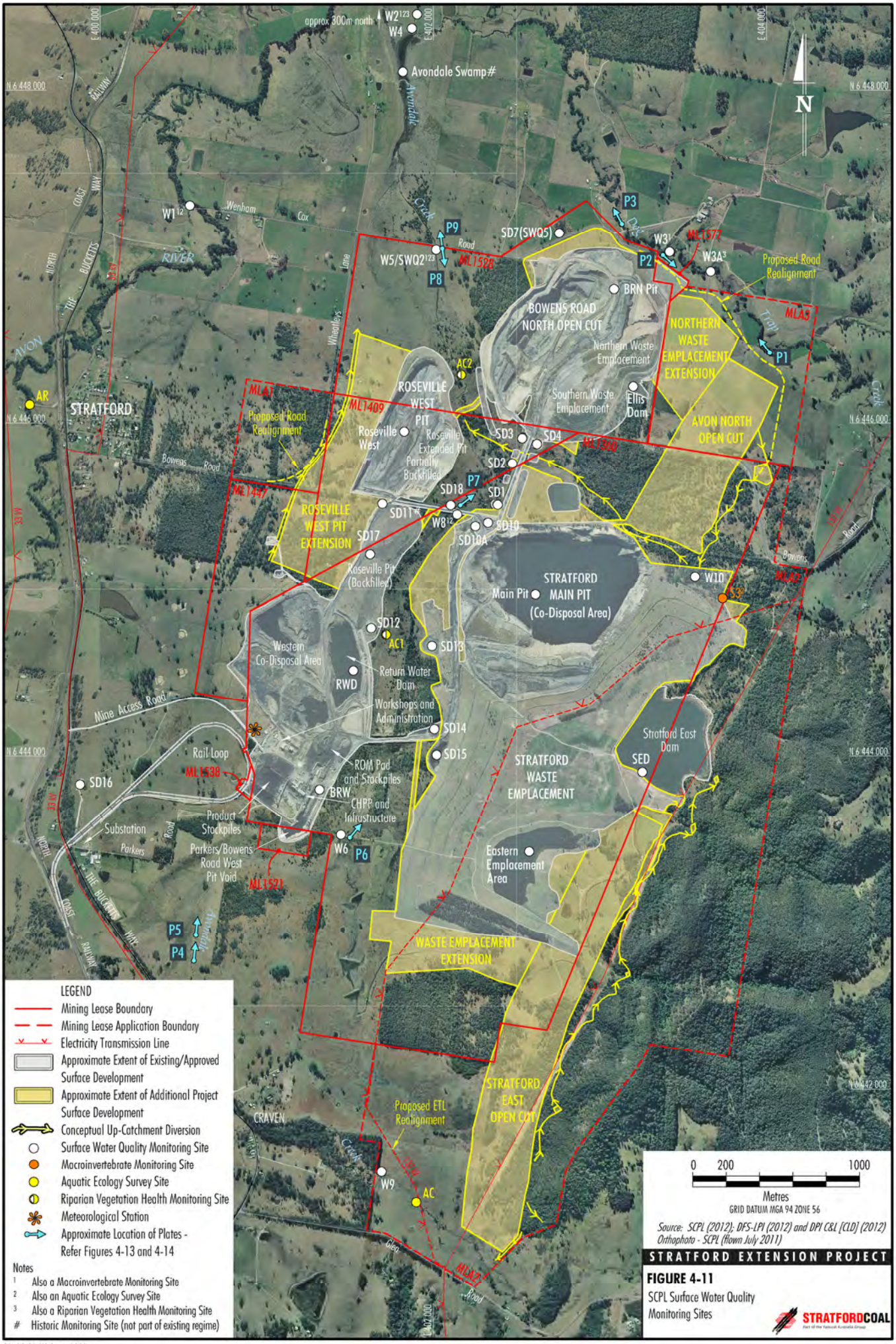

Source: SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012) Orthophoto - SCPL (flown July 2011)

STRATFORD EXTENSION PROJECT

FIGURE 4-11

SCPL Surface Water Quality Monitoring Sites

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- regional water quality data from the NSW Government Water Information website for the Avon River;
- regional water quality and flow data from the AGL Gloucester Gas Project hydrogeological investigations (SRK Consulting, 2010; Parsons Brinckerhoff, 2012);
- water quality from existing and previous SCPL monitoring programs on the Avon River, Avondale Creek, Dog Trap Creek and other minor drainages (Figure 4-11);
- water usage and water quality data from the Stratford Mining Complex water management systems; and
- other geological and regional topographic mapping data.

The Surface Water Assessment has also considered the requirements of the Water Sharing Plan.

In addition, the Surface Water Assessment has incorporated the findings of the Geomorphological Assessment undertaken by Fluvial Systems (2012). The Geomorphological Assessment is included as an attachment to Appendix B. The Surface Water Assessment and Geomorphological Assessment have also drawn upon baseline stream bed and bank characteristics of the tributary of Avondale Creek logged during a field survey which occurred as part of a study undertaken in 1997 (Gilbert and Sutherland, 1997).

Regional Hydrology

The Project is located in an upper catchment of the Manning River system (i.e. Avon River Water Source in the Manning Extraction Management Unit under the Water Sharing Plan within the NSW Lower North Coast Water Management Area). The Manning River system drains some 8,000 km^2 and extends from the Great Dividing Range to the sea near Taree.

The Avon River is a tributary of the Gloucester River which ultimately flows to the Manning River (Figure 4-1). Flows in the Avon River are unregulated and therefore water users rely on the natural flow regime for their water supplies.

The closest existing gauging station on the Avon River to the Project site is located downstream of the Waukivory Creek confluence (GS208028) (Figure 4-10). The gauging station was commissioned in 2004 and has a contributing catchment area of 225 km^2.

The estimated mean annual flow at the gauging station is approximately 110,600 ML (Appendix B).

A second gauging station also operated on the Avon River further upstream at the Below Dam Site (GS208018) (Figure 4-10) between 1971 and 1985. The contributing catchment of the gauging station was 26 km^2 and recorded a mean annual flow of 8,940 ML (Appendix B).

Continuous surface water levels have also been recorded recently at three downstream sites on the Avon River, namely ASW01, ASW02 and TSW01 (Figure 4-10) as part of the AGL Gloucester Gas Project hydrogeological investigations (Parsons Brinckerhoff, 2012).

Streamflow in the Avon River is characterised by strong flow persistence with zero streamflow recorded on only 3% of days at gauging station GS208028 and GS208018 (Figure 4-12). Averaged over the full period of available data (approximately seven years), streamflow in the Avon River at gauging station GS208028 is estimated to amount to some 44% of rainfall in the contributing catchment (Appendix B).

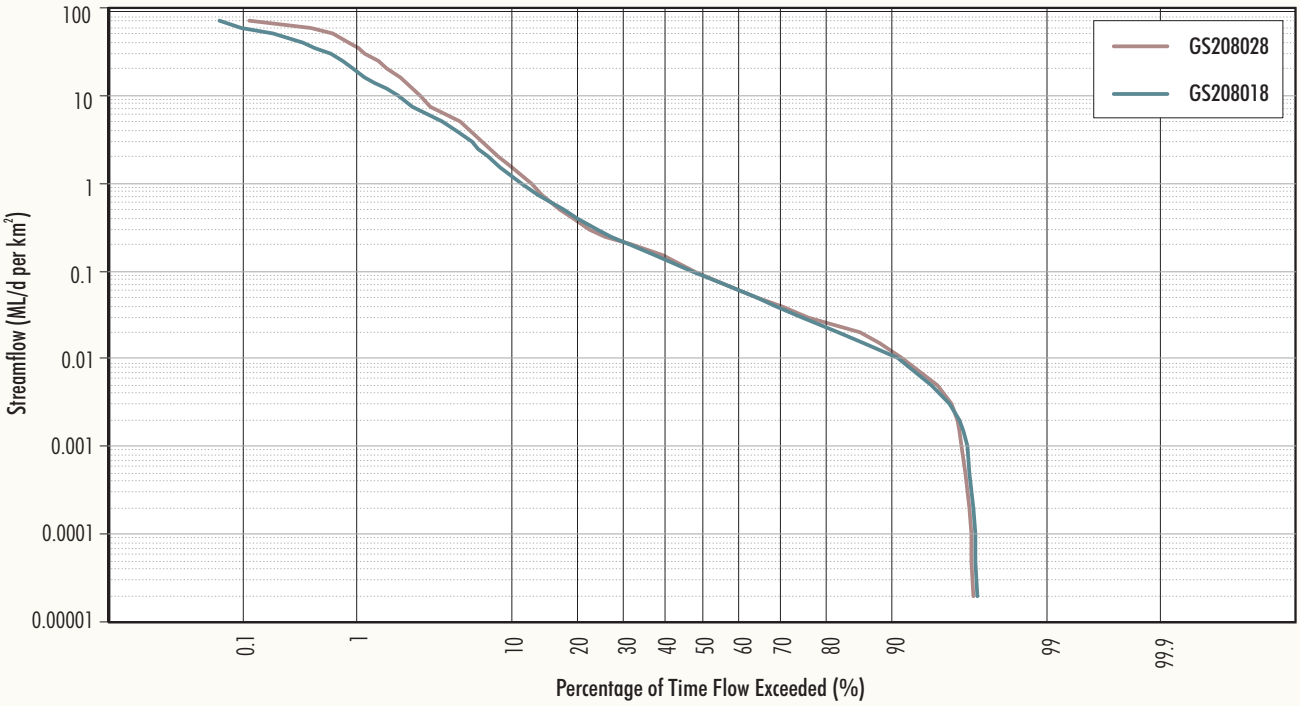
A regional gauging station operates further downstream on the Gloucester River at Doon Ayre (GS208003) (Figure 4-10). Streamflow characteristics for the Gloucester River are illustrated on Figure 4-12. The locations of these gauging stations relative to the Project are shown on Figure 4-10.

Local Hydrology

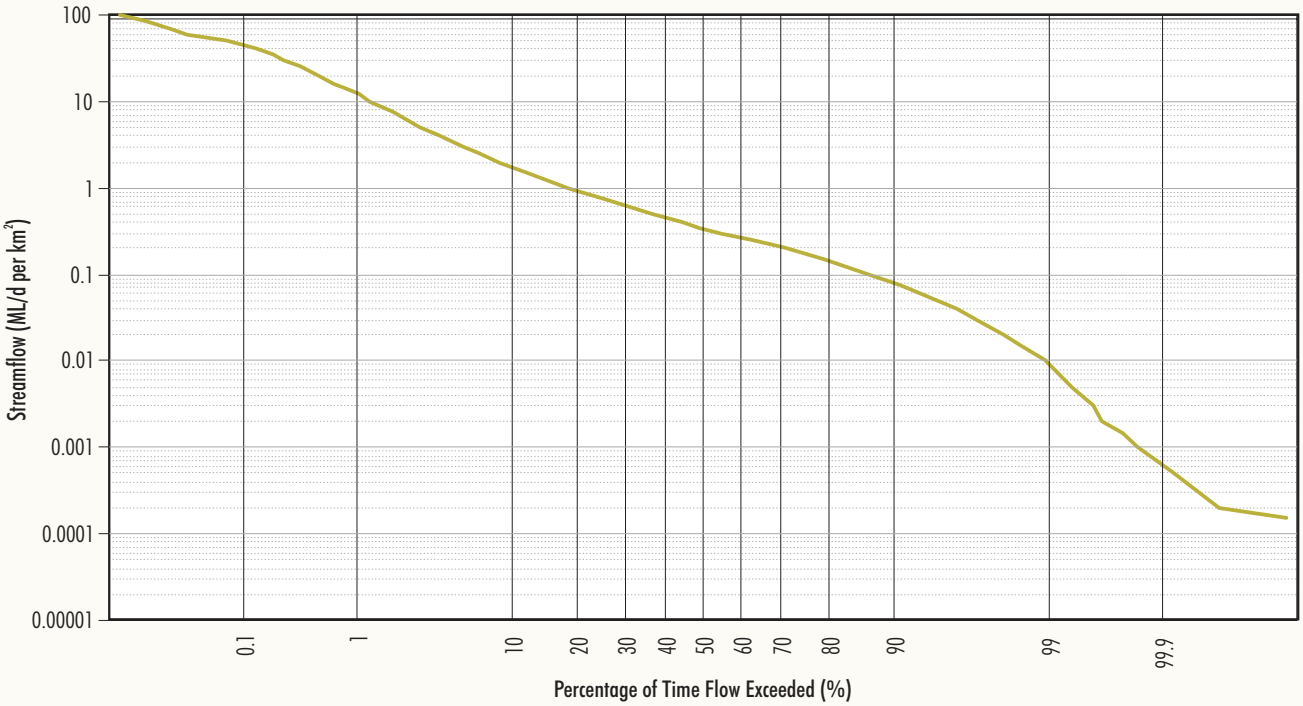
The existing Stratford Mining Complex is located within the Avondale Creek and Dog Trap Creek sub-catchments which ultimately flow into the Avon River (Figure 4-10). A summary of the sub-catchments within the Project area and surrounds is provided in Table 4-5.

Avondale Creek

The headwaters of Avondale Creek rise to the south-east of the Project area. Upstream of the Stratford Mining Complex, Avondale Creek flows to the west before draining northwards between operational areas at the Stratford Mining Complex, and eventually joining Dog Trap Creek approximately 1 km north (and downstream) of the Project (Figure 4-10).



Recorded Streamflow Characteristics for Avon River
(GS208028 and GS208018)



Recorded Streamflow Characteristics for Gloucester River
(GS208003)

Source: Gilbert & Associates (2011)

STRATFORD EXTENSION PROJECT

FIGURE 4-12
Streamflow Characteristics - Avon and Gloucester Rivers

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Table 4-5
Local Sub-Catchment Area Summary

Sub-Catchment	Total Catchment Area (km^2)	Maximum % of Total Catchment Excised by Existing/Approved Stratford Mining Complex
Avondale Creek (upstream of confluence with Dog Trap Creek)	23	27%
Dog Trap Creek (upstream of confluence with Avondale Creek)	17	0.9%
Avon River (upstream of confluence with Oaky Creek)	117	5.5%
Avon River (upstream of confluence with Gloucester River)	292	2.2%

Source: Appendix B.

In the vicinity of the Stratford Mining Complex, Avondale Creek is a second order stream (upstream of the tributary which flows between the BRNOC and Stratford Main Pit) and then third order downstream of that confluence according to the Strahler classification system (Appendix B).

Within the Project area, Avondale Creek is considered an ephemeral waterway experiencing some extended periods of no or negligible flow during dry weather (Appendix B).

Avondale Creek in the Project area is a broadly meandering, swampy and in places a poorly defined stream (Appendix B). A series of photographic plates of Avondale Creek are provided on Figure 4-13.

SCPL operates a stream depth and EC monitoring station on Avondale Creek (W5) which has a reporting catchment of 20.5 km^2 (Appendix B). Recorded data indicates that Avondale Creek exhibits rapid response to rainfall and recedes quickly following rainfall.

A number of ephemeral drainage lines also emanate from the ridges to the east of the Stratford Mining Complex and drain westwards towards Avondale Creek. These drainages, which are well defined in the steeper terrain of the ridges, become ill-defined in the flatter areas near Avondale Creek (Appendix B).

The largest of these drainages is a tributary of Avondale Creek located north of the Stratford East Dam that passes between the Stratford Main Pit and BRNOC. This tributary is a third order stream according to the Strahler classification system (Appendix B).

A portion of the catchment reporting to Avondale Creek (27%) has already been diverted from its original flow path to be captured within the existing/approved Stratford Mining Complex water management system to prevent mine water and sediment laden runoff entering the creek and for on-site usage (Table 4-5). The existing water management systems at the Stratford Mining Complex are described in Section 2.12.1.

Dog Trap Creek

Dog Trap Creek borders the northern extent of the Project area and flows toward the north-west (Figure 4-10).

In the vicinity of the Stratford Mining Complex, Dog Trap Creek is a second to third order stream according to the Strahler classification system (Appendix B).

No streamflow data is available for Dog Trap Creek, however it is considered ephemeral experiencing some extended periods of no or negligible flow (Appendix B).

Observation and anecdotal evidence from SCPL staff indicate that streamflow in Dog Trap Creek has similar flow characteristics to Avondale Creek within the Project area, but less flow persistence than the lower reaches of Avondale Creek downstream of the Project area.

In contrast to Avondale Creek, Dog Trap Creek comprises a much more tightly meandering, well defined, incised channel. A series of photographic plates of Dog Trap Creek are provided on Figure 4-14.

A small portion of the catchment of Dog Trap Creek (0.9%) has also been diverted from its original flow path to be captured within the existing/approved Stratford Mining Complex (specifically BRNOC) water management systems to prevent mine water and sediment laden runoff entering the creek and for on-site usage (Section 2.12.1).

PHOTOGRAPHS TAKEN 1997

Refer P4 on Figure 4-11

Refer P5 on Figure 4-11

PHOTOGRAPHS TAKEN 2011

Refer P6 on Figure 4-11

Refer P7 on Figure 4-11

Refer P8 on Figure 4-11

Refer P9 on Figure 4-11

Source: Gilbert & Associates (2011), SCPL (2011)

STRATFORD EXTENSION PROJECT

FIGURE 4-13
Avondale Creek -
Photographic Plates

STRATFORDCOAL

GCL-10-02 EIS Sect4_003D

PHOTOGRAPHS TAKEN 2011

Refer P1 on Figure 4-11

Refer P2 on Figure 4-11

Refer P3 on Figure 4-11

Source: SCPL (2011)

STRATFORD EXTENSION PROJECT

FIGURE 4-14
Dog Trap Creek -
Photographic Plates

STRATFORDCOAL

Surface Water Quality

Regional Surface Water Resources

The Avon River is the regional surface water resource of relevance to this Project. Further downstream, the Avon River flows into the Gloucester River and then the Manning River.

Figures 4-10 and 4-11 shows existing regional and local surface water quality monitoring sites and sampling locations in the vicinity of the Project.

Regional water quality data is available for the Avon River at several locations both upstream and downstream of any potential/measurable influences of the Stratford Mining Complex. A summary of the regional average water quality data, including comparison to the Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000a) guideline trigger values for the protection aquatic ecosystems, primary industries (irrigation and livestock drinking water) and the Australian Drinking Water Guidelines (National Health and Medical Research Council [NHMRC], 2011), is provided in Table 4-6 and is presented in more detail in Appendix B.

Relative to the ANZECC and ARMCANZ (2000a) guideline trigger values for protection of aquatic ecosystems, water quality of the Avon River is generally characterised by low levels of salinity (EC) (Table 4-6). Based on the available data sets since 1994, there is no visually apparent upward trend in EC with time (Appendix B).

Highest turbidities (typically derived from disturbance within catchments, stream bed and bank erosion, or access by livestock) have been recorded in the mid-sections of the Avon River.

Total nitrogen and total phosphorus concentrations in the Avon River (typically sourced from agricultural runoff and in-stream processes) have been elevated relative to guideline trigger values for protection of aquatic ecosystems.

A comprehensive suite of surface water quality results for local surface water resources is provided in Appendix B.

Table 4-6
Summary of Regional Average Surface Water Quality Data – Avon River

Location (refer Figures 4-10 and 4-11)	Parameter^					
	pH	EC (µS/cm)	Alkalinity (mg/L)	Turbidity (NTU)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)
Avon River						
• Upstream – below Dam Site (GS208018)/at Morgan's Gully (20810030)	7.2	217	51.5	10.3	-	0.03
• Upstream – at Wenham Cox Road (20810019/W1)	7.0	332	67.3	64.9	1.71	0.15
• Downstream – at Dog Trap Creek confluence (W2)	7.0	387	66.9	50.8	1.57	0.20
• Downstream – at Gloucester (20810017)	-	670	-	15.4	-	0.05
ANZECC and ARMCANZ (2000a) Guideline Trigger Values						
• Aquatic Ecosystems [Default]	6.5-8.0*	2,200	-	50	0.35#	0.025#
• Primary Industries - Irrigation Water [Default]	6.0-9.0	950	-	-	5	0.05
• Primary Industries - Livestock Drinking Water [Default]	6.0-9.0	2,985~	-	-	-	-
NHMRC (2011) Australian Drinking Water Guideline Values						
• Aesthetic	6.5-8.5	-	-	5	-	-

Source: After Appendix B.

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

* Value for NSW lowland rivers (<150 m above sea level).

95% species protection.

~ Equivalent to 2,000 mg/L TDS with a conversion factor of 0.67 applied.

NTU = nephelometric turbidity unit.

Local Surface Water Resources

Local water quality sampling has been conducted on Avondale Creek, Dog Trap Creek and other minor tributaries upstream and downstream of the Stratford Mining Complex. Local water quality monitoring sites and aquatic ecology water quality sample locations are shown on Figure 4-11.

Due to the ephemeral nature of Avondale Creek, Dog Trap Creek and their tributaries within the Project area, opportunities to collect water samples are sporadic during dry weather conditions. A summary of local surface water monitoring results is provided in Table 4-7.

The available data for Avondale Creek and Dog Trap Creek indicate that the local surface water resources are generally characterised by near neutral pH conditions.

Recorded EC of local surface water resources was generally low with the exception of the downstream sections of Avondale Creek due to the outcropping/sub-cropping of coal seams within the catchment and associated slow seepage of more saline groundwater into the creek.

The average EC levels were still however below the ANZECC and ARMCANZ (2000a) guideline trigger value for the protection of aquatic ecosystems.

Table 4-7
Summary of Local Average Surface Water Quality Data – Avondale and Dog Trap Creeks

Location (refer Figure 4-11)	Parameter^						
	pH	EC (µS/cm)	TSS (mg/L)	Fe [Filtered] (mg/L)	Sulphate (mg/L)	Total Nitrogen (mg/L)	Total Phosphorous (mg/L)
Avondale Creek							
• Upstream – near Craven (W9)	6.5	227	30	1.18	4.2	1.06	0.17
• Upstream – Parkers Road (W6)	6.6	747	75	1.20	25.0	2.00	0.31
• Downstream – Haul Road Crossing (W8)	6.9	786	193	1.38	48.7	1.25	0.18
• Downstream – Tributary of Avondale Creek (W10)	6.9	617	35	0.74	38.2	0.64	0.08
• Downstream – Wenham Cox Road (W5/SWQ2)	6.7	1,671	85	0.83	72.1	1.66	0.10
• Downstream – Avondale Swamp	6.6	1,601	20	1.70	20.0	-	0.07
Dog Trap Creek							
• Upstream – Road Crossing (W3A)	7.0	383	43	0.78	11.3	2.14	0.30
• Upstream – Road Crossing (W3)	7.0	419	33	0.60	10.5	2.64	0.39
• Upstream – 1981/82 Campaign[+]	6.9	570	26	2.20	15.0	-	0.10
• Downstream – W4	7.0	608	48	0.67	39.2	2.02	0.21
ANZECC and ARMCANZ (2000a) Guideline Trigger Values							
• Aquatic Ecosystems [Default]	6.5-8.0*	2,200	-	-	-	0.35[#]	0.025[#]
• Primary Industries - Livestock Drinking Water [Default]	6.0-9.0	2,985[~]	-	-	1,000	-	-

Source: After Appendices B and G.

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

+ Site located upstream of W3 – sampling point unknown.

* Value for NSW lowland rivers (<150 m above sea level).

[#] 95% species protection.

[~] Equivalent to 2,000 mg/L TDS with a conversion factor of 0.67 applied.

TSS = total suspended solids

Average TSS concentrations recorded in local surface water resources have been moderately elevated and fluctuates upstream to downstream (Table 4-7).

Consistent with water quality records for the Avon River, average total nitrogen and total phosphorus concentrations have also been elevated in local surface water resources relative to guideline trigger values for the protection of aquatic ecosystems (Table 4-7).

Samples collected from Avondale Creek and Dog Trap Creek were also analysed for a suite of metals and results are tabulated in detail in Appendix B. In summary, exceedance of the ANZECC and ARMCANZ (2000a) guideline trigger values for protection of aquatic ecosystems were recorded at several sites on a number of sampling occasions for the following metals:

- cadmium (Cd) (at sites W6 and W8);
- chromium (Cr) (at sites W5, W6, W8 and W9);
- copper (Cu) (at sites W5, W6 and W8);
- lead (Pb) (at sites W5 and W6); and
- manganese (Mn) (at sites W5 and W8).

All other metals exceeded the ANZECC and ARMCANZ (2000a) guideline trigger values for protection of aquatic ecosystems in less than 5% of samples (Appendix B).

A comprehensive suite of surface water quality results for local surface water resources is provided in Appendix B.

Contained Water Storages and Sediment Dams

Water quality sampling and analysis is undertaken at the Stratford Mining Complex in accordance with requirements of Development Consents DA23-98/99 and DA39-02-01 and EPLs 5161 and 11745. A summary of water quality monitoring data ranges from on-site contained water storages and sediment dams is presented in Table 4-8.

A full suite of surface water quality results for contained water storages and sediment dams on-site is provided in Appendix B.

As described in Section 2.12.2, an objective of the on-site water management for the Project is to operate such that there is no contained water storage overflow.

There have been no water related complaints received at the Stratford Mining Complex for several years.

Surface Water Users

Water in the Avon River is used for stock watering and irrigation purposes. There are 45 surface water licences in the Avon River Water Source, with a total volumetric surface water licence of 1,997 ML/annum, of which 95% is used for irrigation purposes.

There are two licences on Dog Trap Creek with a total volumetric licence of 140 ML/year. There are no records of surface water licences on Avondale Creek (Appendix B). With the exception of two properties, SCPL owns all other lands with direct access to Avondale Creek (Figure 1-3a).

Acid Rock Drainage Management

Review of the water quality of contained water stored in the Stratford Main Pit as part of the Geochemistry Assessment (Appendix L) confirms that current management measures at the Stratford Mining Complex have successfully controlled pH from deposited CHPP rejects and maintained a circum neutral pH.

Previous geochemical testwork also identified the potential for concentrations of metals and other constituents in waste rock to mobilise under low pH conditions (Appendix L). SCPL continues to monitor these solute concentrations in contained water storages as part of the existing surface water monitoring program.

The results of some of these parameters monitored are summarised in Table 4-8. A full suite of surface water quality results for contained water storages is provided in Appendix B.

Flooding

Downstream of Stratford, a constriction (i.e. narrowing) of the otherwise 1 to 1.5 km wide valley floodplains of the Avon River occurs near the confluence of Dog Trap Creek, and is likely to control flood levels in the areas immediately upstream.

Further downstream of this point the valley widens substantially with more extensive flood plains and remnant river channel lakes evident (Appendix B).

Within the Project area, the two existing haul road crossings of Avondale Creek cause localised increases in creek levels upstream of these crossings during high flows (Appendix B).

Table 4-8
Stratford Mining Complex – Summary Ranges of Contained Water Quality

Location[#] (refer Figure 4-11)	Parameter^						
	pH	EC (µS/cm)	TSS (mg/L)	Fe (mg/L)	As (mg/L)	Cd (mg/L)	Zn (mg/L)
Open Cut, Pit Dewatering and Rejects Co-Disposal Areas							
• Roseville Pit, Roseville Extended Pit and BRNOC	2.4-9.4	200-12,130	2-13	0.01-541	0.001	0.0001-0.0003	0.0005-2.63
• Parkers/Bowens Road West Pit	2.6-7.9	600-3,660	-	0.01-11.9	-	-	0.0015-4.4
• Stratford Main Pit (rejects co-disposal area)	2.4-8.4	530-6,500	4-220	0.01-150	0.001	0.0001	0.005-0.177
Contained Water Storage							
• Return Water Dam	3.9-8.9	1,850-6,000	2-30	0.01-13	0.001	0.0001-0.01	0.009-0.076
• Stratford East Dam	6.4-9.1	136-2,650	2-670	0.01-7.8	0.001-0.008	0.0001-0.01	0.005-0.05
Sediment Dams							
• BRNOC Sediment Dams (SD1, SD2, SD3, SD4 & SD7)	5-7.9	100-2,500	1-4,480	-	-	-	-
• SCM Sediment Dams (SD8, SD10, SD13, SD14, SD15, SD16, SD18, Ellis)	3.6-8.9	44-6,500	1-5,200	0.01-21	-	0.01	-
ANZECC and ARMCANZ (2000a) Guideline Trigger Values							
• Aquatic Ecosystems [Default]	6.5-8.0*	2,200	-	-	0.024	0.0002	0.008
• Primary Industries - Livestock Drinking Water [Default]	6.0-9.0	2,985~	-	-	0.5	0.01	20

Source: Appendix B.

[#] On-site contained water storage locations are shown/provided in Appendix B.

^ Sample counts for each parameter varies for each location and are provided in Appendix B.

* Value for NSW lowland rivers (<150 m above sea level).

Zn = Zinc.

Hydraulic design and modelling of these crossings and associated flood bunding has been commissioned by SCPL in order to design flood mitigation measures (including bunding) to reduce the risk of flooding of mine areas, with design based on a 100-year ARI flow event.

4.5.2 Potential Impacts

The following sub-sections describe the potential operational and post-mining impacts of the Project on surface water flow regimes and surface water quality, including consideration of potential cumulative impacts.

Surface Water Flow Regimes

The Project would result in changes to flows in local creeks due to the progressive extension of the open cut mining operations and associated subsequent capture and re-use of drainage from operational catchment areas.

Changes to groundwater baseflow contributions to local creeks were also identified as a potential impact of the Project, as discussed in the sub-sections below.

Changes in Contributing Catchment

The surface water flow regimes in Avondale Creek and Dog Trap Creek, and consequently downstream on the Avon River, would be affected by changes in catchment area as a result of runoff capture in disturbance areas over the life of the Project.

Table 4-9 summarises the potential changes in catchment area reporting to these creeks as a result of the Project (in addition to the existing/approved Stratford Mining Complex) and also considers the cumulative impacts with the proposed Rocky Hill Coal Project.

The reduction in average flow in the creeks is likely to be proportional to the reduction in catchment area, however compared to the existing/approved total catchment area excised by the Stratford Mining Complex, the Project is not expected to result in a measurable change to downstream flows in Avondale Creek, Dog Trap Creek or the Avon River (Appendix B). Specifically for licensed surface water users on the Avon River and Dog Trap Creek, this is estimated to be a small reduction in average flows of the order of 3% to 4%, respectively (Appendix B).

Table 4-9
Predicted Maximum Changes to Contributing Catchments

Mine/Project	Percentage Reduction in Contributing Catchment				
	Avondale Creek		Dog Trap Creek	Avon River	
	U/S Tributary Confluence^	U/S Dog Trap Creek Confluence	U/S Avondale Creek Confluence	U/S Oaky Creek Confluence	U/S Gloucester River Confluence
Stratford Mining Complex/Project					
Stratford Mining Complex (existing/approved)	40%	27%	0.9%	2.6%	2.2%
Project (additional)	13%	3.7%	3.5%	0.6%	0.5%
Proposed Rocky Hill Coal Project					
Maximum (conservative)	-	-	-	2.1%	1.7%
Potential Maximum Cumulative Impact*	53%	30.7%	4.4%	5.3%	4.4%
Post-Mining (Project)	19%	7.2%	1.3%	0.9%	0.7%

Source: Appendix B.

^ Tributary which drains between the BRNOC and Stratford Main Pit to join Avondale Creek.

* Changes in contributing catchments by AGL Gloucester Gas Project considered to be negligible (<0.4 ha).

U/S = Upstream.

Potential Impacts on Groundwater Baseflow Contributions

Appendix A concluded that potential impacts on baseflow contributions to Dog Trap Creek and Avondale Creek would be negligible (Section 4.4.2) and therefore the downstream potential impacts on the Avon River would be negligible.

Surface Water Quality

Potential impacts of the Project on surface water quality include the reduction in surface water quality due to uncontrolled runoff from disturbed areas and/or release of contaminants, acid rock drainage from waste rock emplacements and Project irrigation areas and/or alteration of groundwater quality affecting baseflow in surface water resources.

Runoff and Contaminants

Surface water runoff from disturbed areas could potentially contain sediments, dissolved solids, oil, grease, metals and salts. Erosion and sediment controls and land contamination controls that would be applied to the Project are described in Section 4.3.3. Acid rock drainage potential is described in the following sub-section.

As described in Section 2.12.2, sediment dams and would be sized to capture runoff from a 90th percentile rainfall event with a duration of five days (Landcom, 2004 and DECCW, 2008a). Disturbed area dams would be sized consistent with the sizing criteria for existing sediment dams at the Stratford Mining Complex (Section 2.12.1), with pumped transfer of accumulated water back to contained water storages.

The salt balance analysis presented in Appendix B simulated median EC of water in the contained water storages over the Project life, based on estimated EC values assigned to runoff from each water balance model sub-catchment area and other sources (e.g. groundwater and CHPP rejects). The analysis indicates that the EC of water in the contained water storages would fluctuate seasonally, but is predicted to decrease slightly due to the relative increase of rehabilitated and stabilised waste rock emplacement areas as a proportion of the total catchment (Appendix B).

SCPL would continue to operate the site in accordance with the requirements of EPLs 5161 and 11745, or any relevant variations to them.

As described in Section 2.12.2, the Project water management system is to be operated with the objective to achieve no contained water storage overflow.

Based on the above and assuming the implementation of management strategies and monitoring recommended in the Geochemistry Assessment (Appendix L), the risks of elevated dissolved solids and other contaminants impacting downstream waters is considered to be low (Appendix B).

The risk of increased suspended sediment migration to Avondale Creek from erosion associated with up-catchment diversions is also considered low due to the proposed erosion control measures that have been both used in the past and are proposed for future diversions (Section 2.12.2) (Appendix B). Notwithstanding, management and mitigation measures are proposed based on the outcomes of the geomorphology assessment (Fluvial Systems, 2012) and are described in Section 4.5.3.

The risk of a contained water overflow (i.e. spill) from the Project was evaluated as part of the site water balance (Appendix B) and there were no spills simulated during the 123 climatic realisations simulated. Subject to adherence with the operational protocols (including storage of water in active mine pits if required) and other assumptions inherent in the water balance modelling, there is a very low risk of spill occurring from the contained water storages over the life of the Project life to Avondale Creek (Appendix B).

Acid Rock Drainage

A Geochemistry Assessment was conducted by EGi (2012) and is presented in Appendix L.

The Geochemistry Assessment concluded that the waste rock materials generated from three of the four Project open cut mining areas would generally be expected to be NAF, with the exception of a small quantity of overburden immediately adjacent to some of the coal seams in the Avon North Open Cut. The acid base accounting test work indicates that the Stratford East Open Cut waste rock materials would be expected to be generally PAF, with some PAF-LC and NAF materials also expected to be present (Appendix L).

As described in Section 2.10.4, the targeted coal seams in the Stratford East Open Cut are equivalent to those mined at the DCM. Consistent with the PAF management procedures adopted at the DCM, PAF waste rock material would be segregated and selectively handled and then placed in either in-pit (below the predicted final water table recovery level) or out-of-pit waste rock emplacements (PAF waste cells).

The solubility testwork from selected waste rock material samples indicated there would be negligible mobilisation of metals/metalloids under near-neutral pH conditions, however, elevated sulphate salinity may occur when pyritic material is present (Appendix L).

The CHPP reject from the Project are expected to have a lower acid generating potential than rejects currently produced at the CHPP (Section 2.11).

Consistent with existing CHPP rejects management measures, these rejects would be disposed either subaqueously or subaerially. Project CHPP rejects that are deposited subaerially would be treated with limestone prior to inundation.

Based on the implementation of management strategies and monitoring recommended in the Geochemistry Assessment (Appendix L), the risks of elevated dissolved solids and other contaminants impacting downstream waters is considered to be low (Appendix B).

Irrigation

As described in Section 2.12.4, irrigation would only occur on rehabilitated or topsoiled areas from which runoff reports to contained water storages or open pits.

The risk of build-up of salts in irrigation areas and their impact on downstream water quality is considered negligible because irrigation would only occur within the surface catchment of contained water storages (Appendix B).

Alteration of Groundwater Quality

There is not expected to be any measurable changes in the quality of groundwater (alluvial and fractured rock) as a consequence of mining and therefore there would be negligible impact on surface water quality in local creeks (i.e. Dog Trap Creek and Avondale Creek) due to the interaction of groundwater (Appendix A).

Flooding

Flood water inundation potential in the Project area during major floods is controlled by the hydraulic capacity of the existing Avondale Creek haul road crossing, causing water to back-up on the upstream side (i.e. afflux).

Flood modelling of the peak 100-year ARI flow indicates that afflux of 1 centimetre (cm) to 2 cm are predicted upstream of the existing haul road crossing adjacent the CHPP within Yancoal-owned lands. It is therefore considered unlikely that any discernible 100-year ARI peak flow flood level increases would extend upstream of Yancoal-owned land (Appendix B).

Provided that the additional haul road crossing (Section 2.12.2) is designed with similar geometry and capacity as the existing crossings, it is considered highly unlikely that any afflux could extend upstream of Yancoal-owned land (Appendix B).

The potential for flooding in the Project area to impact on mine infrastructure would be managed through the construction of flood bunds, as described in Section 2.12.2.

Post-Mining Surface Water Impacts

The potential post-mining surface water impacts primarily relate to the design of the final voids and performance of the up-catchment diversions and rehabilitated mine landforms in the long-term and are discussed in the following sub-sections.

Final Void

Post-mining inflows to the final voids would comprise three contributing sources:

- incident rainfall;
- runoff (albeit from a reduced reporting catchment); and
- reducing (with time) groundwater inflows (from the fractured rock groundwater system as it recovers and adjacent waste rock emplacement infiltration).

Water would be lost from the final voids through evaporation.

The final voids would be designed not to overflow to the downstream watercourses (Appendix B).

A final void water recovery analysis, including predicted groundwater inflows from the regional groundwater model, has been conducted as part of the Surface Water Assessment (Appendix B). The final void water recovery analysis also includes water quality (salinity) predictions.

The results of the final void water recovery analysis are presented in Section 5.

Up-catchment Diversions

A description of the up-catchment diversions is provided in Section 2.12.2 with further detail presented in Appendix B.

The Geomorphology Assessment (Fluvial Systems, 2012) included in Appendix B concluded the potential for impacts on the geomorphological character of the streams in the Project area was mainly isolated to the tributary of Avondale Creek due to the proposed progressive enlargement of catchment area (some 84%) reporting to the creek during the life of the Project.

Despite an existing diversion being in place for over 10 years at the Stratford Mining Complex resulting in an increase of the pre-mine catchment by some 318%, the tributary of Avondale Creek has retained its basic character, as evidenced by comparison of geomorphological inspections done in 1997 and 2012, and there are no indications of major change in channel form (Fluvial Systems, 2012). The lower sections of the tributary have also remained stable, despite the increased catchment area.

The degree of change to the channel form due to the additional catchment area would be dependent on (Fluvial Systems, 2012):

- exceedance of the inherent hydraulic threshold of resistance to erosion of the creek, which naturally varies over time and amount of vegetative cover; and
- resilience of the stream to geomorphic change, if erosion was initiated (which does not necessarily mean ongoing erosion).

As streams have multiple modes of adjustment to changes in flows (width, depth, slope, roughness and sinuosity) and the adjustment process is largely indeterminate (Richards, 1982), recommendations for monitoring and management are proposed as described in Section 4.5.3.

Rehabilitated Mine Landforms

The Geochemistry Assessment (Appendix L) testwork included pH and EC, acid base accounting, acid buffering characterisation, net acid generation and element enrichment and solubility testwork.

The solubility testwork from selected waste rock material samples indicated there would be negligible mobilisation of metals/metalloids under near-neutral pH conditions, however, elevated sulphate salinity may occur when pyritic material is present (Appendix L). Based on the implementation of management strategies and monitoring recommended in the Geochemistry Assessment (Appendix L), the risks of elevated dissolved solids and other contaminants impacting downstream waters is considered to be low (Appendix B).

As described in Section 5, the existing sediment dams would be retained until the revegetated surface of the waste rock emplacements are stable and runoff water quality reflects runoff water quality from similar un-mined areas, at which time these controls would be removed and the areas would be free-draining.

Cumulative Impacts

The Surface Water Assessment (Appendix B) included consideration of the cumulative impacts of the Project (including the existing Stratford Mining Complex), the proposed Rocky Hill Coal Project and the AGL Gloucester Gas Project.

As indicated in Table 4-9 (including the existing Stratford Mining Complex and proposed Rocky Hill Coal Project), the maximum cumulative reduction in contributing catchments to the Avon River at the confluence with the Gloucester River would be 4.4% during the life of the Project. The cumulative impact of the Project and the AGL Gloucester Gas Project due to surface catchment reduction and flow reduction in local creeks is likely to have negligible difference than that for the Project alone (Appendix B).

Climate Change and Surface Water

The effects (i.e. sensitivity) of climate change on the predicted surface water impacts are presented in Appendix B.

4.5.3 Mitigation Measures, Management and Monitoring

Water Flow Management Measures

Up-catchment Diversions

The existing surface water runoff controls to prevent up-catchment runoff water from entering open cut mining operational areas would be generally retained for the Project. Details of additional up-catchment runoff water control structures to be developed for the Project are discussed in Section 2.12.2.

Prior to extension of the existing eastern up-catchment diversion for the Stratford East Open Cut, the longitudinal profile of the tributary of Avondale Creek would be surveyed from the diversion outlet to the junction of Avondale Creek, to define the location and size of all knickpoints (e.g. gully head erosion points). This survey would also include cross-section surveys at approximately 50 m spacings. The survey would be repeated every two years, with survey data interpreted by a qualified, independent fluvial geomorphologist to determine whether any measured change is within the normal range of variability, or whether a programme of works is required to stabilise the drainage.

Prior to diversion of the 600 m section of the tributary of Avondale Creek adjacent the Avon North Open Cut, an investigation would be undertaken to determine the overall performance of the tributary of Avondale Creek along its length (via survey) to inform the final design.

Permanent up-catchment diversion bunds/drains would remain around final voids (Section 5).

Flood Embankments

As described in Section 2.12.2, the potential for flooding in the Project area to impact on mine infrastructure would continue to be managed through the construction of levees around mine operational areas. The existing flood control embankments constructed adjacent to Avondale Creek would be retained for the Project.

Water Quality Management Measures

Water Management System

The Project water management system would maintain separation between runoff from areas undisturbed by mining and water generated within active mining areas (Section 2.12.2).

The water management system would include a combination of permanent structures (e.g. Stratford East Dam) that would continue to operate post-mine closure, and temporary structures that would only be required until the completion of the rehabilitation works (e.g. diversions and sediment dams).

Water quality monitoring sites for the water management system would be expanded to include new open cut mining areas, disturbed area dams and irrigation water, and is discussed in the Water Management Plan sub-section below.

Erosion and Sediment Control

As described in Section 2.12.2, sediment dams would be sized to capture runoff from a 90^{th} percentile rainfall event with a duration of five days (Landcom, 2004 and DECCW, 2008a). Disturbed area dams would be sized consistent with the sizing criteria for existing sediment dams at the Stratford Mining Complex (Section 2.12.1), with pumped transfer of accumulated water back to contained water storages.

The site sediment and erosion control system would be managed through erosion and sediment control plans that would be progressively developed and approved over the life of the Project. The plans would be updated periodically and the effectiveness of the plans would also be assessed through monitoring and by a formal auditing process.

The operational sediment and erosion control works would be retained and maintained during the revegetation establishment phase. Following the establishment of self-sustaining, stable final landforms, key elements of the operational sediment control structures would either be left as passive water control storages (if practicable) or would be removed if they cannot be left without an ongoing maintenance requirement.

Acid Rock Drainage Management

As described in Sections 2.10.4 and 2.11, PAF management procedures would be implemented for the Project.

In addition, geochemical characterisation and investigation would continue to be undertaken over the life of the Project, including:

- CHPP rejects total sulphur analysis;
- geochemical characterisation of additional samples from Stratford East Open Cut and Roseville West Pit Extension waste rock;
- additional testing of Stratford East Open Cut waste rock to model the distribution of NAF and PAF materials;
- geochemical characterisation of roof rock in the Avon North Open Cut; and
- geochemical review of previously backfilled co-disposal rejects in the Roseville Pit.

Further details on these measures is provided in Appendix L.

The existing Life of Mine Rejects Management Plan would be generally retained with updates to reflect the management measures above.

SCPL would continue to monitor the water quality of contained water storages (i.e. pH and solute concentrations) during the life of the Project as part of the existing surface water monitoring program. If in the event acid rock drainage is identified through the surface water monitoring program (refer below), specific acid rock drainage controls would be implemented.

These management procedures include limestone treatment of open pit floors and other temporary areas where PAF material is present, and encapsulation of PAF waste rock material or placement below the predicted final watertable recovery level.

Irrigation Management

Irrigation activities (refer Section 2.12.4) would be managed by limiting irrigation to mine landforms that only drain directly to contained water storages (i.e. not off-site).

Water Management Plan

The existing Water Management Plan would be reviewed and revised to incorporate the Project. The Water Management Plan would describe the operational site water management system and would include provisions for review of the site water balance, erosion and sediment controls, surface water (and groundwater) monitoring and management.

The Water Management Plan would describe the water management protocols and response procedures for the water management system that would be adhered to throughout the operation of the Project. The water management protocols (to avoid overflows or releases from contained water storages) are described in Appendix B.

Site Water Balance

Review and progressive refinement of the site water balance would continue to be undertaken on a regular basis over the life of the Project to record the status of inflows (water capture), storage and consumption (e.g. CHPP usage, return water from co-disposal areas, dust suppression and irrigation activities) and to optimise water management performance. Monitoring would be undertaken over the life of the Project to provide data for refinement of the site water balance, including:

- records of pumped water volumes;
- storage levels in contained water storages (weekly basis);
- CHPP water usage rates;
- haul road and waste rock emplacement dust suppression water usage rates; and
- irrigation usage rates.

Annual bathymetric survey of the co-disposed rejects surface within the Stratford Main Pit and the Avon North Open Cut (when commissioned for CHPP rejects disposal) would also be undertaken to enable estimates of stored water volumes and *in situ* rejects density to be made.

The results of site water balance reviews would be reported in the Annual Review.

Erosion and Sediment Control

Erosion and sediment control plans would continue to be developed over the life of the Project to identify activities that could cause soil erosion and generate sediment and describe the specific controls (including locations, function and structure capacities) to minimise the potential for soil erosion and transport of sediment off-site (as described above in Water Quality Management Measures sub-section).

The integrity of up-catchment diversion channels/bunds would be visually checked on a monthly basis or after significant rainfall (50 mm or more rainfall in a 24 hour period) to check for any signs of visible erosion or instability to trigger corrective actions.

Surface Water Monitoring Program

The existing surface water monitoring program (Figure 4-11) which is included in the Surface Water Management Plan of the Water Management Plan would be generally retained with updates and additional monitoring locations to be installed during the life of the Project, including:

- establishment of a relationship between flow depth and flow rate (i.e. rating) at Site W5 so flow rate can effectively be continuously monitored, including ongoing checks/updates on a monthly basis (via manual stream gauging) for at least two years;
- water quality monitoring in new open cut mining areas (Avon North Open Cut and Stratford East Open Cut);
- water quality monitoring in disturbed area dams for parameters including pH, EC, acidity/alkalinity, sulphate, Al, Cobalt (Co), Fe, Mn, Nickel (Ni) and Zn, at a frequency consistent with existing sediment dams;
- installation of gauge boards (with board levels surveyed relative to spillway level) for disturbed area dams;
- monitoring of gauge board levels in disturbed area dams (and whether overflow is occurring) at the time of sampling so that water quality can be related to stored volume; and
- monitoring of water used for irrigation for parameters including pH, EC, Residual Sodium Carbonate (RSC) and Sodium Adsorption Ratio (SAR).

Water quality monitoring would be undertaken in accordance with the *Australian Guidelines for Water Quality Monitoring and Reporting* (ANZECC and ARMCANZ, 2000b) and *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC, 2004b).

On-site meteorological monitoring (including on-site rainfall and evaporation) would also continue and is discussed in Section 4.2.2.

Surface Water Licensing

The Project is located within the Avon River Water Source within the broader Manning River Extraction Unit defined in the Water Sharing Plan.

As no surface water is proposed to be directly extracted from Avondale Creek or Dog Trap Creek for the Project, nor would any direct pumping of water from alluvial sediments occur within 40 m of these creeks, the respective components of the Water Sharing Plan would not apply to the Project. Notwithstanding, SCPL holds unregulated river access licence(s) for a total of 140 ML (WAL 19536 and WAL 19514) in the Avon River Water Source under the *Water Management Act, 2000* that are associated with its existing landholdings (Attachment 5).

Further details are provided in Attachment 5 including consideration of the Project against the water management principles and access licence dealing principles under the *Water Management Act, 2000*.

As described in Section 2.12.2 and Appendix B, an objective of the water management on-site throughout the Project life is to maintain separation between runoff from areas undisturbed by mining and water generated within active mining areas. Gilbert & Associates has concluded that no access licences would be required for Project surface water containments (Appendix B).

This conclusion was made on the basis that Project water storages would be relevant excluded works under Schedule 1 (clauses 1 to 3) of the *Water Management (General) Regulation, 2011* (Appendix B).

Maximum Harvestable Right Dam Capacity

Based on the area of Yancoal's contiguous land holdings in the Avon River Water Source (Figure 1-3a), the maximum harvestable right dam capacity has been determined to be 253 ML (Appendix B).

Surface Water Management Plan and Adaptive Management

The existing Surface Water Management Plan which is included in the Water Management Plan for the SCM (Figure 2-3), would be reviewed and revised for the Project. The Surface Water Management Plan would describe any additional measures/procedures that would be implemented over the life of the Project to respond to any potential exceedances of surface water related criteria and contingent mitigation, compensation, and/or offset options if downstream surface water users or riparian vegetation are adversely affected by the Project.

Examples of SCPL's proposed adaptive management approach to manage potential surface water impacts during the life of the Project may include:

- increasing the size of the Stratford East Dam (subject to separate assessment and approval) or other contained water storages, or disrupting mine operations (i.e. transferring water to an active open cut) to avoid overflows or releases to downstream watercourses if significant rainfall were to occur during the 11 year Project life;
- utilisation of dust suppressant to reduce water usage in the event of particularly low rainfall during the 11 year Project life; or
- obtaining appropriate water licences and/or compliance with appropriate trading rules in accordance with the Water Sharing Plan.

Post-Mining Surface Water Management

The management of surface water resources post-mining, including drainage across the final mine landforms, stability of up-catchment diversions and final void water management are discussed in Section 5.

Of particular note, as the up-catchment diversions upslope of the Stratford East Dam would be removed and drainage allowed into this storage, the risk of potential geomorphological changes to the tributary of Avondale Creek described in Section 4.5.2 due to additional catchment would be significantly reduced post-mining (Appendix B).

4.6 NOISE AND BLASTING

A Noise and Blasting Impact Assessment for the Project was undertaken by SLR Consulting (2012) and is presented in Appendix C. It was conducted in accordance with the INP (EPA, 2000), *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Council [ANZEC], 1990), *NSW Road Noise Policy* (RNP) (DECCW, 2011), *Environmental Assessment Requirements for Rail Traffic-Generating Developments* (EPA, 2012a) and the *Interim Construction Noise Guideline* (DECC, 2009).

The Noise and Blasting Impact Assessment was internally peer reviewed by Mr Richard Heggie (Director, SLR Consulting) and the review report is presented in Attachment 3.

Section 4.6.1 provides a description of the existing noise environment, including a description of the existing Stratford Mining Complex noise and blasting management and monitoring regime. Section 4.6.2 describes the potential noise and blasting impacts of the Project, including cumulative impacts. Section 4.6.3 outlines mitigation measures, management and monitoring for the Project.

4.6.1 Existing Environment

Noise and Blasting Management and Monitoring Regime

Noise management at the Stratford Mining Complex is currently undertaken in accordance with the Stratford Mining Complex Noise Management Plan (SCPL, 2012) which outlines:

- noise mitigation measures and controls;
- the noise monitoring and reporting regimes; and
- procedures for the management of exceedances and complaints.

The Noise Management Plan describes general noise management and mitigation measures including:

- contractor environmental training on noise control and awareness of noise issues;
- consideration of sound power levels in equipment selection, and maintaining equipment in good order;
- real-time monitoring and an associated protocol for real-time management of noise emissions;
- management of complaints received;

- attended monitoring to verify compliance with noise criteria; and
- direct measurement of temperature inversion strength.

In addition, the Noise Management Plan details the reasonable and feasible noise mitigation measures that are currently in-place or are proposed for implementation at the Stratford Mining Complex.

The implementation status of a range of mitigation measures is provided in Appendix C.

A mobile real-time noise monitor has recently been procured by SCPL. Consistent with the Noise Management Plan, the real-time monitor is located east of Craven (Figure 4-15).

The *Blasting/Vibration Management Plan* (SCPL, 2006b) describes the blast monitoring regime and general blast management measures. It also describes the process for notifying landowners of upcoming blast events, flyrock distribution monitoring, reporting and complaint management procedures.

Compliance and Complaints

Attended noise monitoring and vibration/air blast monitoring has been undertaken at the Stratford Mining Complex since 1995. Monitoring is currently undertaken at the locations shown on Figure 4-15.

Quarterly attended noise monitoring has been conducted at the Stratford Mining Complex since the commencement of mining operations. From review of available monitoring data between 2008 and 2011 (i.e. the most recent Independent Audit period), the Stratford Mining Complex was compliant with the relevant noise limits with the exception of a single exceedance at site NM1 (Figure 4-15) for the evening component of the March 2011 survey (Applied Environmental Management Consultants [AEMC], 2011). SCPL has since acquired the property where NM1 is located.

From review of blast monitoring, no airblast or vibration results exceeding the structural damage criteria were recorded at any privately owned properties during the period 2008 to 2011. One blast recorded an air blast level in excess of the human comfort air blast criterion at the 31(1) Isaac residence, and two blasts were in excess of the same criterion at the Ex Atkins residence (now 13[1] AGL). These excess levels were within the 5% exceedances allowed by the criteria (AEMC, 2011).

All vibration results were less than 5 millimetres per second (mm/s), therefore conforming to limits specified in the relevant approvals (AEMC, 2011).

SCPL manages complaints in accordance with the Noise Management Plan. A summary of noise and blasting-related complaints is provided in Appendix C.

In 2011, 79 complaints were received from eight complainants in relation to on-site noise and blasting. Of these, 49 complaints specifically referred to operational noise, 22 related to blasting and eight related to rail noise (Appendix C).

One local resident has been responsible for approximately one third of all noise and blasting complaints lodged during the 2002 to 2011 period. This property has recently been purchased by SCPL.

Noise Measurement and Description

The assessed noise levels presented in Appendix C and summarised in this section are expressed in A-weighted decibels (dBA). The logarithmic dBA scale simulates the response of the human ear, which is more sensitive to mid to high frequency sounds and relatively less sensitive to lower frequency sounds. Table 4-10 provides information on common noise sources in dBA for comparative reference.

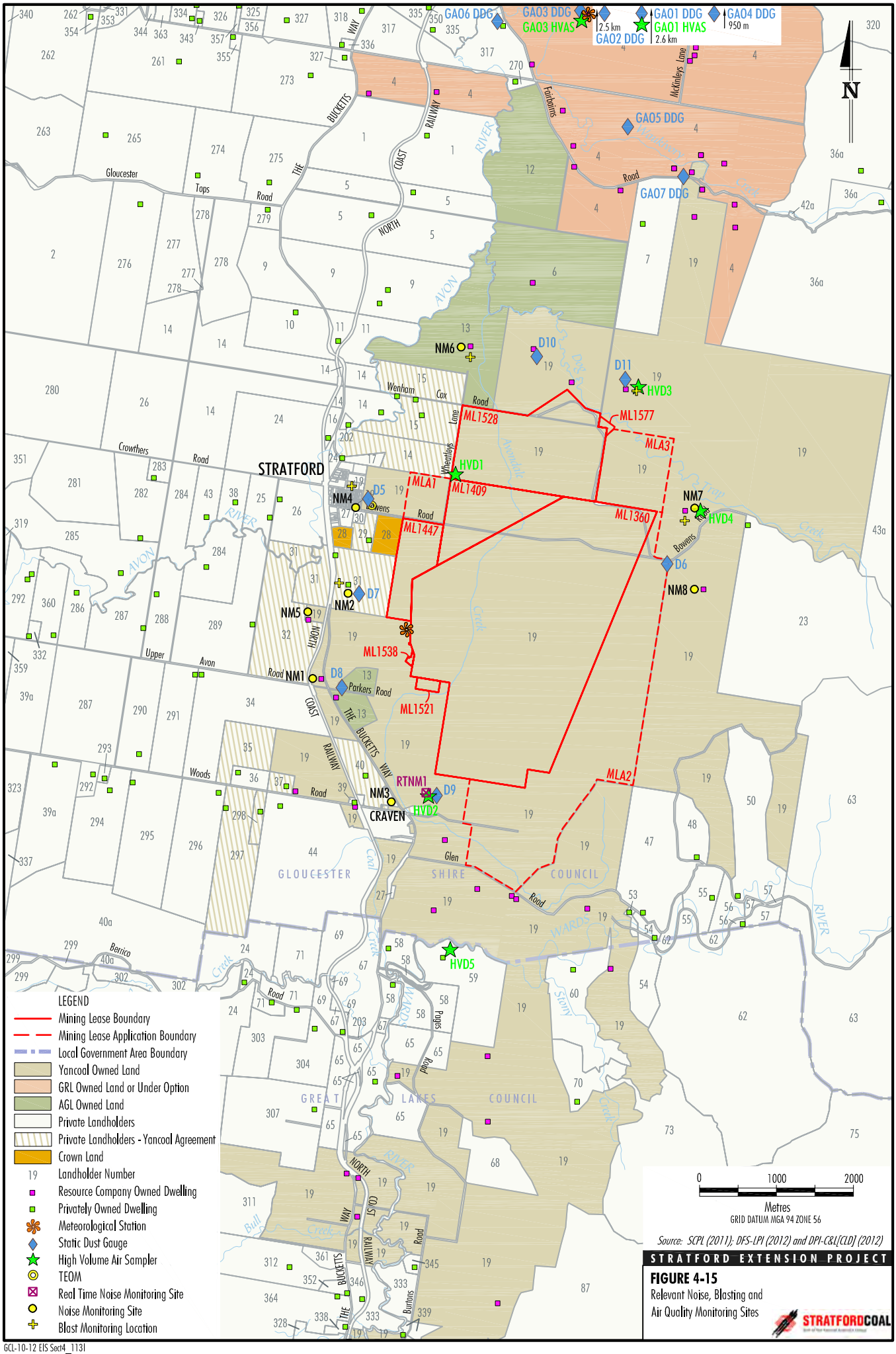
Hearing "nuisance" for most people begins at noise levels of about 70 dBA, while sustained (i.e. eight hours) noise levels of 85 dBA can cause hearing damage.

Measured or predicted noise levels are expressed as statistical noise exceedance levels (L_{AN}) which are the levels exceeded for a specified percentage of the interval period. For example, L_{A10} is the noise level that is exceeded for 10% of the sampling period and is considered to be the average maximum noise level.

The equivalent continuous noise level (L_{Aeq}) refers to the steady sound level, which is equal in energy to the fluctuating levels recorded over the sampling period.

Background Noise Levels

The Rating Background Level is the background noise level determined without the subject premises in operation, in accordance with the INP.



Source: SCPL (2011); DFS-LPI (2012) and DPI-C&L[CLD] (2012)

STRATFORD EXTENSION PROJECT

FIGURE 4-15

Relevant Noise, Blasting and Air Quality Monitoring Sites

STRATFORDCOAL

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Table 4-10
Relative Scale of Various Noise Sources

Noise Level (dBA)	Relative Loudness	Common Indoor Noise Levels	Common Outdoor Noise Levels
110 to 130	Extremely noisy	Rock band	Jet flyover at 1,000 m
100	Very noisy	Internal demolition work (jackhammer)	Petrol engine lawn mower at 1 m
90	Very noisy	Food blender at 1 m	Diesel truck at 15 m
80	Loud	Garbage disposal at 1 m, shouting at 1 m	Urban daytime noise
70	Loud	Vacuum cleaner at 3 m, normal speech at 1 m	Commercial area heavy traffic at 100 m
60	Moderate to quiet	Large business office	-
50	Moderate to quiet	Dishwasher next room, wind in trees	Quiet urban daytime
40	Quiet to very quiet	Small theatre, large conference room (background), library	Quiet urban night-time
30	Quiet to very quiet	Bedroom at night, concert hall (background)	Quiet rural night-time
20	Almost silent	Broadcast and recording studio	-
0 to 10	Silent	Threshold of hearing	-

Source: After United States Department of the Interior (1994) and Richard Heggie Associates (1995).

Given that the Stratford Mining Complex operations are ongoing, SLR Consulting referred to previous background noise surveys (Appendix C).

Review of these background noise levels indicated that Rating Background Levels in Stratford and Craven are 32 dBA during daytime, 31 dBA during evening and 30 dBA during night-time periods. Rating Background Levels in all other areas are 30 dBA during all periods. These Rating Background Levels have been adopted for the Project (Appendix C).

4.6.2 Potential Impacts

The Noise and Blasting Impact Assessment (Appendix C) included assessment of the following potential impacts:

- on-site operational noise (including the potential for sleep disturbance);
- construction noise associated with public road realignments;
- off-site road traffic noise;
- off-site rail noise; and
- on-site blasting.

These aspects are discussed further below and in Appendix C.

Operational Noise Criteria

The INP assessment procedure for industrial noise sources has two components (EPA, 2000):

- controlling potential intrusive noise impacts in the short-term for residences; and
- maintaining noise level amenity for particular land uses, for residences and other land uses.

The INP prescribes detailed calculation routines for establishing project-specific $L_{Aeq(15minute)}$ intrusive criteria and $L_{Aeq(period)}$ amenity criteria. The INP project-specific intrusive and amenity assessment criteria for the Project are presented in Table 4-11. Intrusive criteria are applied on a Project-only basis whilst amenity criteria are applied on both a Project-only and a cumulative basis.

Potential noise impacts on land uses other than residences are also assessable under the INP. Appendix C assessed Project noise levels at an industrial area in the vicinity of the Project (Parkers Road); in addition to noise levels at a school, church, cemetery and a recreational park in Stratford. The relevant INP amenity criteria for these land uses are also provided in Table 4-11.

In those cases where the INP project-specific assessment criteria are exceeded, it does not automatically follow that all people exposed to the noise would find the noise noticeable or unacceptable.

Table 4-11
INP Project-specific Intrusive and Amenity Assessment Criteria (dBA)

Locality	Land Use	Intrusive $L_{Aeq(15minute)}$			Amenity $L_{Aeq(period)}$		
		Day	Evening	Night	Day	Evening	Night
Stratford/Craven	Residential	37	36	35	50	45	40
	Vacant Land						
Other Rural	Rural Residential	35	35	35	50	45	40
	Rural Vacant Land						
Parkers Road	Industrial	Intrusive noise criteria not applicable			70	70	70
Any	School	Intrusive noise criteria not applicable			External 45 when in use		
Any	Church, Cemetery	Intrusive noise criteria not applicable			External 50 when in use		
Any	Active Recreation	Intrusive noise criteria not applicable			External 55 when in use		

Source: Appendix C.

Note: Daytime 7.00 am to 6.00 pm, Evening 6.00 pm to 10.00 pm, Night-time 10.00 pm to 7.00 am.

In subjective terms, exceedances of the INP project-specific assessment criteria can be generally described as follows (Appendix C):

- negligible noise level exceedance (less than 1 dBA) (not noticeable by all people);
- marginal noise level exceedance (between 1 and 2 dBA) (not noticeable by most people);
- moderate noise level exceedance (between 3 and 5 dBA) (not noticeable by some people but may be noticeable by others); and
- appreciable noise level exceedance (greater than 5 dBA) (noticeable by most people).

For the purposes of assessing potential noise impacts, exceedances can be separated into a Noise Management Zone (i.e. 1 to 5 dBA above the criteria) and a Noise Affectation Zone (i.e. greater than 5 dBA above the criteria).

Table 4-12 presents the methodology used for assessing operational noise against the INP project-specific noise assessment criteria.

Table 4-12
Project-specific Noise Level Assessment Methodology

Assessment Type	Project-specific Noise Level	Noise Management Zone		Noise Affectation Zone
		Marginal	Moderate	
Intrusive $L_{Aeq(15minute)}$	RBL plus 5 dBA	1 to 2 dBA above project-specific level	3 to 5 dBA above project-specific level	> 5 dBA above project-specific level

Source: Appendix C.

Operational Noise Modelling

An acoustic model was developed by SLR Consulting that simulates the Project components using noise source information (i.e. sound power levels and locations) and predicts noise levels at relevant receiver locations.

The model considers meteorological effects, surrounding terrain, distance from source to receiver and noise attenuation.

The locations of modelled receivers (i.e. dwellings), including where relevant multiple dwellings or a single landholding, are shown on Figures 1-3a and 1-3b.

Noise Modelling Scenarios

Three scenarios based on the progressive development of the Project were assessed:

- Project Year 2 (Figure 2-9) – Representative of initial mining at the Roseville West Pit Extension (daytime only), Avon North Open Cut and Stratford East Open Cut (24 hours subject to compliance with noise limits) (Table 4-13). Coincides with maximum DCM ROM coal handling, processing and transportation on-site and maximum product coal production. Includes placement of waste rock on the Northern Waste Emplacement Extension. Representative of northern-most operations during the Project.

- Project Year 7 (Figure 2-11) – Representative of production from the continuation of the Roseville West Pit Extension operation (daytime only), and the operation of the Stratford East Open Cut 24 hours a day. Includes placement of Stratford East waste rock on the maximum elevated area of the Stratford Waste Emplacement.
- Project Year 10 (Figure 2-12) – Includes maximum Project ROM coal and waste rock production rates. Representative of southern-most operations during the Project.

Assessment of Feasible and Reasonable Noise Mitigation Measures

SLR Consulting and SCPL conducted an investigation of feasible and reasonable noise mitigation measures for the Project, particularly in relation to night-time operations.

A number of iterative steps were undertaken to develop noise mitigation measures for the Project, including the four listed below:

1. Preliminary noise modelling of scenarios representative of the maximum noise emissions from the Project to identify the potential for noise exceedances.
2. Evaluation of primary noise sources and potential combinations of noise management and mitigation measures to reduce receptor noise levels.
3. Review of the effectiveness of these measures and assessment of their feasibility by SCPL.
4. Adoption by SCPL of management and mitigation measures to minimise noise emissions associated with the Project. These measures are detailed in Table 4-13.

Whilst other, more extensive noise mitigation measures may be technically possible, they are not considered by SCPL to be feasible and reasonable. For example, some elevated night-time noise levels could be avoided by restriction of mining at Avon North Open Cut and Stratford East Open Cut (in Years 6 to 11) to daytime only. However, these measures are not considered to be economically feasible by SCPL. Further discussion of the consideration of alternatives is provided in Section 6.9.2.

Assessment of Meteorological Conditions

In accordance with the INP, Appendix C assessed meteorological data collected at the Stratford Mining Complex to determine the prevailing meteorological conditions for noise modelling. These prevailing conditions generally have the effect of increasing noise levels at receivers relative to calm conditions.

Details of the analysis and the prevailing meteorological conditions modelled are provided in Appendix C. Section 4.2.1 provides a summary description of meteorology in the vicinity of the Project.

Table 4-13
Summary of Project Noise Mitigation Measures

Project Component	Mitigation Measure
Fixed Infrastructure	Implementation of XQ conveyor drives and idlers (e.g. CV01, CV04/05, CV22 and CV23).
Mobile Fleet	Implementation of XQ mobile fleet for all new large haul trucks and dozers. Implementation of management controls on dozers (e.g. restriction of gear usage to first gear only on product stockpiles [refer to Table 27 of Appendix C]).
Operational Hours	Daytime only operation of the Roseville West Pit Extension. Mining operations associated with the Stratford East Open Cut would be conducted 24 hours per day, subject to compliance with noise limits. Fleet associated with the removal of waste rock at the Stratford East Open Cut would generally operate daytime only during Years 1 to 5.
Waste Rock Emplacement	Emplacement of Avon North Open Cut waste rock in the Stratford Main Pit during evening and night-time. Maximising in-pit waste rock emplacement opportunities. Emplacement of out-of-pit waste rock behind acoustic bunding during the Stratford East Open Cut evening and night-time operations (i.e. when in-pit dumping opportunities are not available).
Haul Roads	Installation of approximately 8 km of 6 m high acoustic bunds.
Rail Loop	Installation of approximately 4 km of 6 m high acoustic bunds.

Source: After Appendix C.

Predicted Noise Emissions

In summary, the operational noise assessment indicates the following (Appendix C):

- during the daytime, operational noise would exceed the relevant criteria at two privately-owned receivers. However, both receivers are subject to an existing landholder agreement in relation to Project impacts/management;
- during evening and night-time periods, operational noise would comply with the relevant criteria at all privately-owned receivers during periods of calm meteorological conditions;
- during evening and night-time periods with adverse meteorological conditions, operational noise would exceed the relevant criteria at 16 privately-owned receivers; five of these receivers would be in the marginal noise management zone (1 to 2 dBA above the criteria), six would be in the moderate noise management zone (3 to 5 dBA above the criteria), while five receivers would be in the noise affectation zone (greater than 5 dBA above the criteria). Of these receivers, nine are subject to an existing landholder agreement in relation to Project impacts/management. A further three are identified in the existing SCM Development Consent (DA 23-98/99) as being in the Noise Management Zone.

Table 4-14 presents a summary of potential exceedances of intrusive operational noise criteria at private receivers during daytime, evening and night-time. Figure 4-16 individually identifies multiple dwellings within a single landholding (e.g. 15[2] and 15[3]) and Figure 1-3b identifies dwellings within Stratford and Craven (e.g. Cr.2).

Indicative noise contours for night-time operations under adverse meteorological conditions for Years 2, 7 and 10 are presented in Figures 4-16, 4-17 and 4-18, respectively.

Of the receivers listed in Table 4-14, 10 are in the existing SCM Development Consent (DA 23-98/99) noise affectation and management zones, of which seven are subject to a private landholder agreement in relation to Project impacts/management. A further four receivers in Table 4-14 are subject to an existing landholder agreement.

Table 4-15 presents a matrix that identifies each privately-owned receiver where operational noise or blasting exceedances are predicted, including potential intrusive noise exceedances.

Table 4-15 also shows receivers that are in the existing SCM Development Consent affectation zone or management zone or receivers that have a landholder agreement with SCPL. Detailed results are provided in Appendix C.

Table 4-14
Summary of Potential Operational Noise Exceedances at Private Receivers

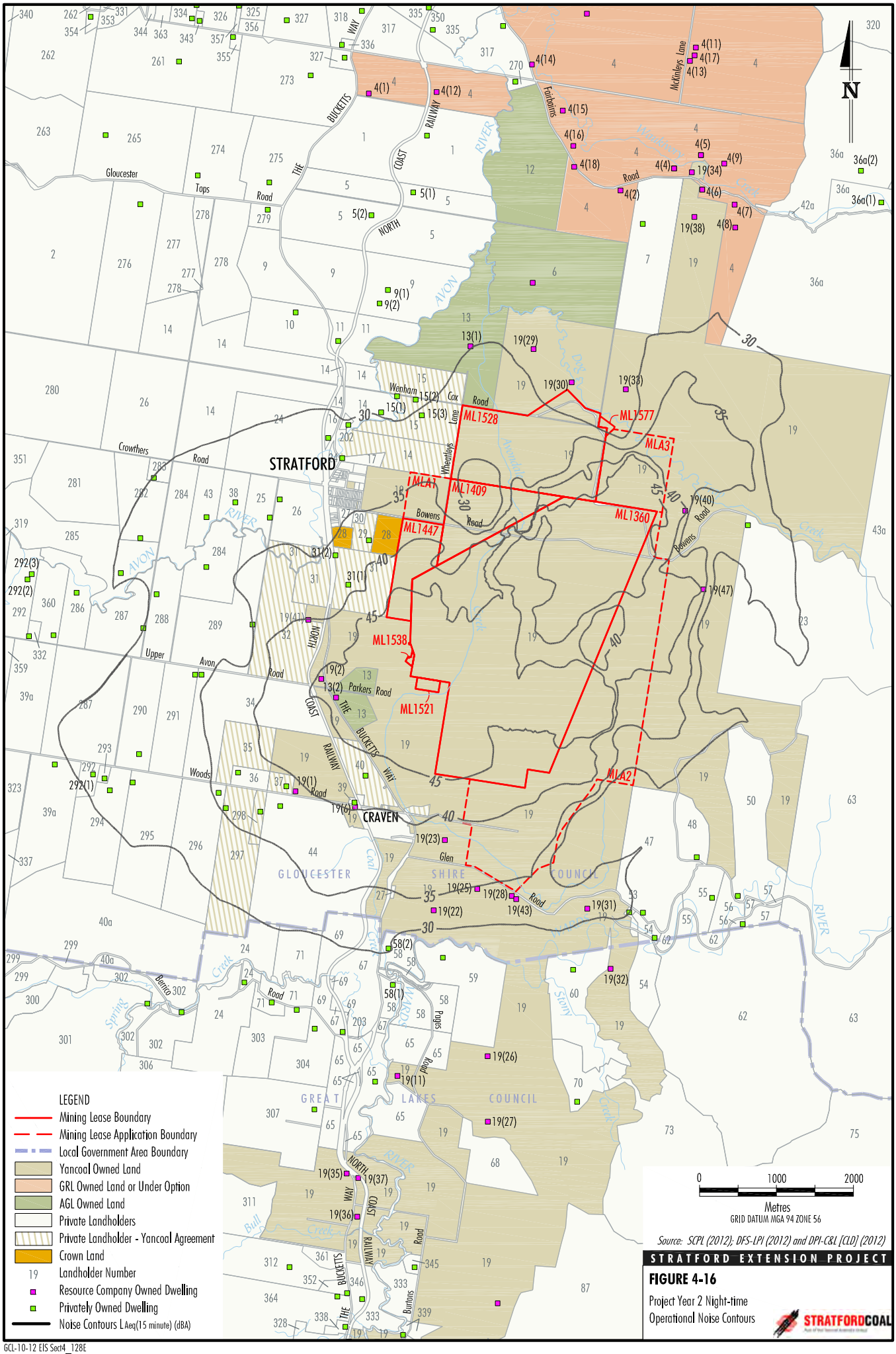
Period	Noise Management Zone		Noise Affection Zone
	Marginal 1 dBA to 2 dBA above Project-specific Noise Levels	**Moderate 3 dBA to 5 dBA above Project-specific Noise Levels**	**> 5 dBA above Project-specific Noise Levels**
Daytime	15(2)[3]	15(3)[3]	-
Evening	31(2)[1,3], 36[2], 37[3], 44, 60	29[1,3], 39[2], Cr.2[2,3], 31(1)[1,3], Cr.7[2]	42[2,3], 40[1,3]
Night-time	29[1,3], 23, 31(2)[1,3], 296, 297[3], 298[2,3]	36[2], 37[3], 44, 60, 31(1)[1,3]	39[2], 42[2,3], Cr.2[2,3], Cr.7[2], 40[1,3]

Source: Appendix C.

1 Receivers identified in the existing SCM Development Consent (DA 23-98/99) as being in the Noise Affectation Zone.

2 Receivers identified in the existing SCM Development Consent (DA 23-98/99) as being in the Noise Management Zone.

3 Receivers subject to an existing Landholder Agreement.



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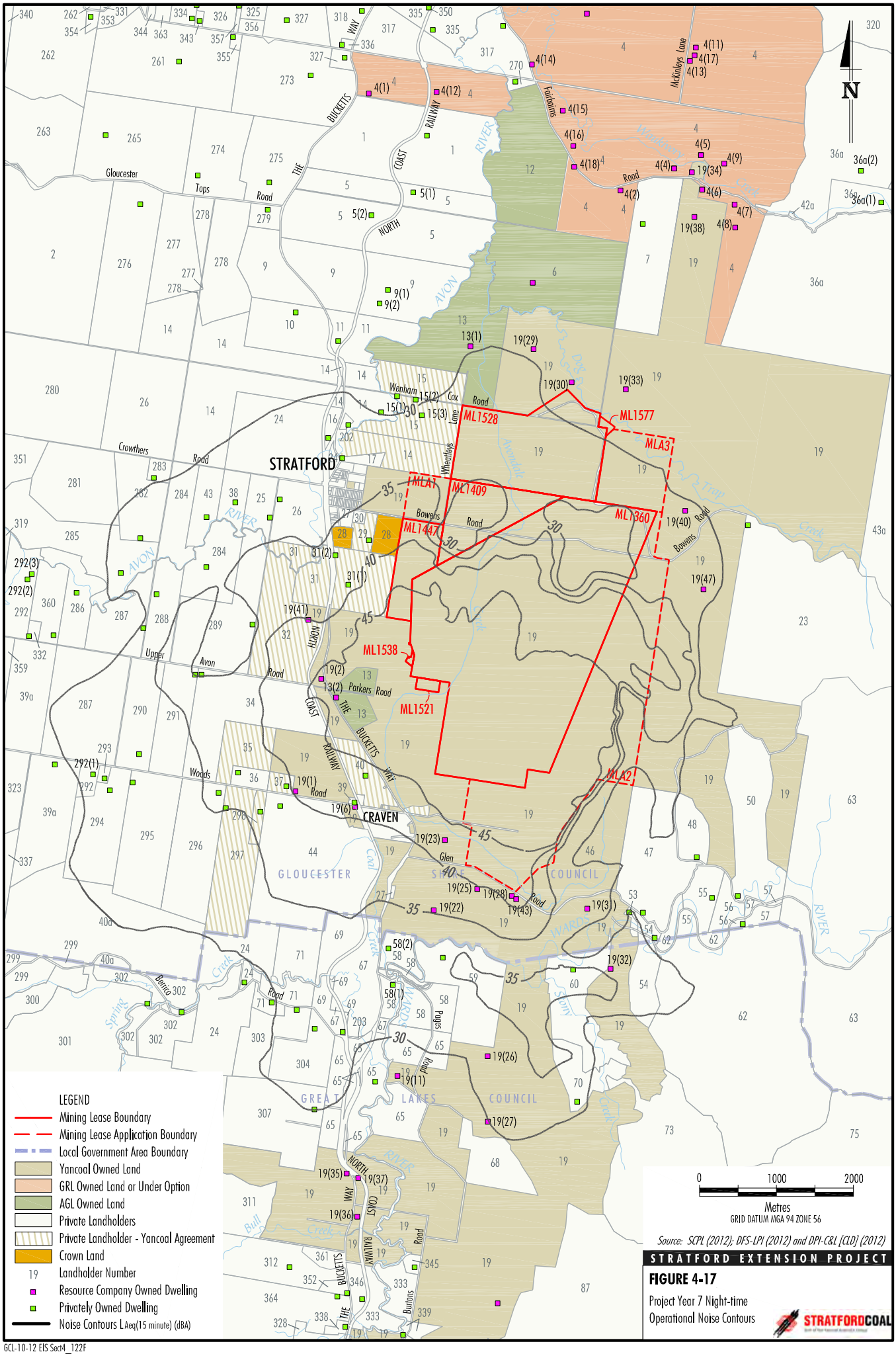

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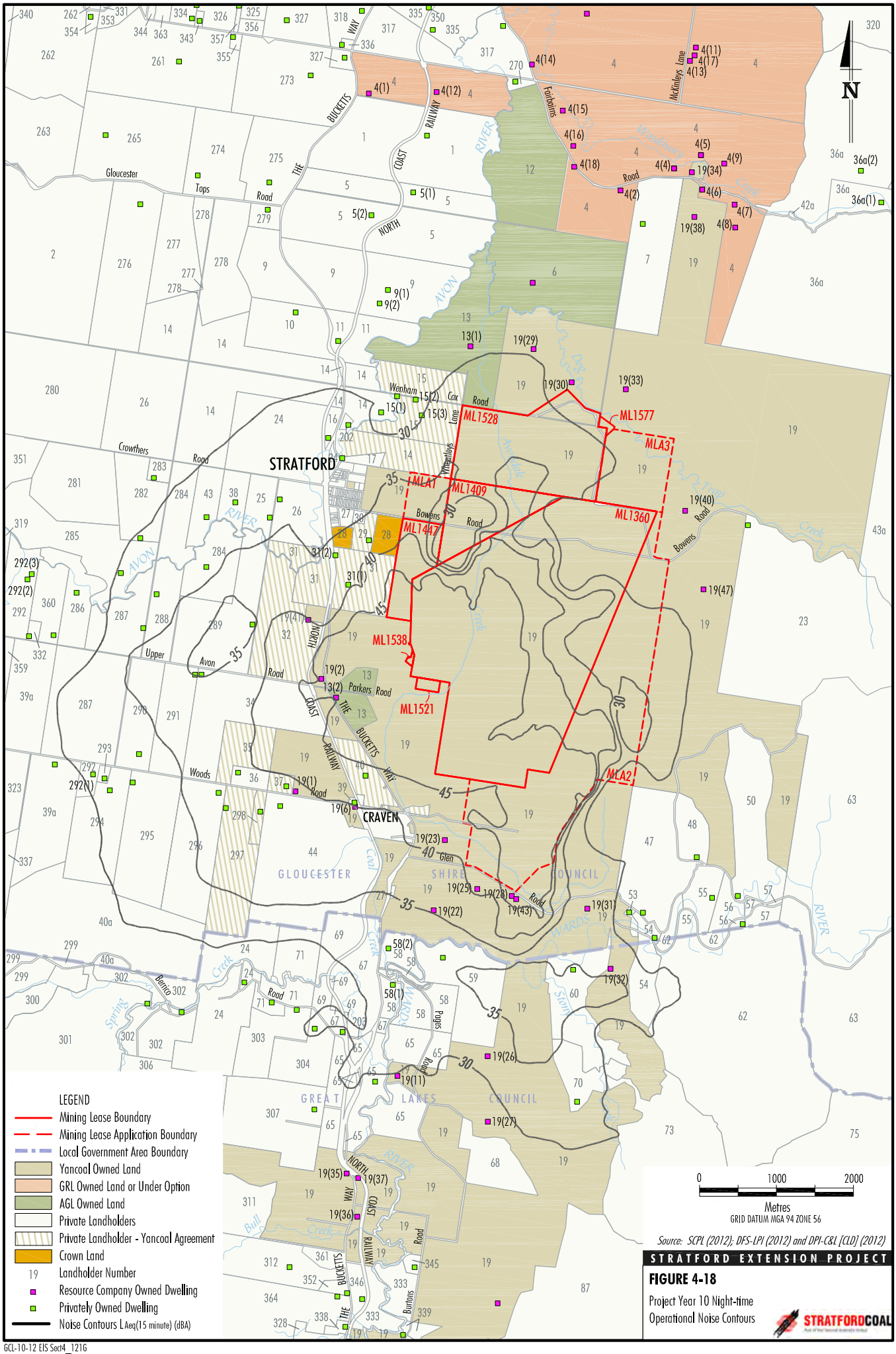

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Table 4-15
Summary of Private Receivers with Identified Potential Operational Noise and Blasting Exceedances of Relevant Criteria

Receiver Number	Owner	Operational Noise							Blasting	
		Intrusive Affectation Zone	Intrusive Management Zone (Moderate Exceedance)	Intrusive Management Zone (Marginal Exceedance)	Sleep Disturbance	Amenity Criteria (Project Only)	Amenity Criteria (Cumulative)	Vacant Land	Vibration/ Airblast Exceedance	Property Boundary within 500 m of Open Pit
39[2]	Standen	✓	-	-	✓	-	✓	-	-	-
40[1,3]	L. Blanch	✓	-	-	✓	✓	✓	-	-	-
42[2,3]	D. Blanch	✓	-	-	✓	✓	✓	-	-	-
Cr.2[2,3]	Boorer	✓	-	-	✓	-	✓	-	-	-
Cr.7[2]	Pryce-Jones	✓	-	-	✓	✓	✓	-	-	-
29[1,3]	Ward	-	✓	-	-	-	-	-	✓	-
31 (1)[1,3]	Isaac	-	✓	-	✓	-	-	-	-	✓
36[2]	Wallace	-	✓	-	✓	-	-	-	-	-
37[3]	Worth	-	✓	-	✓	-	-	-	-	-
44	Cross/Jane	-	✓	-	✓	-	-	-	-	-
60	Greenwood	-	✓	-	-	-	-	-	-	-
15 (3)[3]	Falla	-	✓	-	-	-	-	-	✓	✓
15 (2)[3]	Falla	-	-	✓	-	-	-	-	✓	✓
23	R. Bagnall	-	-	✓	-	-	-	-	-	-
31 (2)[1,3]	Isaac	-	-	✓	-	-	-	-	-	✓
296	Watson	-	-	✓	-	-	-	-	-	-
298[2,3]	Yates	-	-	✓	-	-	-	-	-	-
297[3]	Bosma	-	-	✓	-	-	-	-	-	-
Cr.1[1,3]	Wood	✓	-	-	-	-	-	✓	-	-
51	Gloucester Printing	✓	-	-	-	-	-	✓	-	-
35[3]	Dillon	✓	-	-	-	-	-	✓	-	-
32[1,3]	McIntosh	✓	-	-	-	-	-	✓	-	-
14[3]	Wenham	-	-	-	-	-	-	-	-	✓

Source: Appendix C.

[1] Properties identified in the existing SCM Development Consent (DA 23-98/99) as being in the Noise Affectation Zone.

[2] Properties identified in the existing SCM Development Consent (DA 23-98/99) as being in the Noise Management Zone.

[3] Properties subject to an existing Landholder Agreement.

Vacant Land Assessment

SLR Consulting (2012) also reviewed potential intrusive noise impacts on private vacant land and concluded that greater than 25% of vacant land on four properties is predicted to be affected by Project noise in excess of 40 dBA $L_{Aeq,15\ minute}$ (Appendix C). Of these, three properties are subject to an existing landholder agreement with SCPL.

Other Land Uses

Other (non-residential) land uses were assessed by SLR Consulting in accordance with the INP. No exceedances of the relevant INP amenity criteria were predicted (Appendix C).

Project-only Noise Amenity Assessment

Assessment of Project-only noise emissions against applicable INP amenity criteria is provided in Appendix C.

Exceedances of the amenity criteria due to the Project only are also presented in Table 4-15.

Cumulative Noise Emissions

Existing and proposed coal mining and processing operations as well as CSG development in the vicinity of the Stratford Mining Complex that may potentially be sources of cumulative noise emissions include:

- the AGL Gloucester Gas Project;
- the proposed Rocky Hill Coal Project; and
- the existing DCM.

Cumulative noise impacts resulting from the concurrent operation of the Project and developments listed above were assessed against the INP amenity criteria.

The methodology used for cumulative assessment was to logarithmically sum the respective noise predictions for the Project, DCM, AGL Gloucester Gas Project and proposed Rocky Hill Coal Project, and compare the results for each receiver against the INP amenity criteria.

For this assessment, SLR Consulting used noise level predictions from the AGL Gloucester Gas Project Environmental Assessment (AECOM, 2009), from noise performance commitments in the Rocky Hill Coal Project Request for DGRs (GRL, 2012) and from the Duralie Extension Project Environmental Assessment (DCPL, 2010).

This assessment focused on evening and night-time noise levels. This was because Project noise levels are predicted to be most pronounced in these periods (Appendix C).

No cumulative exceedance of the recommended acceptable amenity criterion (45 dBA) was predicted during the evening period.

The assessment also indicated that cumulative noise levels resulting from the concurrent operation of the Project, DCM, AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project would not exceed the night-time recommended maximum amenity criterion (45 dBA) at any receiver and would exceed the night-time recommended acceptable amenity criterion (40 dBA) at five privately-owned receivers (Appendix C).

Cumulative exceedances of the amenity criteria at privately-owned receivers are identified in Table 4-15.

It is relevant to note that all of the receivers with predicted cumulative amenity criteria exceedances also fall within the Project operational (intrusive) noise affectation zone (Table 4-15). Therefore, these receivers would be offered:

- reasonable and feasible acoustical mitigation at the receiver; or
- negotiated agreements.

No cumulative amenity criteria exceedances at non-residential land uses were predicted (Appendix C).

Sleep Disturbance

Appendix C also presents an assessment of potential sleep disturbance impacts. A sleep disturbance criterion of $L_{A1(1minute)}$ 45 dBA has been adopted by the EPA. The sleep disturbance criteria are not considered by the EPA to be ideal, because the research into disturbance of sleep due to extraneous noise sources remains inconclusive (Appendix C). More recent research by the OEH in the RNP (DECCW, 2011), indicates that sleep awakening reactions are likely to occur at higher noise levels than the criteria adopted by the EPA (Appendix C).

Predicted sleep disturbance exceedances at privately owned receivers of the relevant criteria are presented in Table 4-15. Detailed results are provided in Appendix C.

It is relevant to note that all of the receivers with predicted sleep disturbance criteria exceedances also fall within the operational (intrusive) noise affectation zone or are in the moderate (3 to 5 dBA exceedance) management zone (Table 4-15). Therefore, all of these receivers would be offered:

- reasonable and feasible acoustical mitigation at the receivers; or
- negotiated agreements.

Construction Noise

Appendix C presents an assessment of the potential for noise impacts from daytime construction of realignments of Wenham Cox/Bowens Roads and Wheatleys Lane and Bowens Road in accordance with the *Interim Construction Noise Guideline* (DECC, 2009) (Appendix C).

This assessment indicated that no receiver would exceed the construction noise criteria.

Road Traffic Noise

Road Noise Criteria

Road traffic noise along public roads was been assessed by SLR Consulting in accordance with the RNP, which establishes criteria for the assessment of road noise in NSW (Appendix C). The total traffic noise and relative increase criteria are provided in Table 4-16.

In relation to situations where exceedances of the road traffic noise assessment criteria are predicted, the RNP states that an increase of up to 2 dB is considered under the RNP to be barely perceptible (DECCW, 2011).

Predicted Road Noise Emissions

The following sections of road were assessed for road traffic noise (Appendix C):

- The Bucketts Way north of the SCM access road; and
- The Bucketts Way south of the SCM access road.

The methodology for assessment was to:

- calculate existing traffic road noise levels;
- calculate road noise levels in Project Years 1 and 11 corresponding to Project and cumulative (i.e. baseline, AGL Gloucester Gas Project and proposed Rocky Hill Coal Project) traffic movements; and
- compare these noise levels with the relevant RNP criteria.

On The Bucketts Way (north of the SCM access) in Year 1 the relative daytime increase in traffic flow due to the Project would be approximately 6%. This increase corresponded to a negligible 0.2 decibel (dB) increase in the existing daytime $L_{Aeq(15hour)}$ traffic noise levels (Appendix C).

On The Bucketts Way (north of the SCM access) in Year 1, the relative night-time increase in traffic flow due to the Project would be approximately 37%. This increase corresponded to a marginal 1.4 dB increase in the existing night-time $L_{Aeq(9hour)}$ traffic noise levels (Appendix C).

In both cases the relative increase in traffic noise due to the Project would be less than 12 dBA (Table 4-16). Furthermore, the relative increase was less than 2 dBA and in accordance with the RNP would represent a minor impact that is considered barely perceptible (Appendix C). The relative increase in traffic flow on The Bucketts Way south of the SCM access is less than the relative increase north of the SCM access (Appendix C).

Rail Noise

The existing/approved average product coal rail movements of 2.5 trains per day would be unchanged for the Project. However, peak product coal rail movements would increase from 5 to 6 trains per day (Section 2.9).

Project product coal would be transported via rail from the SCM rail loop to Newcastle (Section 2.9). Consequently, a rail noise assessment was undertaken for the North Coast Railway (Appendix C).

Table 4-16
Road Noise Policy Criteria for Residential Land Uses (dBA)

Road	Type of Project and Land Use	Total Traffic Noise Criteria	Relative Increase Criteria
The Bucketts Way	Land use developments generating additional traffic on existing sub-arterial roads.	Daytime 60 $L_{Aeq(15hour)}$	Existing $L_{Aeq(15hour)}$ plus 12 dBA
		Night-time 55 $L_{Aeq(9hour)}$	Existing $L_{Aeq(9hour)}$ plus 12 dBA

Source: Appendix C.

Note: Daytime 7.00 am to 10.00 pm, Night-time 10.00 pm to 7.00 am.

Rail Noise Criteria

The EPA's rail noise assessment trigger levels (EPA, 2012a) are presented in Table 4-17. An assessment of rail noise impacts against the ARTC's EPL noise goals and a recently released draft EPA guideline (i.e. *Rail Infrastructure Noise Guideline* [EPA, 2012b]) is presented in Appendix C.

Table 4-17
EPA Guideline Railway Noise Assessment Trigger Levels

Descriptor	Rail Traffic Goal
$L_{Aeq,24\ hour}$	60 dBA
Maximum Pass-by L_{Amax} (95^{th} percentile)	85 dBA
Project related rail noise increase	> 0.5 dBA

Source: Appendix C.

Predicted Rail Noise Emissions

A rail noise assessment was conducted in accordance with EPA requirements for rail traffic-generating development (EPA, 2012a). The rail noise assessment focuses on the North Coast Railway between the SCM and the DCM (Appendix C).

A rail traffic noise survey was conducted by SLR Consulting in May 2011 to quantify the near-field rail traffic noise at Craven Station adjacent to the North Coast Railway. A follow-up rail noise survey was also conducted in March 2012. The findings of these two surveys are summarised in Appendix C.

Using data on existing, approved and proposed train movements, SLR Consulting modelled cumulative train movements and the distance from the rail line at which EPA trigger levels would be exceeded using predicted energy average L_{Aeq} and sound exposure level noise levels from the RailCorp NSW standard rail noise database for passenger trains, locomotives and freight wagons. Cumulative trains from the Project, DCM shuttle, freight and passenger trains were assessed.

In summary, the results of this assessment are listed below:

- A comparison of the cumulative $L_{Aeq(24hour)}$ rail noise in the absence of the Project with the cumulative rail noise with the Project indicates that the 24 hour rail noise would increase by up to 0.6 dBA as a result of the Project.
- The $L_{Aeq(24hour)}$ rail noise 60 dBA trigger level would be met in the absence of the Project at a distance of 58 m and greater. Nine receivers currently exceed the 60 dBA trigger level as a result of cumulative rail movements in the absence of the Project.
- The $L_{Aeq(24hour)}$ rail noise 60 dBA trigger level would be met with the Project at a distance of 67 m and greater. Nine additional receivers are predicted to exceed the 60 dBA trigger level as a result of the Project rail movements.

The L_{Amax} passby noise levels would not change due to the Project (Appendix C).

The EPA guideline indicates that where the cumulative noise level exceeds the noise assessment trigger levels and Project-related noise increases of greater 0.5 dBA are predicted, then all feasible and reasonable noise mitigation measures should be implemented.

In all cases where the L_{Aeq} noise level increases are more than 2 dBA, strong justification should be provided as to why it is not feasible or reasonable to reduce the increase (EPA, 2012a).

The average Project-related rail noise level increase is 0.2 dBA (therefore less than 0.5 dBA) and the peak Project-related rail noise level increase is 0.6 dBA (therefore slightly greater than 0.5 dBA). This noise level increase would not be perceptible to most people (Appendix C). It was concluded by SLR Consulting that the assessment of "all of feasible and reasonable noise mitigation measures" is not warranted to achieve a negligible 0.6 dBA noise reduction for the Project. Notwithstanding, Project rail noise monitoring measures are described in Section 4.6.3.

SLR Consulting also separately assessed a scenario with additional proposed Rocky Hill Coal Project trains (Appendix C).

Blasting

Blasting Measurement and Description

Overpressure (or airblast) is reported in linear decibels (dBL) and is the measurable effect of a blast on air pressure, including generated energy that is below the limit of human hearing. Ground vibration is the measurable movement of the ground surface caused by a blast and is measured in mm/s as Peak Vector Sum (PVS) vibration velocity.

Discernible blast emission effects can be divided into the three categories listed below:

1. Occupants of a building can be inconvenienced or disturbed (i.e. temporary amenity effects).
2. Contents of a building can be affected.
3. Integrity of a building structure can be affected.

An individual's response to blasting vibration and overpressure is highly dependent on previous experience and expectations.

Blasting Criteria

Ground vibration and airblast levels which cause human discomfort are generally lower than the recommended structural damage limits. Therefore, compliance with the lowest applicable human comfort criteria generally means that the potential to cause structural damage to buildings is minimal.

The EPA adopts the ANZEC (1990) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* for assessing potential annoyance from blast emissions during daytime hours, as listed below (Appendix C):

- The recommended maximum level for airblast is 115 dBL.
- The level of 115 dBL may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120 dBL at any time.
- The recommended maximum for ground vibration is 5 mm/s, PVS vibration velocity.
- The PVS level of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10 mm/s at any time.

AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* provides guidance in assessing blast-induced ground (and structural) vibration and airblast effects on buildings and their occupants. In relation to building damage airblast criteria, AS 2187.1 recommends a maximum airblast of 133 dB (peak linear [pkLinear]). In accordance with AS 2187.1, SLR Consulting also adopted 12.5 mm/s as the building damage vibration criterion.

Predicted Blasting Emissions

SCPL would vary the maximum instantaneous charge (MIC) (or other relevant blasting parameters) of blasts over the life of the Project according to the location of the blast and the proximity of nearby private receivers, to minimise blasting effects at nearby receivers. MICs for the Project would range from 680 kilograms (kg) to 1,500 kg for Stratford East and Avon North Open Cuts, and would be limited to 400 kg for the Roseville West Pit Extension and BRNOC.

Appendix C predicts that exceedance of the vibration and/or airblast amenity criteria would occur at three private receivers (Table 4-15). However, these receivers are subject to an existing landholder agreement with SCPL.

No exceedance of the structural damage criteria is predicted for the Project. Detailed blasting results are provided in Appendix C.

Flyrock

Flyrock is any material ejected from the blast site by the force of the blast. Flyrock is managed by appropriate blast design and execution in accordance with the Blast Management Plan.

Operational experience indicates that the majority of blasts result in either no flyrock or limited flyrock less than 50 m from the blast. Occasional anomalous blast events have resulted in flyrock being recorded around 100 m to 150 m from blasts (Appendix C).

4.6.3 Mitigation Measures, Management and Monitoring

Noise and blasting mitigation and management measures for the existing Stratford Mining Complex are described in the Noise Management Plan and the Blasting/Vibration Management Plan (Section 4.6.1). These plans would be reviewed and updated to address the Project, subject to the conditions of any Development Consent for the Project.

Operational Noise Mitigation Measures

As described in Section 4.6.2, the private receivers where intrusive noise emissions are predicted to exceed the project-specific criteria can be divided into a Noise Management Zone and a Noise Affectation Zone (Table 4-12). Proposed management procedures for receivers in these zones are described below.

Noise Management Zone

Depending on the degree of exceedance of the project-specific noise levels, potential noise impacts in the Noise Management Zone could range from marginal to moderate (in terms of the perceived noise level increase).

In addition to the noise mitigation measures included in the predictive modelling, noise management procedures would include:

- noise monitoring on-site (i.e. measurement of machinery and plant sound power levels) and within the vicinity of the Stratford Mining Complex, including real-time monitoring;
- prompt response to any community concerns or complaints;
- refinement of on-site noise mitigation measures and operating procedures where practicable; and
- implementation of reasonable and feasible acoustical mitigation at receivers (which may include measures such as enhanced glazing, insulation and/or air conditioning), in consultation with the relevant landowner, where noise monitoring shows noise levels which are 3 to 5 dBA above project-specific noise levels.

The above procedures would continue to be documented in the Noise Management Plan and would form part of the adaptive management approach to Project noise management that would include real-time noise monitoring and meteorological forecasting.

Noise Affectation Zone

Exposure to noise levels greater than 5 dBA above project-specific criteria may be considered unacceptable by some landowners. Management procedures for the Noise Affectation Zone would include:

- discussions with relevant landowners to identify and assess any concerns or complaints;
- implementation of reasonable and feasible acoustical mitigation at receivers (which may include measures such as enhanced glazing, insulation and/or air conditioning), in consultation with the relevant landowner, where noise monitoring shows noise levels from the mine which are greater than 5 dBA above project-specific noise levels; and
- negotiated agreements with landowners where required.

The above procedures would continue to be documented in the Noise Management Plan and would form part of the adaptive management approach to Project noise management that would include real-time noise monitoring and meteorological forecasting.

Sleep Disturbance

As noted in Section 4.6.2, all privately-owned receivers where sleep disturbance criteria exceedances are predicted would be in the noise management zone or affectation zone. Therefore, these receivers would be afforded the operational noise mitigation measures described above.

Rail Noise

In accordance with the existing SCM Development Consent (as a component of renegotiation of relevant rail contracts), SCPL would continue to require the provision of product train locomotives that are approved to operate on the NSW rail network in accordance with the ARTC EPL 3142.

Quarterly monitoring would be conducted along the North Coast Railway to verify the ongoing noise performance of the product coal trains over the life of the Project.

Noise Management Plan

The Noise Management Plan would, as relevant, be revised for the Project to include the following list of additional components:

- The Project feasible and reasonable noise mitigation and operational management measures (Section 4.6.3).
- Inclusion of an additional real-time noise monitor in the vicinity of Stratford to augment the existing real-time monitoring and management system.
- Details of revised triggers for the Project real-time monitoring and management system. As described in Section 4.6.3 and the Noise Management Plan, this would include trigger-based protocols incorporating review of prevailing weather conditions, identification of on-site noise sources responsible for elevated noise levels and shut-down or adjustment of relevant noise sources, where necessary, to achieve the relevant noise criteria.

- Details of a predictive meteorological forecasting system which would be used as part of a proactive management system and would work in conjunction with the real-time monitoring and management system. The predictive system would provide an alert for the appropriate personnel to review and manage the intensity of upcoming activities for the ensuing day as may be required.
- Details of quarterly rail noise monitoring at two locations (Craven and Wards River), including unattended monitoring and attended monitoring. The rail noise monitoring would be used to verify the ongoing noise performance of the product coal train over the life of the Project.

Blasting/Vibration Management Plan

The existing Blasting/Vibration Management Plan would, as relevant, be revised for the Project to include the following list of additional components:

- Development and ongoing review of "site laws" (i.e. site based prediction equations) for ground vibration and airblast.
- Safety control measures and notification/closure procedures in relation to blasting within 500 m of Bowens Road, Wenham Cox Road, Wheatleys Lane and Glen Road (including providing 24 hours notice of blast-related closures to relevant residences located on these roads).
- Management of potential flyrock impacts at the following privately-owned properties during blast events within 500 m of the property boundary:
  - 31 (Isaac)[3];
  - 15 (Falla)[3]; and
  - 14 (Wenham)[3].
- A commitment to notify the occupants of residences within 2 km of Project blasting activities that they are entitled to a structural inspection by a suitably qualified, experienced and independent person.
- Extension of the blast notification list to include any new landowners within 2 km of Project blasting areas, including properties within 2 km that do not have residences within 2 km.
- Safety control measures and notification procedures for property managers regarding livestock in proximity to blasting activities.
- Additional blast monitoring locations (e.g. CTS-1 – Section 4.12.3).

Blast management measures that relate to blasting fumes are provided in Section 4.7.3.

4.7 AIR QUALITY

An Air Quality and Greenhouse Gas Assessment for the Project was undertaken by PAEHolmes (2012a) and is presented as Appendix D. The assessment was conducted in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) (DEC, 2005c). The assessment was peer reviewed by Dr Nigel Holmes and the review report is presented in Attachment 3.

A description of the existing environment relating to air quality and Stratford Mining Complex air quality management and monitoring is provided in Section 4.7.1. Section 4.7.2 describes the potential air quality impacts of the Project, including cumulative impacts, and Section 4.7.3 outlines Project air quality mitigation measures, management and monitoring.

Project greenhouse gas emissions are discussed in Section 4.8.

4.7.1 Existing Environment

Air Quality Management Regime

Air quality mitigation and management measures currently employed at the Stratford Mining Complex are described in the AQGHGMP (SCPL, 2011b). The AQGHGMP includes management and mitigation measures, air quality monitoring requirements and a complaints response protocol. Existing key air quality management and mitigation measures are provided in Table 4-18.

Thirteen complaints relating to dust or air quality have been received at the Stratford Mining Complex since 2003. An annual breakdown of complaints received is provided in Appendix D.

[3] Property subject to an existing landholder agreement.

Table 4-18
Existing Stratford Mining Complex Air Quality Mitigation and Management Measures

Emission Type	Activity	Management Measure
Wind Blown Particulate Matter Sources	Areas disturbed by mining	• Only the minimum area necessary for mining is disturbed. • Exposed areas are reshaped, topsoiled and revegetated as soon as practicable.
	Waste rock emplacement areas	• Exposed waste emplacement surfaces that are trafficked are watered to suppress dust. • Progressive rehabilitation (i.e. reshaping, topsoil placement and revegetation) of waste emplacement areas continues throughout the life of the Stratford Mining Complex.
	Coal handling areas	• Coal-handling areas are kept in a moist state using water carts to minimise wind blown and traffic generated dust.
	Coal stockpiles	• Automatic sprinklers are installed in the existing Stratford Mining Complex product coal stockpile area and are activated when wind speeds exceed 5 m/s, except during rain events.
Mining Generated Particulate Matter Sources	Haul road dust	• All roads and trafficked areas are watered using water carts to minimise the generation of dust. • Obsolete roads are ripped and revegetated.
	Minor roads	• Development of minor roads are limited and the locations of these are clearly defined. • Regularly used minor roads are watered. • Obsolete roads are ripped and revegetated.
	Topsoil stripping	• Access tracks used for topsoil stripping during the loading and unloading cycle are watered.
	Topsoil stockpiling	• Long-term topsoil stockpiles are revegetated with a cover crop.
	Drilling	• Dust aprons are lowered during drilling. • Water injection or dust suppression sprays are used when high levels of dust are being generated.
	Blasting	• Fine material collected during drilling is not used for blast stemming. • Adequate stemming is used at all times. • Blasting only occurs following an assessment of weather conditions by the Environmental Officer to ensure that wind speed and direction will not result in excess dust emissions from the site towards adjacent residences (refer to the Blasting/Vibration Management Plan for further information). No blasting occurs at the Stratford Mining Complex when wind speeds exceed 5 m/s in a direction that would be likely to carry dust to a nearby receiver.

Source: SCPL (2011b).

Air Quality Criteria

Concentrations of Suspended Particulate Matter

The Project mining activities described in Section 2 have the potential to generate particulate matter (i.e. dust) emissions in the form of:

- TSP;
- particulate matter with an equivalent aerodynamic diameter of 10 micrometres (μm) or less (PM_{10}) (a subset of TSP); and
- particulate matter with an equivalent aerodynamic diameter of 2.5 μm or less (PM2.5) (a subset of TSP and PM10).

Exposure to suspended particulate matter can result in adverse health impacts. The likely risk of these impacts to a person depends on a range of factors including the size, chemical composition and concentration of the particulate matter, and the existing health of the person (NSW Health and NSW Minerals Council, 2011).

The OEH assessment criteria are generally based on thresholds relating to human health effects. These criteria have been developed to a large extent in urban areas, where the primary pollutants are the products of combustion, which are more harmful to human health than particulates of crustal origin, such as particulate matter from mining operations (Appendix D).

Relevant health based air quality criteria (i.e. criteria set at levels to reduce the risk of adverse health effects) for PM_{10} and TSP concentrations, as specified by the OEH in the Approved Methods (DEC, 2005c), are provided in Table 4-19.

The EPA does not have specific criteria for $PM_{2.5}$. In the absence of EPA criteria, Table 4-19 also contains $PM_{2.5}$ criteria that are based on the Ambient Air National Environmental Protection Measure (NEPM) (National Environment Protection Council, 2003) reporting standard.

Table 4-19
Criteria for Particulate Matter Concentrations

Pollutant	Averaging Period	Criteria ($\mu g/m^3$)
TSP	Annual mean	90
PM_{10}	24-hour maximum[1]	50
	Annual mean	30
$PM_{2.5}$	24-hour maximum	25
	Annual mean	8

Source: Appendix D.

$\mu g/m^3$ = micrograms per cubic metre.

[1] The 50 $\mu g/m^3$ 24-hour maximum PM_{10} criteria are cumulative (i.e. include background concentrations but exclude regional dust events such as bushfires) in the SCM and BRNOC Development Consents (DA-23-98/99 and DA 39-02-01), however property acquisition criteria in the Development Consent are specifically Project-only.

Dust Deposition

Particulate matter has the potential to cause nuisance (amenity) effects when it is deposited on surfaces.

The amenity criteria for the maximum increase in dust deposition and maximum total dust deposition, as specified by the OEH in the Approved Methods (DEC, 2005c) are provided in Table 4-20.

Table 4-20
Criteria for Dust Deposition (Insoluble Solids)

Pollutant	Averaging Period	Maximum Increase in Deposited Dust Level (g/m^2/month)	Maximum Total Deposited Dust Level (g/m^2/month)
Deposited dust	Annual	2	4

Source: Appendix D.

g/m^2/month = grams per square metre per month.

Existing Air Quality

PM_{10} and dust deposition data are collected at the Stratford Mining Complex. In addition, data collected for the proposed Rocky Hill Coal Project were also reviewed by PAEHolmes for comparative reference. A summary of monitoring results is provided below.

PM_{10}

Long-term PM_{10} monitoring data have been collected by SCPL at five locations (Figure 4-15) using high volume air samplers (HVASs). The monitoring captures particulate matter from sources including current mining operations, other localised particulate matter sources (e.g. vehicles using unsealed roads, stock movements, cropping and other exposed areas) and regional particulate matter sources (e.g. bushfires and dust storms).

Recorded annual average PM_{10} concentrations in the period 2001 to 2011 are provided in Table 4-21.

PM_{10} monitoring results show that since monitoring commenced in 2001, there have been no exceedances of the EPA annual average criterion of 30 $\mu g/m^3$. The average across all sites for the monitoring period is 11 $\mu g/m^3$ (Appendix D).

Monitoring data collected at the Stratford Mining Complex HVASs indicate that there have been 15 elevated recordings above the EPA 24-hour average criterion of 50 $\mu g/m^3$ across all sites over the period of record (Appendix D).

A more detailed review shows that the worst-case 24-hour PM_{10} concentrations are strongly influenced by regional-scale phenomena, such as bushfires and dust storms (Appendix D).

In addition, PM_{10} monitoring data recorded at the proposed Rocky Hill Coal Project (Figure 4-15) were also reviewed by PAEHolmes. Data from two HVAS sites were reviewed for the period July 2010 to November 2011, with the average over both sites being 8.5 $\mu g/m^3$ (Appendix D).

$PM_{2.5}$

No $PM_{2.5}$ concentration data are available in the vicinity of the Project. Co-located monitors for PM_{10} and $PM_{2.5}$ are operated by the EPA at a number of locations in the Hunter Valley. From the data collected in the Hunter Valley, approximately 40% of the PM_{10} is $PM_{2.5}$ (Appendix D). This relationship has been used to determine estimated $PM_{2.5}$ levels for this assessment.

Table 4-21
Annual average PM_{10} Concentrations ($\mu g/m^3$)

Period	HVD1	HVD2	HVD3	HVD4	HVD5
July 2001 - June 2002	8	11	ND	ND	ND
July 2002 - June 2003	14	16	11	9	ND
July 2003 - June 2004	11	11	15	12	ND
July 2004 - June 2005	11	11	13	10	ND
July 2005 - June 2006	10	9	14	7	ND
July 2006 - June 2007	10	10	14	8	ND
July 2007 - June 2008	8	8	11	7	ND
July 2008 - June 2009	14	15	15	10	15
July 2009 - June 2010	13	13	16	12	12
July 2010 - June 2011	8	9	9	8	8
July 2011 - September 2011	7	10	10	7	7
Average	**10**	**11**	**13**	**9**	**11**
Average across all sites					**11**

Source: Appendix D.
ND = No Data Record.

TSP

There are no TSP data collected in the vicinity of the Project. Studies indicate that in regions of mining activity, approximately 40% of the TSP is PM_{10} (Appendix D). This relationship has been used to determine estimated TSP levels for this assessment.

Dust Deposition

The Stratford Mining Complex dust deposition monitoring network consists of seven dust deposition gauges (Figure 4-15). A summary of the dust deposition data collected from the gauges between 2001 and 2011 is provided in Table 4-22.

Since July 2001 there have been three occasions (at monitoring site D10) when the measured dust deposition levels were higher than the EPA criterion of 4 g/m^2/month. Notes accompanying the recorded data indicate significant contamination was likely at this site during these measurement periods (Appendix D). The average across all sites for the last 10 years is 1 g/m^2/month (Appendix D).

Dust deposition data from the seven dust gauges for proposed Rocky Hill Coal Project were also reviewed for the period July 2010 to November 2011 by PAEHolmes, with the average being 0.8 g/m^2/month (Appendix D).

Table 4-22
Annual Average Dust Deposition (Insoluble Solids) Levels (g/m^2/month)

Period	D5	D6	D7	D8	D9	D10	D11
July 2001 - June 2002	0.5	0.8	0.6	3.3	1.5	4.7	ND
July 2002 - June 2003	1.6	1.0	1.2	1.5	2.1	5.2	0.9
July 2003 - June 2004	0.6	0.7	0.7	1.1	1.4	7.4	1.2
July 2004 - June 2005	0.6	0.7	0.6	0.7	0.7	1.7	1.0
July 2005 - June 2006	0.6	0.5	1.4	0.6	0.6	0.4	1.2
July 2006 - June 2007	0.5	0.5	1.5	0.9	0.6	0.5	1.1
July 2007 - June 2008	0.5	0.5	0.5	0.4	0.6	0.5	0.6
July 2008 - June 2009	0.5	0.5	0.9	0.6	0.4	0.6	0.7
July 2009 - June 2010	0.9	0.6	1.5	0.6	0.5	0.5	0.7
July 2010 - June 2011	0.7	0.7	0.9	0.7	1.0	0.8	0.8
July 2011 - September 2011	0.3	0.8	0.8	0.6	0.6	0.3	0.6
Average	**0.7**	**0.7**	**1.0**	**1.0**	**0.9**	**2.0**	**0.9**
Average across all sites							**1.0**

Source: Appendix D.
ND = No Data Record.

Background Air Quality for Assessment Purposes

The assessment of Project and cumulative annual average air quality impacts requires background particulate matter concentrations and dust deposition levels to be defined and added to dispersion modelling results for Project emissions. The proximity of local dust gauges and HVASs to the existing mining operations means that the recorded air quality data includes particulate and dust contributions from the existing Stratford Mining Complex (Appendix D).

Use of these data therefore has the potential to result in double-counting of Project-related emissions. Therefore, background PM_{10} concentrations excluding contributions from the Stratford Mining Complex have been estimated to reduce the potential for double counting by analysing:

- modelling of existing mining operations and comparing the result with contemporaneous PM_{10} data in order to estimate mine contributions; and
- data recorded at HVASs in the vicinity of the proposed Rocky Hill Coal Project, some 5 km from the Project (Figure 4-15) and therefore indicative of PM_{10} data in the absence of the Stratford Mining Complex particulate matter contributions (annual average of approximately 8.5 µg/m^3 recorded over approximately 12 months).

As a result of this analysis, it was estimated by PAEHolmes that the background PM_{10} concentrations in the absence of contributions from the Stratford Mining Complex would be 8 µg/m^3. This is the adopted background concentration for annual average PM_{10}. Background concentrations for TSP and $PM_{2.5}$ have been derived based on this PM_{10} value and scaled according to the relationships described previously. Further discussion is provided in Appendix D.

For dust deposition, the annual average dust deposition level of 1 g/m^2/month across all Stratford Mining Complex sites was adopted (Appendix D). Although these measured data would incorporate contributions from the Stratford Mining Complex, given the generally low levels recorded, the Project-only dust deposition criteria (Table 4-20) would likely be the more stringent criteria rather than the maximum total criteria which includes background contributions. Therefore, 1 g/m^2/month was conservatively assumed as the background measured dust deposition level by PAEHolmes.

In summary, for the purposes of assessing Project and cumulative impacts, PAEHolmes (2012a) assumed the following background air quality concentrations/levels for sources other than local mining activity:

- annual average PM_{10} concentration of 8 µg/m^3;
- annual average $PM_{2.5}$ concentration of 3 µg/m^3;
- annual average TSP concentration of 20 µg/m^3; and
- annual average dust deposition of 1 g/m^2/month.

Spontaneous Combustion

Two separate spontaneous combustion incidents have occurred historically in the Stratford Main Pit and were associated with the Glenview Seam being exposed in the final highwall/endwall (Appendix D).

A Spontaneous Combustion Management Plan is currently in place at the Stratford Mining Complex and outlines management and mitigation measures to reduce the potential for spontaneous combustion events.

4.7.2 Potential Impacts

Assessment Methodology

Modelling Scenarios

Potential air quality impacts were assessed for Years 2, 6 and 10 of the Project. These years were chosen by PAEHolmes to account for potential worst case air quality impacts at any particular residential receiver, based on the following:

- Project Year 2 – Representative of initial mining at the Roseville West Pit Extension, Avon North Open Cut and Stratford East Open Cut. Coincides with maximum DCM ROM coal handling, processing and train loading on-site and maximum product coal production. Representative of northern-most operations during the Project.
- Project Year 6 – Representative of the first full year of 24 hour waste rock production from the Stratford East Open Cut and the final year of receipt of DCM coal (for processing and train loading).
- Project Year 10 – Includes maximum Project ROM coal and waste rock production rates in the absence of DCM ROM coal handling, processing and train loading. Representative of southern-most operations during the Project.

Table 2-3 provides the indicative coal processing and production schedule for the Project.

Emission Inventories

Air quality emission inventories were prepared for Years 2, 6 and 10 in consideration of the anticipated mining activities for each year, including ROM coal extraction, waste rock removal rates, haul road distances and routes, active stockpile and pit areas and equipment operating hours.

The major emission sources were associated with the following activities (Appendix D):

- hauling of waste rock and ROM coal in trucks on unpaved roads;
- dozer operations;
- wind erosion of exposed areas; and
- handling and loading/unloading of ROM and product coal from DCM and the Project.

A full description of the dispersion model methodology and emissions inventories is provided in Appendix D.

Comparison with Best Practice Mitigation Measures

In 2011, the OEH commissioned a review of methods to minimise coal mining particulate matter emissions called the *NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining* (Katestone Environmental, 2011) (the Best Practice Report).

As an outcome of the Best Practice Report, the EPA developed a pollution reduction program (PRP) that requires each mining company to prepare a report on the practicality of implementing best practice measures to reduce particulate matter emissions.

In 2011, the PRP requirements were included in the Stratford Mining Complex EPLs (5161 and 11745). Subsequent to this, SCPL responded to the Coal Mine Particulate Matter Control Best Practice PRP in February 2012 (PAEHolmes, 2012b).

For each source identified in the Project emission inventories, existing mitigation measures employed at the Stratford Mining Complex (Table 4-18) were benchmarked against the best practice mitigation measures described in the Best Practice Report.

As a result of the evaluation, the following additional best practice measures were identified (PAEHolmes, 2012b):

- vehicle speed restriction to 60 kilometres per hour (km/hr);
- use of larger capacity vehicles to transport coal and waste rock;
- increased intensity of haul road sprays;
- watering of wind erosion areas; and
- vegetative groundcover on wind erosion areas.

The above measures were included in the Project air quality emissions modelling, with the exception of the vehicle speed restriction and vegetative groundcover on wind erosion areas which were conservatively not included (Appendix D).

Dispersion Modelling

The CALMET/CALPUFF modelling system was used by PAEHolmes to assess potential air quality impacts associated with the Project. CALPUFF is a multi-layer, non-steady state puff dispersion model that is approved by the OEH (DEC, 2005c) and endorsed by the United States Environmental Protection Agency (Appendix D).

CALMET is a meteorological pre-processor that produces the three-dimensional meteorological fields that are used in the CALPUFF dispersion model. Observed hourly meteorological data including data from the SCM, DCM, proposed Rocky Hill Coal Project and Murrurundi Gap BoM site (cloud amount and cloud heights only) were used as input for CALMET.

Cumulative Impacts

Cumulative impacts associated with the proposed Rocky Hill Coal Project were conservatively included in the air quality assessment (Appendix D). The proposed Rocky Hill Coal Project emissions were estimated using information provided by GRL (2012) and the estimated TSP emission ratio (i.e. kg of TSP emission per tonne of ROM coal produced) for the Project (Appendix D).

The air quality impacts associated with the AGL Gloucester Gas Project are reported to be low at nearby receivers. Therefore, PAEHolmes did not quantitatively include AGL Gloucester Gas Project emissions as part of the cumulative air quality assessment (Appendix D).

Potential Project Only Impacts

All privately-owned receivers were predicted to comply with the EPA's criteria for 24-hour average PM_{10} and $PM_{2.5}$, annual average PM_{10} and $PM_{2.5}$ and annual average TSP concentrations as well as annual average dust deposition for the Project Years 2, 6 and 10 (Appendix D).

In addition, no exceedance of the OEH annual average criteria for PM_{10}, $PM_{2.5}$ and TSP concentrations or dust deposition criteria was predicted when accounting for Project emissions in consideration of background concentrations and levels (Appendix D).

Figures 4-19 and 4-20 show the predicted maximum Project only 24-hour PM_{10} contours for Years 2 and 10 respectively. Additional air quality contour plots (including 24-hour PM_{10} contours for Year 6) are provided in Appendix D.

Vacant Land

Recent conditions of consent in relation to air quality (e.g. SCM and BRNOC Development Consents [DA-23-98/99 and DA 39-02-01]) have included reference to vacant land in air quality criteria. Specifically, vacant land is considered to be affected if greater than 25% of a property is predicted to exceed the impact assessment criteria.

PAEHolmes (2012a) reviewed the relevant air quality contours and land tenure information for the Project. From this review, it was concluded that there was no predicted air quality affected vacant land (Appendix D).

Potential Effects of Dust on Tank Water Supply

A study conducted by GSC (Parkinson and Stimson, 2010) included laboratory testwork of rainwater tanks in Stratford as well as from tanks in a number of other villages remote from coal mining areas. The study concluded that there was no indication of any significant difference in tank water quality between Stratford and the other villages tested.

Given the highest predicted incremental (Project-only) dust deposition rate is 0.2 g/m^2/month and well below the EPA's criteria of 2 g/m^2/month, and in consideration of the GSC study, minimal adverse impact on tank water quality is expected to occur as a result of the Project.

132 kV Power Line

A 132 kV power line which is to be realigned within the Project mining tenements is also located within the DCM mining tenements.

At the DCM, the power line traverses an open pit and waste rock emplacement. No dust effects on the power line have been recorded to date, even during periods where mining operations occurred underneath and immediately adjacent to the power line.

Accordingly, there are no dust effects expected on the realigned power line from the Project.

Potential Cumulative Impacts

Annual Average PM_{10}

The annual average PM_{10} concentrations were not predicted to exceed the OEH annual average criterion (30 $\mu g/m^3$) due to the cumulative contributions from the Project, proposed Rocky Hill Coal Project and background levels (Appendix D).

24-hour Average PM_{10}

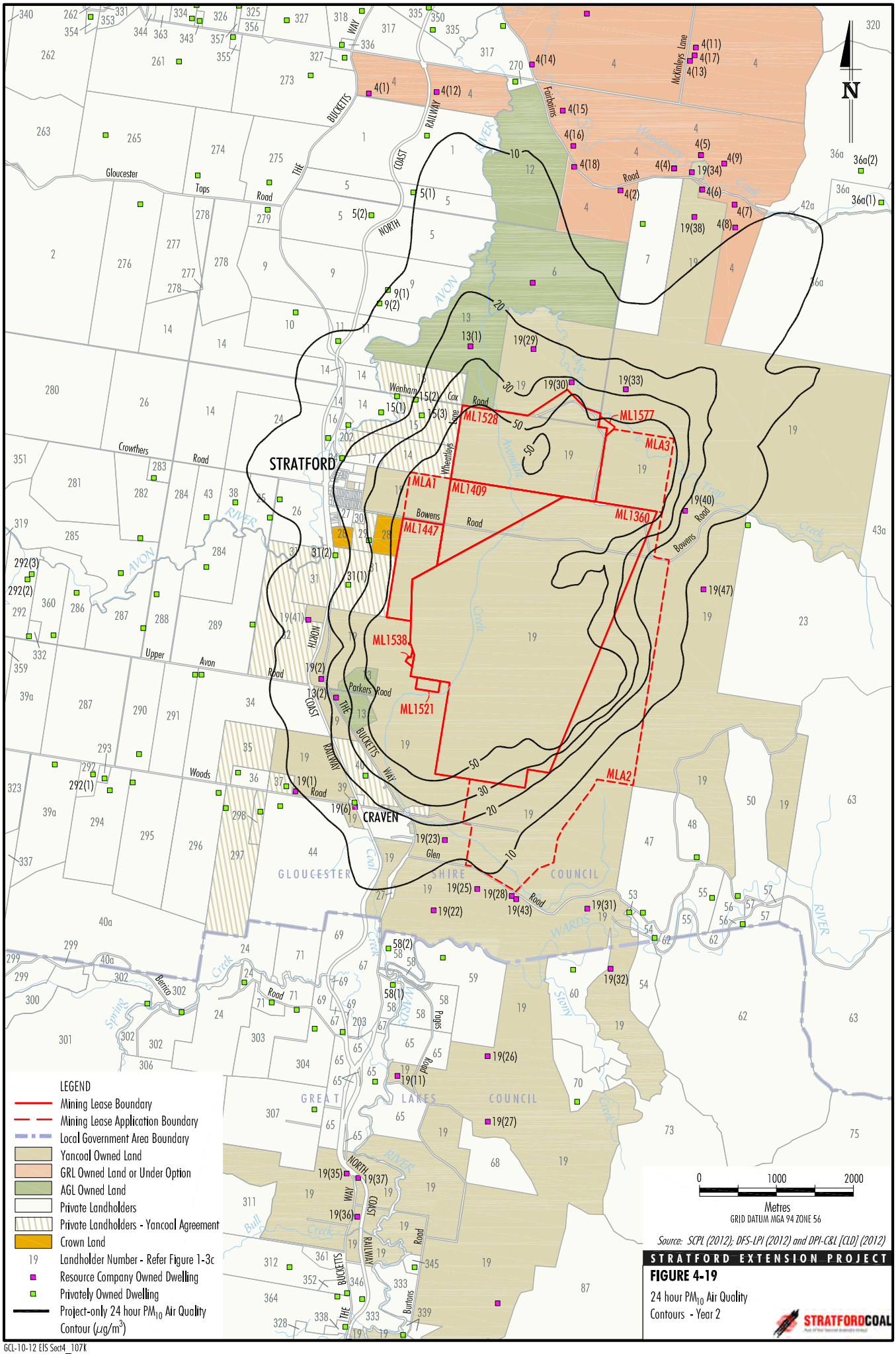
Potential cumulative 24-hour PM_{10} impacts were considered by PAEHolmes (2012a).

Analysis of model predictions for receivers located between the Project and the proposed Rocky Hill Coal Project shows that the maximum 24-hour PM_{10} predictions from these two sources would not occur on the same day at the same location. This was considered by PAEHolmes to be because the Project maximum contribution is predicted under prevailing southerly wind conditions, whilst the proposed Rocky Hill Coal Project maximum contributions at these residences would be under generally northerly wind conditions (Appendix D).

As it is unlikely that northerlies and southerlies would occur at the same time, the potential for significant 24-hour PM_{10} contributions from both projects at receivers located between the Project and the proposed Rocky Hill Coal Project is considered to be low (Appendix D).

In addition, the Project would not be a significant contributor to 24-hour PM_{10} emissions at receivers to the north of the proposed Rocky Hill Coal Project because of the distance (i.e. greater than 5 km) between the source and the receivers. Similarly, the proposed Rocky Hill Coal Project is unlikely to be a significant contributor of emissions to the south of the Project (Appendix D).

Potential cumulative impacts would also be influenced by elevated background levels due to other episodic short-term (non-mining) events (such as bushfires and dust storms). These events cannot be predicted in the medium/long-term.



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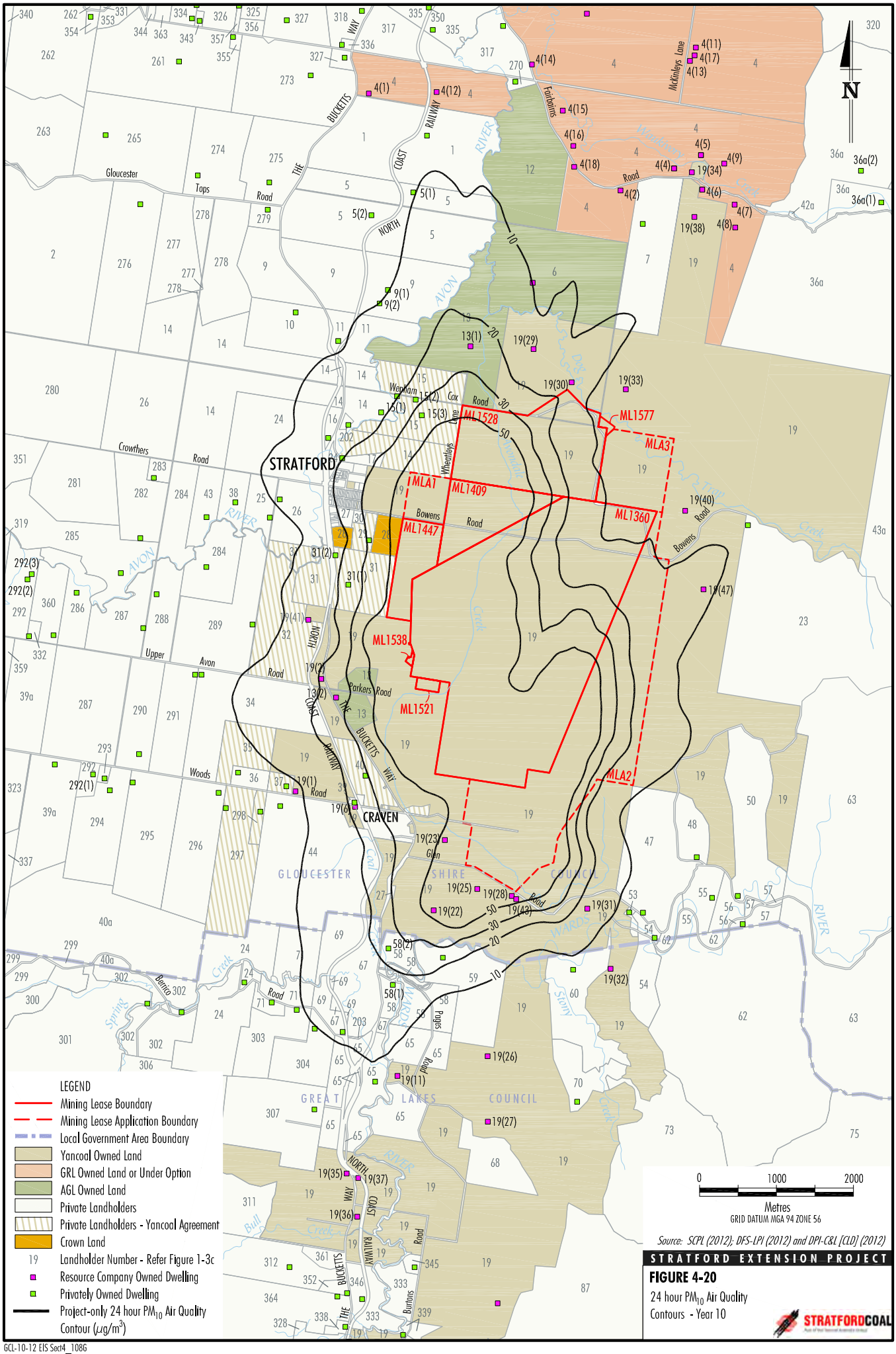


Source: SCPL (2012); DFS-LPI (2012) and DPI-C&L [CLD] (2012)

STRATFORD EXTENSION PROJECT

FIGURE 4-20

24 hour PM_{10} Air Quality Contours - Year 10

STRATFORDCOAL

GCL-10-12 EIS Sect4_1086

However, Appendix D presents a statistical analysis of the potential for these events to result in cumulative exceedances of the 24-hour PM_{10} criterion, using data recorded at the Stratford Mining Complex's HVASs. This analysis shows that there is a less than 1% chance of cumulative (i.e. Project and proposed Rocky Hill Coal Project) 24-hour PM_{10} criteria exceedances, even when including background concentrations (Appendix D).

Annual Average TSP

No exceedance of the OEH annual average TSP criterion (90 µg/m³) was predicted at any privately owned residence due to the cumulative contributions from the Project, proposed Rocky Hill Coal Project and background levels.

Annual Average $PM_{2.5}$

The annual average $PM_{2.5}$ concentrations were not predicted to exceed the NEPM reporting standard annual average criterion (8 µg/m³) due to the cumulative contributions from the Project, proposed Rocky Hill Coal Project and background levels (Appendix D).

Dust Deposition

No exceedance of the OEH maximum total deposited dust level criterion (4 g/m²/month [annual average]) was predicted at any privately owned residence due to the cumulative contributions from the Project, proposed Rocky Hill Coal Project and background levels.

Potential Blasting Fume Emissions

Blasting activities have the potential to result in fugitive fume and particulate matter emissions. Particulate matter emissions from blasting are included in dispersion modelling results and are controlled by adequate stemming of the blast (Appendix D).

Imperfect blasts (e.g. when the explosive product is incorrectly formulated) may result in nitrogen oxide (NO_x) fumes (Australian Explosives Industry and Safety Group Inc., 2011). Measures to minimise or avoid imperfect blasts would be implemented in accordance with *Code of Practice: Prevention and Management of Blast Generated NO_x Gases in Surface Blasting* (Australian Explosives Industry and Safety Group Inc., 2011), and these measures would be incorporated into a revision of the existing Blasting/Vibration Management Plan (Sections 4.6.3 and 4.7.3).

Potential Construction/Development Impacts

Construction/development activities would potentially be sources of short-term particulate matter emissions.

Particulate matter emissions from construction activities (e.g. road diversions) would typically be contained to specific areas, and would be of limited duration (Appendix D). Construction dust emissions would be effectively managed through best practice mitigation measures, as described in Section 4.7.3 and Appendix D.

Coal Transport

Product coal is transported via the North Coast Railway to Newcastle.

SCPL commissioned an investigation of dust emissions from the transportation of coal between the Stratford Mining Complex and the Port of Newcastle (Introspec Consulting, 2012). The study objective was to determine the dust extinction moisture level for the SCM product coal and to simulate the dust lift-off levels from the transport of coal between the Stratford Mining Complex and the Port of Newcastle.

The report concludes that the dust extinction moisture level for Stratford Mining Complex washed thermal coal of 5% is significantly lower than product coal moisture levels advised by SCPL (7% to 8%). SCPL also has confirmed that the moisture content of export coal (thermal and coking) received at the Port of Newcastle during the months of January and February 2012 was consistently greater than or equal to 5%.

This analysis suggests that dust lift-off from product coal during transportation by rail is likely to be minimal (i.e. as the moisture levels of the coal remains above or equal to the dust extinction moisture level) (Appendix D).

Spontaneous Combustion

Spontaneous combustion events have the potential to give rise to odour emissions. The Glenview Seam may be a feature of the proposed Avon North Open Cut and, therefore, there is some potential for spontaneous combustion events if the seam is exposed in the final highwall or end wall (Appendix D).

4.7.3 Mitigation Measures, Management and Monitoring

Air quality management measures are currently implemented at the Stratford Mining Complex in accordance with the AQGHGMP (SCPL, 2011b) (Section 4.7.1). Current ambient air quality monitoring at the Stratford Mining Complex shows that existing operations have a minimal impact on local air quality (Appendix D).

Air Quality and Greenhouse Gas Management Plan

The management measures in the AQGHGMP would be revised and implemented during construction and operation of the Project. This would include the additional best practice mitigation measures identified and included in the air quality assessment (e.g. increased haul road spraying and increased watering).

The AQGHGMP would be updated to include specific dust suppression measures to be implemented during Project construction/ development activities (e.g. road diversions), such as minimisation of disturbance areas and watering of trafficked areas.

An additional aspect of the best practice management at the site is the real-time monitoring and management system. An outline of the proposed real-time monitoring management system is provided in the Stratford Mining Complex AQGHGMP (SCPL, 2011b).

In summary, consistent with the AQGHGMP, a Tapered Element Oscillating Microbalance (TEOM) analyser would be installed to monitor PM_{10} concentrations continuously, at a location in close proximity to Stratford.

For the Project, a second TEOM would be installed to monitor $PM_{2.5}$ and PM_{10} concentrations continuously, at a location in close proximity to Craven. In addition, a $PM_{2.5}$ monitor would be installed in close proximity to Stratford.

These monitors would enable SCPL to proactively and reactively manage the potential short-term particulate matter emissions from the Project, to prevent or minimise potential impacts at privately-owned receivers.

The AQGHGMP would also be updated to include a meteorological forecasting system as part of the Project. This system would predict meteorological conditions for the coming day to determine in advance where the risk of dust emissions may occur (e.g. based on wind speed, direction, rainfall and atmospheric stability) (Appendix D).

The predictive meteorological forecasting system would work in conjunction with the real-time monitoring and management system, providing an alert for the appropriate personnel to review the real-time data. This would allow for proactive management measures to be invoked, including increasing controls or limiting activity in various areas of the site to reduce particulate matter emissions (Appendix D).

Blasting Fume Emissions

The existing Blasting/Vibration Management Plan (SCPL, 2011c) would be revised to include measures for the minimisation of fume and particulate matter emissions from Project blasts.

Fume emissions would be managed in accordance with Australian Explosives Industry and Safety Group Inc. (2011). Measures that would be implemented include (Appendix D):

- Conduct of a risk assessment prior to blasting, which would review factors such as:
  - geological conditions;
  - ground conditions (e.g. presence of clay or loose/broken ground or heavy rain affected ground);
  - location of the blast relative to previous blasts which may have triggered fume events;
  - blasting product selection; and
  - presence of groundwater.
- Based on the outcomes of the risk assessment, the blasting method would be altered including consideration of the following:
  - minimising the time between drilling and loading, and loading and shooting of the blast;
  - formulation of explosive products to an appropriate oxygen balance to reduce the likelihood of fumes; and
  - meteorological conditions in blast scheduling.

Spontaneous Combustion

The existing Spontaneous Combustion Management Plan would be reviewed or augmented as necessary to address the Project and the potential for spontaneous combustion in the Avon North Open Cut. In particular, the plan would describe the measures that would be implemented to limit the potential for long-term exposure of the Glenview Seam in the Avon North Open Cut final highwall or end wall.

4.8 GREENHOUSE GAS EMISSIONS

4.8.1 Quantitative Assessment of Potential Scope 1, 2 and 3 Greenhouse Gas Emissions

A quantitative assessment of Project greenhouse gas emissions is provided in Appendix D. A summary of the assessment is provided below.

Greenhouse Gas Protocol Emission Scopes

The Greenhouse Gas Protocol (GHG Protocol) (World Business Council for Sustainable Development [WBCSD] and World Resources Institute [WRI], 2004) defines three 'scopes' of emissions (Scope 1, Scope 2 and Scope 3). Scopes 1 and 2 have been defined such that two or more entities would not account for emissions in the same scope.

Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the entity (WBCSD and WRI, 2004). Direct greenhouse gas emissions are those emissions that are principally the result of the types of activities undertaken by an entity that are listed below:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources (e.g. boilers, furnaces and turbines).
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials (e.g. the manufacture of cement, aluminium, adipic acid and ammonia, or waste processing).
- Transportation of materials, products, waste, and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources (e.g. trucks, trains, ships, aeroplanes, buses and cars).
- Fugitive emissions. These emissions result from intentional or unintentional releases (e.g. equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; hydroflurocarbon emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport) (WBCSD and WRI, 2004).

Scope 2: Electricity Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that account for greenhouse gas emissions from the generation of purchased electricity consumed by the entity.

Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity (WBCSD and WRI, 2004). Scope 2 emissions physically occur at the facility where electricity is generated (WBCSD and WRI, 2004). Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as Scope 2.

Scope 3: Other Indirect Greenhouse Gas Emissions

Under the GHG Protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions.

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services (WBCSD and WRI, 2004).

The GHG Protocol provides that reporting of Scope 3 emissions is optional (WBCSD and WRI, 2004). If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and 2. However, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or projects difficult because reporting is voluntary.

Greenhouse Gas Emissions Estimation

Project direct and indirect greenhouse gas emissions have been estimated by PAEHolmes using published emission factors from the *National Greenhouse Accounts Factors July 2011* (NGA Factors) (DCCEE, 2011a), where possible. Where NGA Factors were not available (e.g. for rail transport of product coal), other published emissions factors have been used.

The NGA Factors provide greenhouse gas emission factors for carbon dioxide, methane and nitrous oxide. Emission factors are standardised for each of these greenhouse gases by being expressed as a carbon dioxide equivalent (CO_2-e) based on their Global Warming Potential. This is determined by the differing times greenhouse gases remain in the atmosphere and their relative effectiveness in absorbing outgoing infrared radiation (e.g. methane has a Global Warming Potential 21 times that of carbon dioxide) (DCCEE, 2011b).

Project Greenhouse Gas Emissions

A summary of potential Project greenhouse gas emissions sources and their respective scopes is provided in Table 4-23.

The total direct (i.e. Scope 1) emissions over the life of the Project are estimated to be approximately 1.6 million tonnes of carbon dioxide equivalent (Mt CO_2-e), which is an average of approximately 0.1 Mt CO_2-e per annum over the life of the Project (Appendix D).

Annual average Scope 1 emissions would represent approximately 0.03% of Australia's Kyoto Protocol commitment (an average of 591.5 Mt CO_2-e per annum for the period 2008 to 2012) and a very small portion of global greenhouse emissions. The major source (approximately 60%) of estimated direct greenhouse gas emissions from the Project would be fugitive emissions from coal seams (Appendix D). These emissions were estimated using a state-wide default emission factor sourced from the NGA Factors.

A site specific emission factor was derived for the Stratford Mining Complex based on measurements of gas content for borehole samples in coal seams associated with the Stratford East Open Cut, and was less than 2% of the state-wide default emission factor assumed for the assessment (PAEHolmes, 2012a). As gas content testwork has not been undertaken for other Project open cut areas, the state-wide default emission factor has been conservatively used. As such, fugitive emissions from coal seams for the Project are likely to have been overestimated (Appendix D).

Table 4-23
Summary of Potential Project Greenhouse Gas Emissions

Component	Direct Emissions	Indirect Emissions	
	Scope 1	Scope 2	Scope 3
Fugitive Emissions	Emissions from the release of coal seam methane and carbon dioxide as a result of the Project.	N/A	N/A
Diesel Consumption	Emissions from the combustion of diesel at the Project.	N/A	Emissions attributable to the extraction, production and transport of diesel consumed at the Project.
Vegetation Clearance	Emissions from vegetation clearance associated with the Project.	N/A	N/A
Electricity Consumption for the Processing of Project ROM Coal	N/A	Emissions from the generation of purchased electricity used at the Project.	Emissions from the extraction, production and transport of fuel burned for the generation of electricity consumed, and the electricity lost in delivery in the transmission and distribution network.
Product Coal Transport	N/A	N/A	Emissions from the combustion of diesel used by the rail haulage contractor (product coal to the Port of Newcastle).
Combustion of Coal	N/A	N/A	Third party emissions from the combustion of product coal from the Project.

Source: After Appendix D.

The total indirect emissions (i.e. Scopes 2 and 3) over the life of the Project are estimated to be approximately 39 Mt CO_2-e, which is an average of approximately 3.5 Mt CO_2-e per annum. Approximately 99% of these emissions would be associated with the combustion of product coal by third parties.

Project Greenhouse Gas Emissions Intensity

Using the annual emission calculations, the estimated greenhouse gas emissions intensity of the Project is approximately 0.11 tonnes of carbon dioxide equivalent per tonne (t CO_2-e/t) saleable coal (this includes all Scope 1 emissions) (Appendix D).

The largest sources of scope 1 emissions are fugitive methane emissions which have likely been over-estimated by using the NGA Factors default emission factor. Using the site specific fugitive methane emissions factor for the Stratford East Open Cut, the average emissions intensity reduces to 0.05 t CO_2-e/t saleable coal, which would place the Project emissions in line with the average emissions for Australian open cut mines as reported in Deslandes (1999) (Appendix D).

Potential Impacts of Greenhouse Gas Emissions on the Environment

The Project's contribution to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions (Appendix D).

The Project's contribution to Australian and global emissions would be relatively small.

Conservatively estimated average annual Scope 1 emissions from the Project (0.1 Mt CO_2-e) represent approximately 0.03% of Australia's commitment under the Kyoto Protocol (591.5 Mt CO_2-e) (Appendix D), and a very small portion of global greenhouse emissions, given Australia contributed approximately 1.5% of global greenhouse gas emissions in 2005 (Commonwealth of Australia, 2011).

Increased greenhouse gas levels have the potential to alter climate variables such as temperature, rainfall and evaporation. Projected changes to climate variables would have associated impacts, including to land, settlements and ecosystems, as described in Section 6.9.3.

4.8.2 Australian Greenhouse Gas Emission Reduction Targets and Carbon Pricing Mechanism

The potential impacts of greenhouse gas emissions from all Australian sources will be collectively managed at a national level, through initiatives implemented by the Commonwealth Government.

The Commonwealth Government has committed to reduce greenhouse gas emissions by between 5 to 25% below 2000 levels by 2020, with the level of reduction dependent on the extent of reduction actions undertaken internationally (Commonwealth of Australia, 2011).

The Federal Opposition has committed to a 5% reduction below 1990 levels by 2020 (Liberal Party of Australia, 2010).

Greenhouse gas emissions from the Project would contribute to Australia's greenhouse gas emissions inventory, and would be considered in these emission reduction targets.

The commitment from the Commonwealth Government to reduce greenhouse gas emissions is proposed to be achieved through carbon pricing mechanisms, as detailed in the *Clean Energy Act, 2011*, which commenced on 2 April 2012 (Section 6.4.2).

As of 1 July 2012, this involves a fixed price on greenhouse gas emissions, with no cap on Australia's greenhouse gas emissions, or emissions from individual facilities (Commonwealth of Australia, 2011). From 1 July 2015 (i.e. during Project Year 3) an emissions trading scheme is proposed to be implemented. As such, Australia's greenhouse gas emissions, inclusive of emissions associated with the Project, would be capped at a level specified by the Commonwealth Government.

Under the emissions trading scheme, there would be no limit on the level of greenhouse gas emissions from specific individual facilities, with the incentive for facilities to reduce their greenhouse gas emissions driven by the carbon pricing mechanism (Commonwealth of Australia, 2011).

It is expected that the Project would trigger the facility threshold of 25,000 t CO_2-e per annum for participation in the proposed carbon pricing mechanisms. As such, SCPL would contribute to Commonwealth revenue generated in the scheme, which is to be used to fund the following initiatives designed to reduce Australia's greenhouse gas emissions (Commonwealth of Australia, 2011):

- $1.2 billion Clean Technology Program to improve energy efficiency in manufacturing industries and support research and development in low-pollution technologies.
- $10 billion Clean Energy Finance Corporation to invest in renewable energy, low-pollution and energy efficiency technologies.
- $946 million (M) Biodiversity Fund (over the first six years) to protect biodiverse carbon stores and secure environmental outcomes from carbon farming.

SCPL would also implement Project-specific greenhouse gas mitigation measures, as described in Section 4.8.3.

4.8.3 Project Greenhouse Gas Mitigation Measures, Management and Monitoring

The existing AQGHGMP (SCPL, 2011b) describes measures to reduce greenhouse gas emissions, including:

- maximising energy efficiency by mine planning decisions which minimise haul distances for ROM coal and waste rock transport, and associated fuel use;
- regular maintenance of plant and equipment to minimise fuel consumption; and
- consideration of energy efficiency in the plant and equipment selection phase.

These measures would continue to be implemented for the Project. In addition, SPCL would directly measure the gas content representative of the coal seams being mined in order to provide a site specific factor of the Scope 1 fugitive emissions for all open cuts.

The revegetation of previously cleared areas at the proposed Project biodiversity offset areas would also assist with reducing the Project's net greenhouse gas emissions. This revegetation in the biodiversity offset areas would be in addition to the extensive on-site revegetation of Project disturbance areas (Section 5).

Ongoing monitoring and management of greenhouse gas emissions and energy consumption at the Project would occur through Yancoal's participation in the Commonwealth Government's National Greenhouse and Energy Report System (NGERS) (Section 6.4.2).

Under NGERS requirements, relevant sources of greenhouse gas emissions and energy consumption must be measured and reported on an annual basis, allowing major sources and trends in emissions/ energy consumption to be identified. The development of a site specific Scope 1 emission factor for fugitive emissions from coal seams would assist in satisfying part of ongoing NGERS measurement and reporting requirements.

Yancoal is also a participant in the Commonwealth Government's EEO Program (Section 6.4.2).

As such, Yancoal would assess energy usage from all aspects of its operations, including the Project, and publicly report the results of energy efficiency assessments, and the opportunities that exist for energy efficiency projects with a financial payback of up to four years.

For the Stratford Mining Complex, Yancoal is due to submit its initial EEO report to the Commonwealth Department of Resources Energy and Tourism by the end of 2013. From investigations undertaken to date, process improvements at the CHPP have potential to deliver significant energy usage reductions (SCPL, pers. comm. 19 April 2012).

4.9 FLORA

A Flora Assessment has been prepared for the Project by Dr. Colin Bower of FloraSearch (2012) and is presented in Appendix E.

A description of the existing environment relating to flora is provided in Section 4.9.1. Section 4.9.2 describes the potential impacts of the Project on flora, including cumulative impacts, and Section 4.9.3 outlines flora mitigation measures, management and monitoring. Section 4.9.4 describes the components of the Project biodiversity offset strategy relevant to flora.

4.9.1 Existing Environment

Regional and Local Setting

There are various regional delineations in NSW that can be used to predict which native flora and fauna species are likely to occur within a particular area. The Project area is in the Hunter-Central Rivers CMA region as well as within the NSW North Coast Bioregion as defined in the *Interim Biogeographic Regionalisation for Australia: a Framework for Establishing the National System of Reserves* (Thackway and Cresswell, 1995; SEWPaC, 2011a).

The existing Stratford Mining Complex is located in a rural area characterised by cattle grazing on native and improved pastures (Figure 4-3). The portion of Stratford Mining Complex MLs not currently subject to mining is managed for a combination of biodiversity conservation (i.e. wildlife corridor/biodiversity enhancement area) and cattle grazing. In addition, there are a number of existing Voluntary Conservation Areas in the vicinity of the Stratford Mining Complex (Figure 4-4).

Flora Surveys

SCPL (1994b) and Dowling (2001) conducted flora surveys within and surrounding the Project area prior to the development of the existing Stratford Mining Complex. A review of these studies is provided in Appendix E.

Flora surveys have been undertaken for the Project using standard survey techniques (quadrats, spot samples and random meanders) in accordance with OEH guidelines. Ecobiological (Attachment A of Appendix E) gathered flora data over three years (2007, 2008 and 2010) and FloraSearch (Appendix E) gathered additional survey data in 2010 and 2011.

The survey encompassed all patches of native vegetation within the Project area in order to sample and identify all flora species present. All habitat types were surveyed to maximise the chance of finding populations of any threatened flora species.

Australian Museum Business Services (2011a) also conducted surveys in the vicinity of the Project for the Project biodiversity offset areas (Attachment B of Appendix E). Further discussion of the Project biodiversity offset strategy is provided in Section 4.9.4.

Targeted searches for threatened flora species and ecological communities were conducted as part of the above studies. Potential habitat for threatened flora species was evaluated based on the habitat requirements of threatened species which could possibility occur in the Project area and a vegetation condition assessment was undertaken (Appendix E).

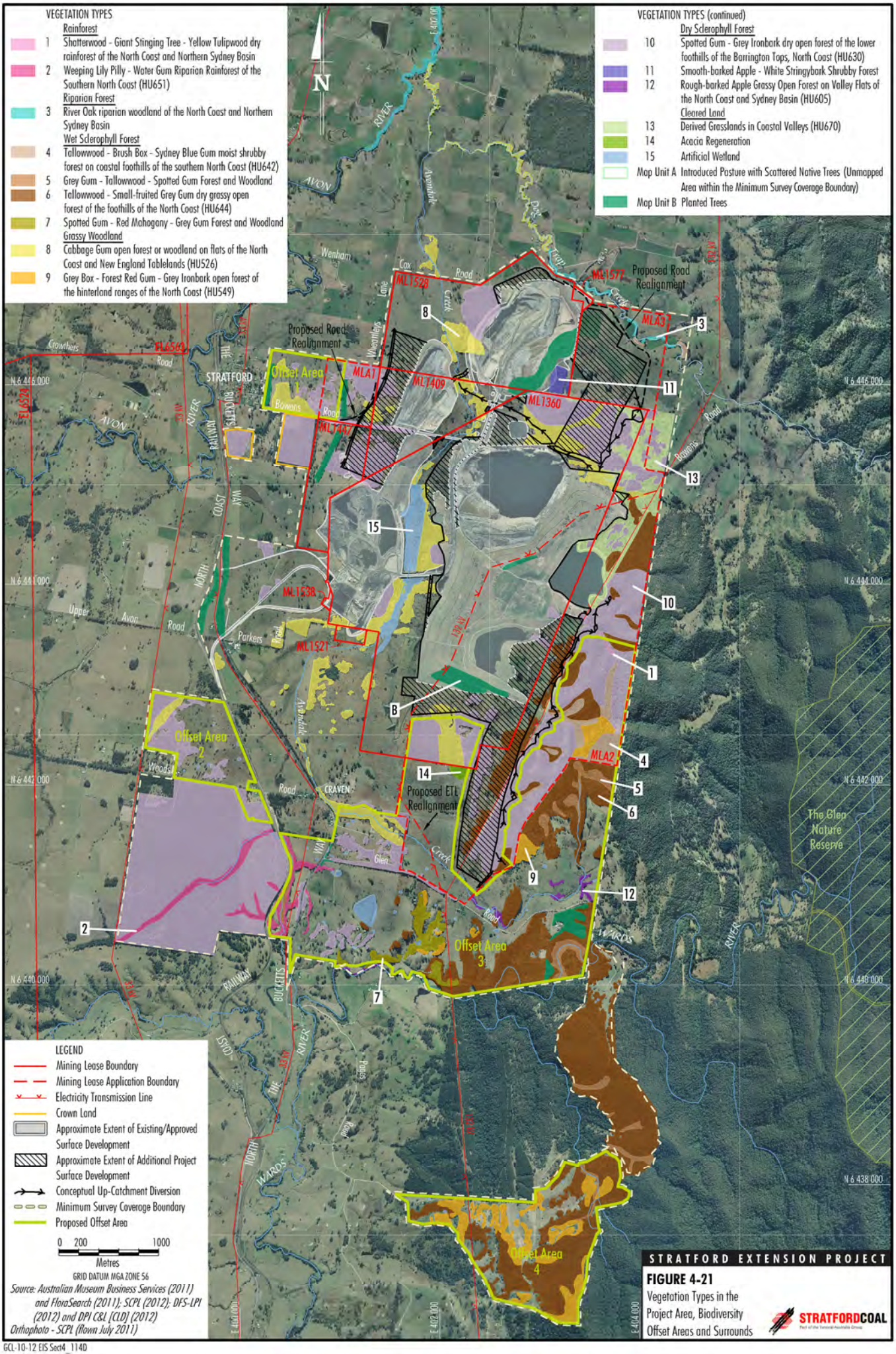
Vegetation Types

The Project area is predominantly cleared land comprised of grasslands dominated by introduced species (Figure 4-21 and Appendix E). However, native vegetation occurs in various patches. Twelve native vegetation types and two map units have been identified in the Project area, biodiversity offset areas and surrounds. Six vegetation types and both map units occur within the additional surface development area as listed below:

- Vegetation Type 4: Tallowwood – Brush Box – Sydney Blue Gum moist shrubby forest on coastal foothills of the southern North Coast;
- Vegetation Type 6: Tallowwood – Small-fruited Grey Gum dry grassy open forest of the foothills of the North Coast;
- Vegetation Type 8: Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands;
- Vegetation Type 10: Spotted Gum – Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast;
- Vegetation Type 13: Derived Grasslands in Coastal Valleys;
- Vegetation Type 14: Acacia Regeneration;
- Map Unit A: Introduced pasture with scattered nature trees; and
- Map Unit B: Planted Trees.

Vegetation Types 4 and 6 represent wet sclerophyll forests on foothills and steeper slopes. In the flat areas of the valley floor with impeded drainage there is grassy woodland (Vegetation Type 8). Vegetation Type 10 is a dry sclerophyll forest with shrubby understorey on well-drained substrate.

Map Unit A (Introduced Pasture with Scattered Native Trees) comprises the majority of lands in the Project area and surrounds (Figure 4-21) and includes approximately 200 ha of rehabilitated waste rock emplacements at the Stratford Mining Complex that are used for grazing (Appendix K).



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Map Unit B (Planted Trees) is primarily located on areas of existing Stratford Mining Complex vegetation screen plantings and woodlot areas on the existing waste emplacements.

A vegetation condition assessment was also undertaken by FloraSearch (2012) and the results are presented in Appendix E. A review of historic aerial photographs for the general area shows that the area has been extensively cleared in the past with a greater vegetation cover in more recent years (Appendix E).

Threatened Ecological Communities

No threatened ecological communities listed under the *NSW Threatened Species Conservation Act, 1995* (TSC Act) or EPBC Act have been recorded within the Project area (Appendix E). The *White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland* threatened ecological community was identified by SEWPaC as potentially occurring, however, it does not occur in the Project area or surrounds.

Regionally Significant Vegetation and Vegetation Corridors

Most of the identified vegetation types are estimated to be only moderately cleared in the region (30 to 35%), however, Vegetation Type 8 is considered to be 70% cleared (DECCW, 2008b; Appendix E). While there are many remnants of Vegetation Type 8 on surrounding farmland, most are small, highly fragmented and severely affected by livestock grazing and weed invasion. Vegetation Type 8 occurs in the Project biodiversity offset areas (Section 4.9.4).

The Project area is situated on the western edge of a very large area of native vegetation, including The Glen Nature Reserve and surrounding forested private land, the Myall River State Forest and Ghi-Doo-Ee National Park to the south and south-east (Figures 4-1 and 4-21). Much larger areas of natural vegetation also exist in the Barrington Tops complex of State Forests and National Parks located to the west of the Avon River valley (Figure 4-1).

Flora Species Composition

A combined total of 510 flora species (408 native species) were found by the recent surveys conducted by FloraSearch and Ecobiological. A complete list of flora species identified in surveys of the Stratford Mining Complex area to 2011 is provided in Appendix E.

All recent and past surveys conducted in the survey area and surrounds have recorded a total of 696 flora species (81% native species and 19% introduced species) (Appendix E). The plant families with the highest numbers of native species were grasses, family Poaceae (83 species); daisies, Asteraceae (52 species); and the Eucalypts and related genera in the family Myrtaceae (49 species) (Appendix E).

Introduced Flora Species and Noxious Weeds

A total of 102 introduced flora species have been recorded during the recent surveys (Appendix E). The highest proportions of introduced species and weeds were in the cleared pasture areas and along the watercourses. Five weed species listed as noxious under the NSW *Noxious Weeds Act, 1993* in the Gloucester LGA (DPI, 2011) have been recorded, *viz.* Blackberry aggregate species, Crofton Weed, Giant Parramatta Grass, Lantana and Basket Willow (Appendix E).

Threatened Flora Species and Populations

FloraSearch and Ecobiological undertook a literature and database review in addition to targeted surveys to identify threatened flora species listed under the TSC Act or EPBC Act which could potentially occur within the Project area.

No threatened flora species have been recorded in the Project area or immediate surrounds (Appendix E). No threatened flora populations listed under the TSC Act or EPBC Act are relevant to the Project (Appendix E).

Critical Habitat

No critical flora habitat occurs within the vicinity of the Project (Appendix E).

Biodiversity Enhancement Area

The MLs associated with the Stratford Mining Complex are managed to provide a mixed land use – mining, agriculture (grazing livestock) and biodiversity conservation. Land outside of the proposed additional disturbance area would continue to be used for a combination of grazing livestock and conservation of biodiversity (Figure 4-4).

4.9.2 Potential Impacts

Vegetation Clearance

The additional surface development associated with the Project would involve the clearance of approximately 105 ha of native vegetation types and approximately 195 ha of cleared land with a small portion containing planted trees (approximately 1.3 ha). The native vegetation types which would be cleared include (Figure 4-21) (Appendix E):

- approximately 0.2 ha of Vegetation Type 4: Tallowwood – Brush Box – Sydney Blue Gum moist shrubby forest on coastal foothills of the southern North Coast;
- approximately 19 ha of Vegetation Type 6: Tallowwood – Small-fruited Grey Gum dry grassy open forest of the foothills of the North Coast;
- approximately 13.5 ha of Vegetation Type 8: Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands;
- approximately 65 ha of Vegetation Type 10: Spotted Gum – Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast;
- approximately 5.5 ha of Vegetation Type 13: Derived Grasslands in Coastal Valleys; and
- approximately 0.5 ha of Vegetation Type 14: Acacia Regeneration.

The Roseville West Pit Extension would involve the clearance of vegetation from two patches of dry sclerophyll forest and smaller areas of disturbed grassy woodland adjacent to the existing pit (Figure 4-21). Some of the trees in this area have regrown since the 1970s (Appendix F).

The Avon North Open Cut would also involve the clearance of dry sclerophyll forest and grassy woodland (Figure 4-21). The area has been extensively cleared in the past. During the 1960s and 1970s, the habitat in this area was predominantly scattered trees, and since the 1980s, the forest and woodland habitat in this area has substantially regrown (Appendix F).

The Stratford East Open Cut would involve clearing of wet and dry sclerophyll forest, mostly regrown since the 1960s and 1970s (Appendix F). An existing power line runs through the area and the vegetation beneath the power line is regularly slashed.

In addition, the Project would involve the re-disturbance of areas within the existing Stratford Mining Complex that have previously been disturbed and rehabilitated to a combination of pasture and native vegetation (e.g. Northern Waste Emplacement and Stratford Waste Emplacement) (i.e. Mapping Units A and B).

Potential Impacts from Irrigation

The existing Stratford Mining Complex is approved to undertake irrigation on rehabilitation areas within a contained catchment. This irrigation method would be continued for the Project with the proposed irrigation areas draining directly to mine water storages. No adverse impacts on existing native vegetation would occur (Appendix E).

Groundwater Dependent Vegetation

No groundwater dependent vegetation has been identified on or near the Project Area (after National Water Commission, 2006) (Appendix E). FloraSearch (2012) concluded that no vegetation near the Project area appears to be associated with groundwater; rather all vegetation appears to be dependent on rainfall and surface water flows.

Introduced Flora

The proposed vegetation disturbance associated with the Project has the potential to act as a catalyst for weed incursion and, if management measures are not in place, proliferation of weeds could occur. Measures to prevent and control weeds are provided in Appendix E and Section 4.9.4.

Introduced Fauna

Competition and grazing by the feral European Rabbit is a key threatening process listed under the TSC Act.

The European Rabbit and other introduced animals can result in erosion problems as well as reduce recruitment and survival of native plants. Measures to prevent and control introduced fauna are provided in Appendix E and Section 4.9.4.

Vegetation and Dust

Project activities such as blasting, materials handling and vehicle movements may result in the generation and dispersion of atmospheric dust. Studies have shown that excessive dust generation can impact on the health and viability of surrounding vegetation. Any effects of dust on vegetation are likely to be minor at the Project due to the relatively high and reliable rainfall (Appendix E). Project dust control measures are described in Section 4.7.3 and Appendix E.

High Frequency Fire

High frequency fire resulting in the disruption of lifecycle processes in plants and animals, and loss of vegetation structure and composition is a key threatening process listed under the TSC Act. The risk of high frequency fire as a result of the Project is considered to be relatively low (Appendix E) given the relatively high rainfall in the area and grazing management, supported by the observed lack of evidence of past fires.

Threatened Flora Species

As stated in Section 4.9.1, no threatened flora have been recorded in the Project area. Potentially occurring threatened flora species were assessed via an Assessment of Significance under section 5A of the EP&A Act (Appendix E). The section 5A assessments conclude that the Project would be unlikely to significantly impact any threatened flora species listed under the TSC Act. Similarly, the Project would not significantly impact any threatened flora species listed under the EPBC Act.

Cumulative Impacts

The incremental impacts of the Project and the existing/approved Stratford Mining Complex in the context of the existing land uses and past logging have been considered in Appendix E.

The incremental impacts of the Project on flora are expected to occur as a result of additional vegetation clearing.

FloraSearch (Appendix E) describes how the consequence of the history of land clearing in the Gloucester Valley is that native vegetation types characteristic of the more fertile soils of the valley floor and footslopes have been considerably reduced in the region with only small fragmented remnants remaining, usually on privately-owned land. The Project further reduces the occurrence of already highly cleared vegetation types (specifically the Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands) – Vegetation Type 8. However, the Project biodiversity offset strategy provides for the conservation, enhancement, and revegetation of larger areas of this vegetation type (Section 4.9.4). FloraSearch (Appendix E) concludes that the Project would maintain and improve biodiversity (flora) values in the region in the long-term.

4.9.3 Mitigation Measures, Management and Monitoring

Refinements to the Project Design to Minimise Land Clearance

Refinements to the Project design have resulted in avoiding additional impacts on flora and their habitats as listed below:

- Optimising the area of the open cuts that are backfilled to minimise the overall mine footprint, including complete backfilling of the Stratford Main Pit and BRNOC as well as partial backfilling of the Roseville West Pit Extension, Avon North Open Cut and Stratford East Open Cut.
- Continued use of several existing features at the Stratford Mining Complex, including:
  - open cut voids for water and rejects storage;
  - Stratford East Dam for water management;
  - CHPP; and
  - rail facilities.
- Avoiding clearance of areas of surrounding bushland:
  - between the Stratford Main Pit, the Stratford Waste Emplacement Extension, the proposed Avon North Open Cut and the proposed Northern Waste Emplacement Extension;
  - west of the Roseville West Pit Extension; and
  - south of the Stratford Waste Emplacement and west of the proposed Stratford East Open Cut.
- Avoiding disturbance to Avondale Creek (apart from the additional creek crossing) (Section 2.12).
- Increasing the maximum height of the existing waste emplacements to minimise the overall mine footprint.

Proposed Biodiversity Management Plan

SCPL would prepare and implement a Biodiversity Management Plan for the Project that covers the following aspects relevant to flora:

- vegetation clearance procedures;
- seed collection;
- weed control;
- bushfire prevention;

- land management – continuation of the biodiversity enhancement area; and
- biodiversity offset strategy for the Project.

The Biodiversity Management Plan would also cover the following additional aspects relevant to fauna:

- timing land clearance to minimise harm of fauna;
- salvage and relocation of logs, vegetative material and rocks;
- salvage and relocation of tree hollows;
- nest box programme;
- seed collection;
- management of exotic animals;
- management of artificial lighting;
- vehicular speed limits; and
- measures specific to the New Holland Mouse, Glossy Black-Cockatoo and Squirrel Glider.

The Biodiversity Management Plan would also cover the following additional aspects relevant to aquatic ecology:

- construction and design of creek crossings; and
- monitoring aquatic ecology.

The measures relevant to flora are discussed below and in Section 4.9.4. The measures relevant to fauna and aquatic ecology are discussed in Sections 4.10.3 and 4.11.3, respectively.

Vegetation Clearance Procedures

A Vegetation Clearance Protocol has been developed for the Stratford Mining Complex (SCPL, 2002b). Land clearance for the Project would be undertaken progressively. Planned disturbance areas would be delineated prior to clearing activities, with restriction of clearing to the minimum area necessary to undertake the approved activities.

Seed Collection

Seed present during land clearance activities would be collected for use in plant propagation programmes to provide tube stock for revegetation activities. Seed from mature Forest Oak (*Allocasuarina torulosa*) would be specifically salvaged during vegetation clearing, wherever possible, to assist with the re-establishment of foraging habitat for the local Glossy Black-Cockatoo (Section 4.10.3). The seed collected (type and quantity) would be reported in the Annual Review.

Weed Control

Weed management measures would include:

- minimisation of seed transport from the site during construction and operation through the use of the Stratford Mining Complex vehicle wash bay;
- identification of weeds via regular site inspections and communication with landholders and regulatory authorities;
- mechanical removal of identified weeds and/or the application of approved herbicides in authorised areas; and
- specific control of noxious weeds, including Blackberry aggregate species, Crofton Weed, Giant Parramatta Grass, Lantana and Basket Willow.

Appropriately qualified persons would be engaged to undertake weed control. Follow-up site inspections would occur to determine the effectiveness of weed control. Weed management and monitoring results would be reported in the Annual Review.

Weed management would also be included in the Property Management Strategy for Yancoal-owned lands (Section 4.3.3).

Bushfire Prevention

Management measures that would be implemented in consultation with the RFS to minimise the potential for fire ignition include those listed below:

- Clearing would not be undertaken during periods of extreme fire danger as defined by the BoM (2011).
- Controlled high intensity short-term grazing would be employed to assist in the reduction of vegetative fuel loads on areas on which active mining operations are not occurring and appropriate fencing is available.

- All personnel and contractors would be required to use diesel vehicles and/or remain on defined roads or tracks.
- Provision of fire fighting equipment on-site.

Biodiversity Enhancement Area

The biodiversity enhancement area covers approximately 240 ha (Figure 4-4).

The following measures are relevant to the management of the biodiversity enhancement area:

- planting with suitable tree species currently occurring on the Project area from local seed;
- exclusion of stock via maintenance of perimeter fencing around the area undergoing revegetation;
- weed and exotic animal control; and
- nest box programme (Section 4.10.3).

The biodiversity enhancement area (Figure 4-4) would be established within 12 months of grant of Development Consent (i.e. exclusion of stock and commencement of flora/fauna management measures). A monitoring programme (i.e. annual flora and three yearly fauna usage monitoring) would be undertaken to evaluate and report on the effectiveness of the management measures and the performance of the biodiversity enhancement area, with reporting to be carried out annually. The monitoring would be undertaken by a suitably qualified person(s).

The biodiversity enhancement area is a proposal for land management during the life of the Project. The final tenure of the biodiversity enhancement area would be subject to future consultation.

Proposed Rehabilitation Management Plan

SCPL would prepare and implement a Rehabilitation Management Plan for the Project that would describe the revegetation programme for the mine landforms. Further information on the content of the Rehabilitation Management Plan is provided in Section 5.

The disturbance areas associated with the Project would be progressively rehabilitated and revegetated with species characteristic of native woodland/open forest (350 ha) and pasture with scattered trees (300 ha) (Figure 4-4). An objective of the rehabilitation programme is to restore ecosystem function to land affected by the Project development including maintaining or establishing self-sustaining ecosystems.

Revegetation of the post-mine landforms would be under regular review, including annual flora surveys by appropriately qualified and experienced persons to identify the progress of the rehabilitation programme and identify any additional measures to facilitate ongoing rehabilitation success.

A monitoring programme would be designed to track the progress of the revegetation programme (in terms of plant growth and species diversity) and to determine the requirement of intervention measures such as ecological thinning to reduce locked-regrowth, or additional plantings that may be required. A detailed monitoring report would be prepared annually that includes a summary of previous monitoring reports. The monitoring results would be reported in the Annual Review.

Other Management Measures Relevant to Flora

Dust mitigation and management measures to be undertaken as part of the Project are described in Section 4.7.3.

4.9.4 Biodiversity Offset Strategy

The DGRs for the Project (Section 1.2 and Attachment 1) state that the EIS must include a description of the measures that would be implemented to offset the potential impacts of the Project and maintain or improve biodiversity values of the surrounding region in the medium to long-term.

Proposed Biodiversity Offset Areas

The biodiversity offset strategy for the Project involves conserving areas of land with existing conservation values and providing active management to maintain and enhance their values. SCPL proposes four biodiversity offset areas (Figure 4-22).

Table 4-24 provides a summary of the additional surface development area and the associated biodiversity offset areas. Within the proposed biodiversity offset areas, existing native vegetation communities would be enhanced (approximately 490 ha), cleared land would be revegetated (approximately 435 ha) (Figure 4-22) and 10 ha of existing planted trees would be retained (Appendix E).

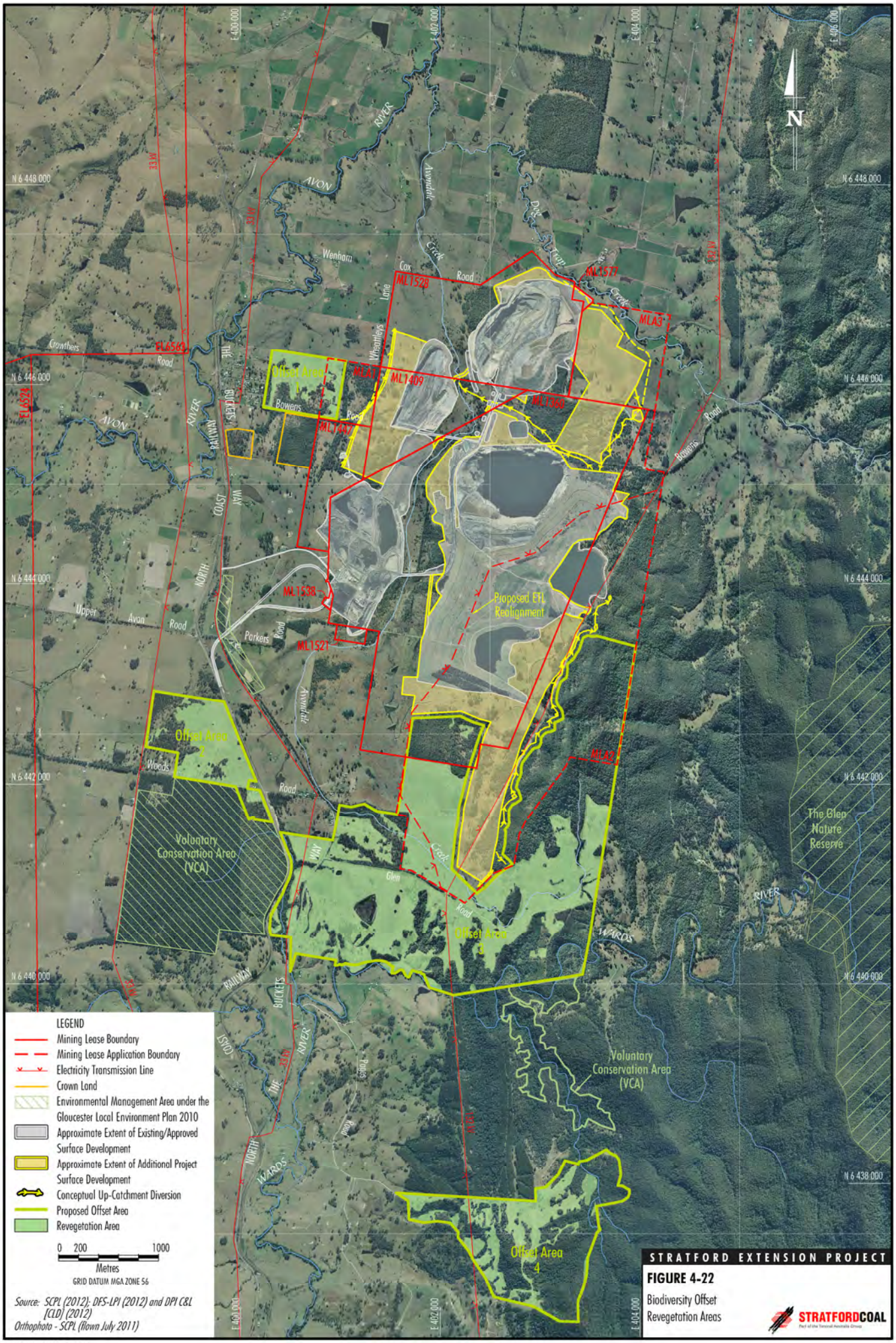

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Table 4-24
Quantification of Project Disturbance Areas and the Proposed Biodiversity Offset Areas

Vegetation	Additional Surface Development (ha) (Figure 4-21)	Proposed Biodiversity Offset Areas (ha)^
Existing native vegetation	105*	490*
Cleared land (and planted trees)	195*	445*
Total	300	935

* Approximate areas are based on vegetation mapping provided on Figure 4-21.

^ The total areas exclude existing infrastructure in the biodiversity offset areas.

Methodology for Selecting the Biodiversity Offset Areas

The proposed biodiversity offset areas (size, location and proposed management regime) were selected using a methodology that takes into consideration a range of factors (Appendices E and F):

- the location of the proposed disturbance relative to the proposed offsets;
- how the proposed offsets could complement the existing reserve system;
- the regional conservation priorities (e.g. corridors [DECC, 2007b]) and vegetation most in need of conservation;
- the available land tenure on which to locate a biodiversity offset area;
- the vegetation composition of the proposed disturbance area relative to the proposed biodiversity offset areas;
- the composition of the fauna habitats of the proposed disturbance area relative to the proposed biodiversity offset areas;
- the presence of threatened fauna species and their habitat requirements;
- the size of the biodiversity offset areas relative to the proposed disturbance area;
- the shape of the proposed biodiversity offset areas in relation to the spatial arrangement of existing vegetation in the landscape;
- the ecosystem resilience and condition of the proposed biodiversity offset areas; and
- existing infrastructure - roads, rail, power lines and houses.

In addition to the above, a reconciliation of the proposed biodiversity offsets against the relevant State (OEH's *Principles for the Use of Biodiversity Offsets in NSW* [OEH, 2011]) and Commonwealth requirements (SEWPaC 2011b and 2011c; Commonwealth Department of Environment, Water, Heritage and the Arts, 2007a and 2007b) was undertaken by FloraSearch (Appendix E) and Australian Museum Business Services (Appendix F).

Vegetation Types

The biodiversity offset areas contain rainforest, riparian forest, wet sclerophyll forest, grassy woodlands, dry sclerophyll forests and cleared land (Figure 4-21). Tables 4-25 and 4-26 compare the vegetation types/map units within the additional surface development area with those in the proposed biodiversity offset areas (Figure 4-21), and indicate that all of the relevant vegetation types/map units are represented in the offset areas.

Broad Fauna Habitat Types

The biodiversity offset areas contain a range of fauna habitat types including rainforest, riparian forest, wet sclerophyll forest, grassy woodlands, dry sclerophyll forests and cleared land (Figure 4-23; Table 4-27). All broad fauna habitats located in the Project area occur within the biodiversity offset areas (noting that derived grassland/shrub regrowth is a disturbed version of dry sclerophyll forest), and the habitat areas in the offsets are greater than the area lost due to the Project.

Threatened Fauna Species

Numerous threatened species are known to inhabit the biodiversity offset areas (Figures 4-24 to 4-26):

- six birds (Comb-crested Jacana; Glossy Black-Cockatoo; Masked Owl; Scarlet Robin; Grey-crowned Babbler; Varied Sittella);
- six non-flying mammals (Koala; Brush-tailed Phascogale; Yellow-bellied Glider; Squirrel Glider; New Holland Mouse; Long-nosed Potoroo); and
- five bats (Grey-headed Flying-fox; Eastern Bentwing-bat; Little Bentwing-bat; Eastern Freetail-bat; Southern Myotis).

Table 4-25
Quantification of Native Vegetation Types in the Project Disturbance Area and Proposed Biodiversity Offset Areas

Vegetation Type	Additional Surface Development (ha) (Figure 4-21)	Approximate Area to be Offset (ha)
1: Shatterwood - Giant Stinging Tree – Yellow Tulipwood dry rainforest of the North Coast and northern Sydney Basin	0	0.7
2: Weeping Lily Pilly – Water Gum Riparian Rainforest of the Southern North Coast	0	8.5
4: Tallowwood – Brush Box – Sydney Blue Gum moist shrubby forest on coastal foothills of the southern North Coast	0.2	20
5: Grey Gum – Tallowwood Spotted Gum Forest and Woodland	0	18
6: Tallowwood – Small-fruited Grey Gum dry grassy open forest of the foothills of the North Coast	19	194.5
7: Spotted Gum – Red Mahogany – Grey Gum Forest and Woodland	0	16.5
8: Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands	13.5	30
9: Grey Box – Forest Red Gum – Grey Ironbark open forest of the hinterland ranges of the North Coast	0	50
10: Spotted Gum – Grey Ironbark dry open forest of the lower foothills of the Barrington Tops, North Coast	65	142
12: Rough-barked Apple Grassy Open Forest on Valley Flats of the North Coast and Sydney Basin	0	3.5
13: Derived Grasslands in Coastal Valleys	5.5*	0*
14: Acacia Regeneration	0.5	2
15: Artificial Wetlands	0	8
Total	**103.7 (rounded to 105 ha)**	**493.7 ha (rounded to 490 ha)**

Source: After Appendix E.

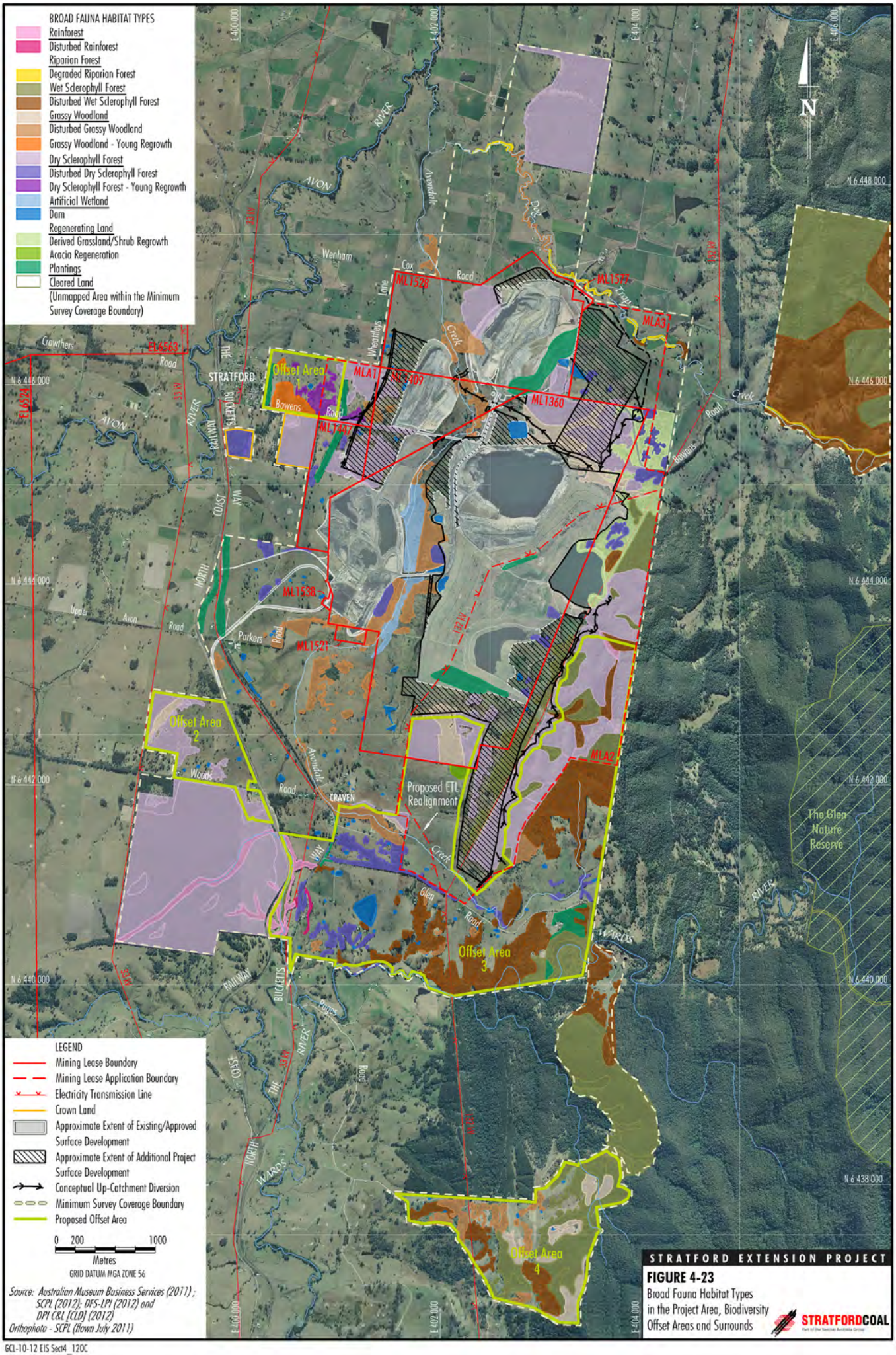
* This is a grassland which is derived as a result of previous land use activities from the other vegetation types recorded in the additional surface development area.

Note: Vegetation Types 3 and 11 are not located in the extent of the proposed surface development area or biodiversity offset areas.

Table 4-26
Quantification of Map Units in the Project Disturbance Area and Proposed Biodiversity Offset Areas

Map Unit Type	Additional Surface Development (ha) (Figure 4-21)	Approximate Area to be Offset (ha)
Map Unit A: Introduced Pasture with Scattered Native Trees	190 ha	436.6 ha (rounded to 435 ha)
Map Unit B: Planted Trees	1.3 ha	9.9 ha
Total	**191.3 (rounded to 195 ha)**	**446.5 ha (rounded to 445 ha)**

Source: Appendix E.



STRATFORD EXTENSION PROJECT

FIGURE 4-23

Broad Fauna Habitat Types in the Project Area, Biodiversity Offset Areas and Surrounds

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Table 4-27
Quantification of Broad Fauna Habitat Types in the Project Disturbance Area and Proposed Biodiversity Offset Areas

Fauna Habitat Type	Additional Surface Development (ha) (Figure 4-21)	Approximate Area to be Offset (ha)
Rainforest	0	9.2
Wet Sclerophyll Forest	19.2	249
Grassy Woodland	13.5	80
Dry Sclerophyll Forest	65	145.5
Derived Grassland/Shrub Regrowth	5.5*	0*
Acacia Regeneration	0.5	2
Artificial Wetlands	0	8
Cleared Land (including planted trees)	191.3	445
Total	**295 (rounded to 300)**	**938.7 (rounded to 935)**

Source: Appendix F.

* Derived Grassland/Shrub Regrowth is a disturbed version of Dry Sclerophyll Forest.

The only threatened fauna species to be found in the Project disturbance area that has not been identified in the biodiversity offset areas is the Little Lorikeet. This species is nomadic, with movements apparently related to food availability (NSW Scientific Committee, 2009). They feed primarily on nectar and pollen, particularly on profusely-flowering eucalypts (NSW Scientific Committee, 2009). As such, potential foraging habitat exists throughout most of the biodiversity offset areas.

Strategic Benefit of the Biodiversity Offset Areas

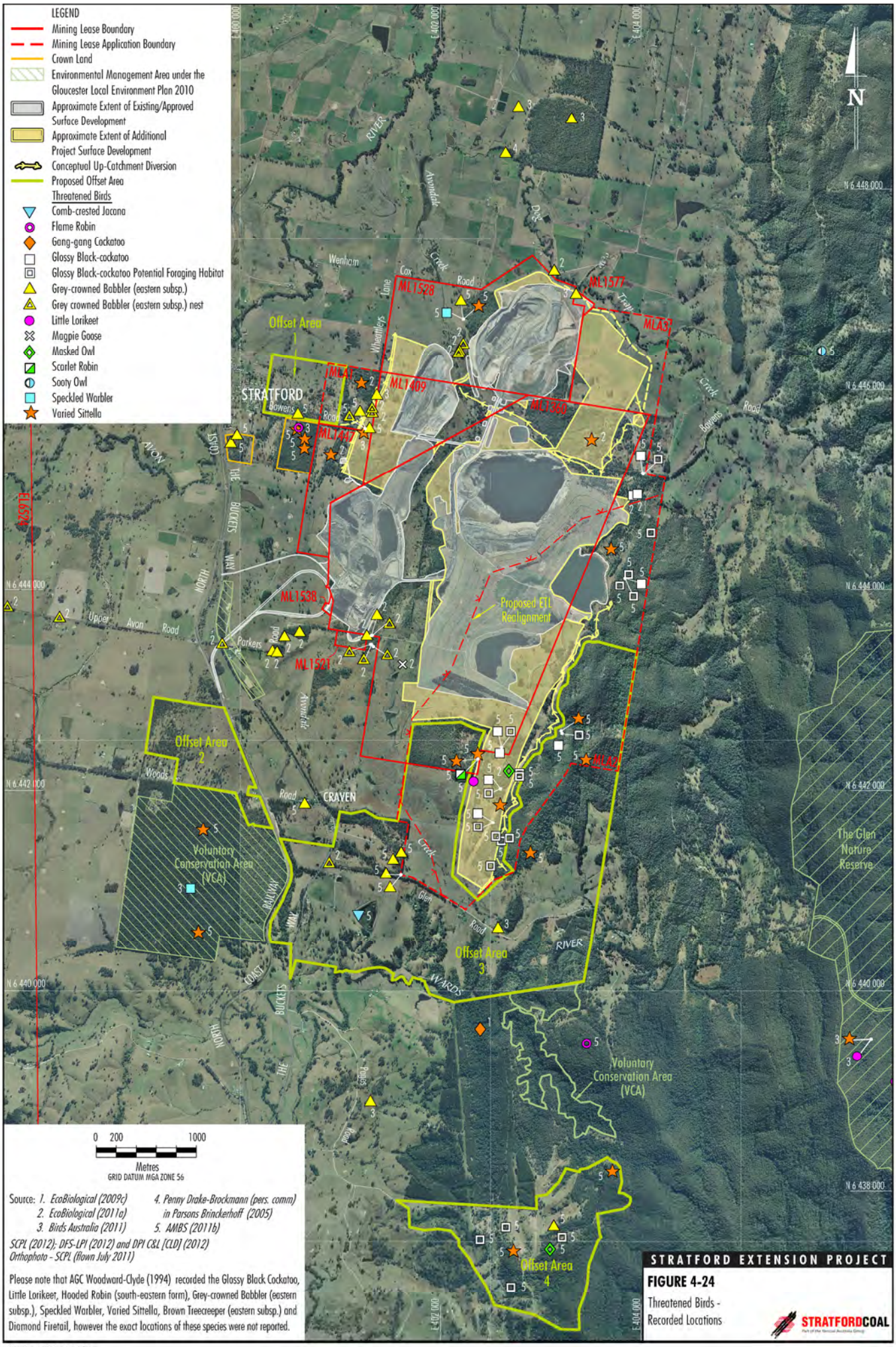
The strategic benefits of the four biodiversity offset areas are outlined in Table 4-28.

Ecological Gains

Ecological gains from the proposed biodiversity offset areas are listed below (Appendices E and F):

- Each vegetation type proposed to be cleared by the Project is represented in the biodiversity offset areas[3].
- The proposed biodiversity offset areas are suitably located because they are local to the area proposed to be disturbed and therefore have a greater chance of maintaining and improving the biodiversity that would be impacted.
- The biodiversity offset areas contain a number of watercourses, namely, two reaches of the Wards River occur in the proposed Offset Area 3 (approximately 0.5 km and 0.65 km), the upper reach of the Avondale Creek in the proposed Offset Area 3 (approximately 4.4 km) and other drainage lines (Figure 4-22).
- When agricultural parts of the biodiversity offset areas are removed from agricultural production, remnant woodlands can be expected to begin natural regeneration.
- Cleared paddock areas would be planted strategically to appropriate tree and shrub species to provide habitat for recolonisation by flora and fauna.
- The plantings would also be designed to link isolated woodland remnants to facilitate movement of plants and animals between remnants.
- The biodiversity offset areas support samples of all native vegetation types within the Project disturbance area and provide a greater diversity of vegetation types[4] than occur in the Project area.
- Offset Areas 3 and 4 are bordered to the east and south-east by a very large block of largely undisturbed natural vegetation. Consequently, the biodiversity offset areas are not isolated in the landscape and the high connectivity would help to facilitate long-term viability. Conversely, the addition of the biodiversity offsets as new protected areas would enhance nature conservation in the region.

[4] With the exception of Derived Grassland, which is derived as a result of previous land use activities from other vegetation types recorded in the surface development area and biodiversity offset areas.



Source: *1. EcoBiological (2009c)* *2. EcoBiological (2011a)* *3. Birds Australia (2011)* *4. Penny Drake-Brockmann (pers. comm) in Parsons Brinckerhoff (2005)* *5. AMBS (2011b)*

SCPL (2012); DFS-LPI (2012) and DPI C&L [CLD] (2012)
Orthophoto - SCPL (flown July 2011)

Please note that AGC Woodward-Clyde (1994) recorded the Glossy Black Cockatoo, Little Lorikeet, Hooded Robin (south-eastern form), Grey-crowned Babbler (eastern subsp.), Speckled Warbler, Varied Sittella, Brown Treecreeper (eastern subsp.) and Diamond Firetail, however the exact locations of these species were not reported.

STRATFORD EXTENSION PROJECT

FIGURE 4-24

Threatened Birds - Recorded Locations

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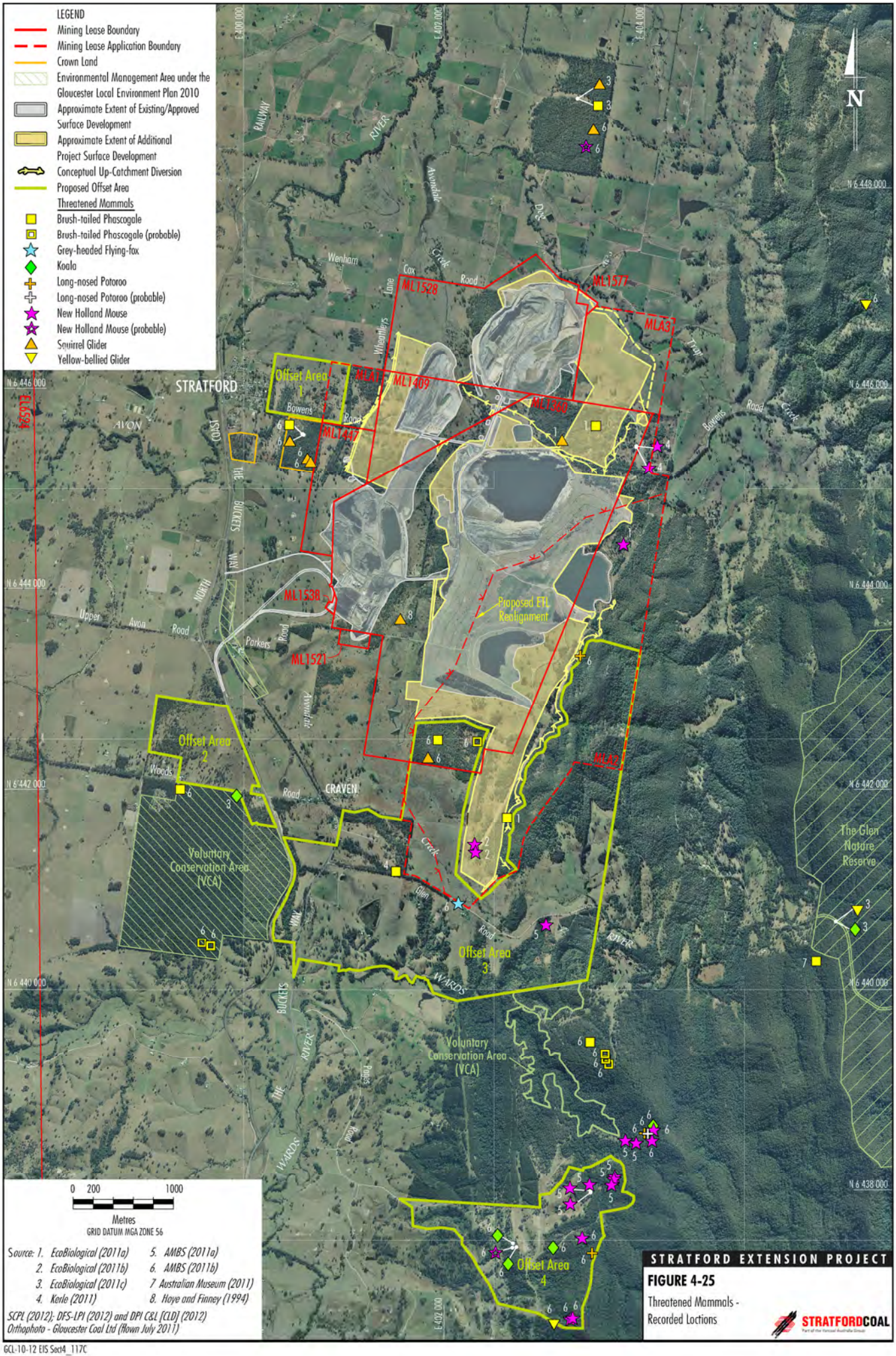

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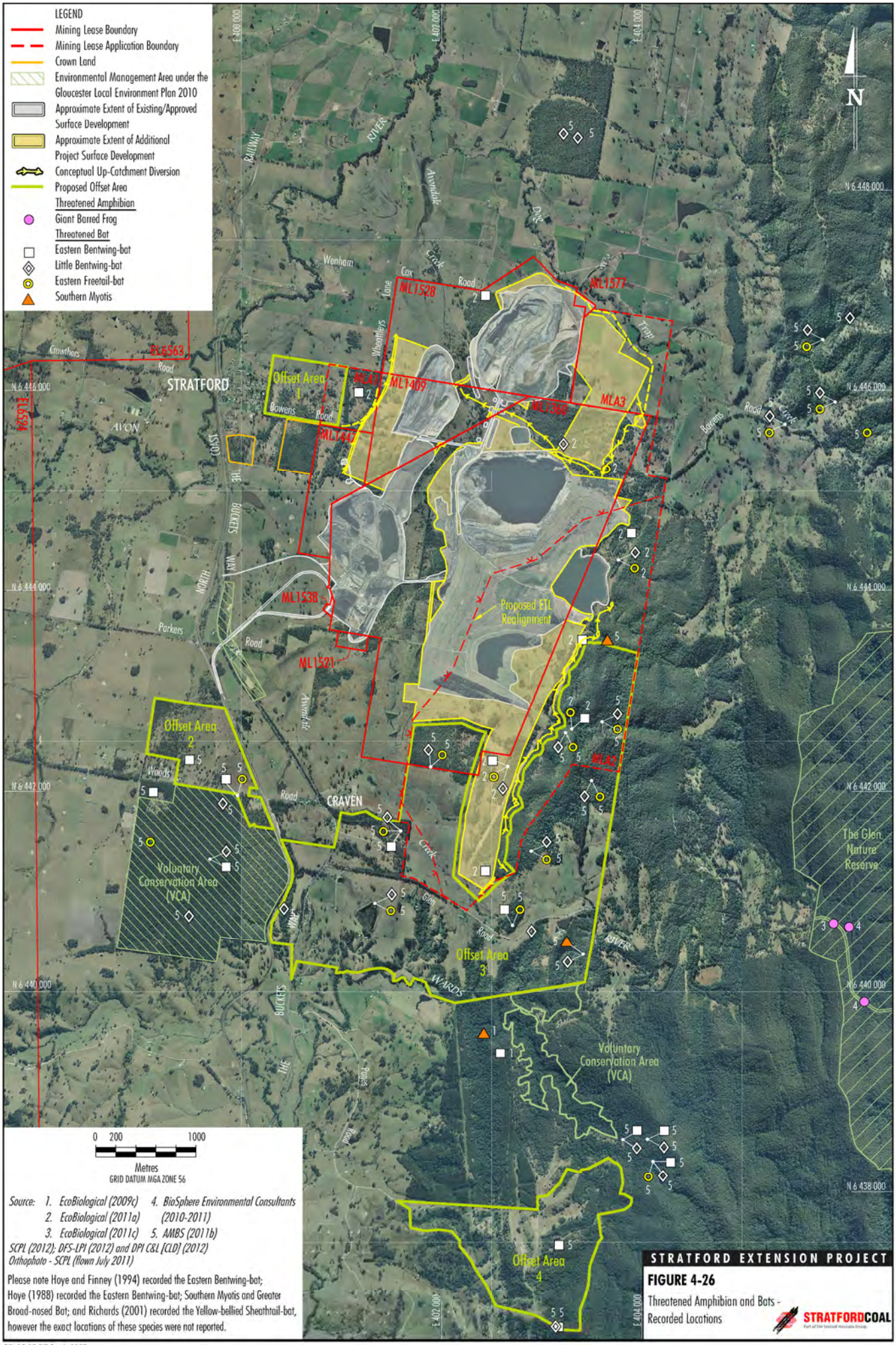

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Table 4-28
Strategic Benefit of the Biodiversity Offset Areas

Component (Figure 4-22)	Area (ha)	Description
Offset Area 1	40	• Contains the same vegetation types and broad fauna habitat types present within the Project area. • Contains 8 ha of Vegetation Type 8: Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands which is 70% cleared in the CMA. • Contains cleared land that was likely to have contained Vegetation Type 8. • Adds to the overall size of vegetation in the area by expanding the area of vegetation on the opposite side of Bowens Road next to the crown reserve. • Known to contain threatened species such as the Grey-crowned Babbler (eastern subspecies) and adjoins habitat which has recorded the Squirrel Glider, Brush-tailed Phascogale, Varied Sittella, Flame Robin and Eastern Bentwing-bat.
Offset Area 2	70	• Contains the same vegetation types present within the Project area. • Contains similar habitat types present within the Project area. • Contains 3.5 ha of Vegetation Type 8: Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands which is 70% cleared in the CMA. • Contains cleared land that was likely to have contained Vegetation Type 8. • Adds to the overall size of vegetation in the area by expanding the area of vegetation adjoining the existing Voluntary Conservation Area. • Adjoins a Voluntary Conservation Area that has records for threatened species such as the Brush-tailed Phascogale, Koala, Varied Sittella, Speckled Warbler, Eastern Freetail-bat, Eastern Bentwing-bat and Little Bentwing-bat. • Adds to the overall amount of fauna habitat in the area by expanding the area of vegetation adjoining the existing Voluntary Conservation Area.
Offset Area 3	655	• Contains the same vegetation types and broad fauna habitat types present within the Project area plus four additional vegetation types. • Contains 18.4 ha of Vegetation Type 8: Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands. • Contains cleared land that was likely to have contained Vegetation Type 8. • Known to contain threatened species such as the Squirrel Glider, the Brush-tailed Phascogale, the New Holland Mouse, the Grey-headed Flying Fox, Eastern Bentwing-bat, Little Bentwing-bat, Eastern Freetail-bat, Southern Myotis, Grey-crowned Babbler (eastern subspecies), Scarlet Robin, Glossy Black-Cockatoo, Varied Sitella and the Comb-crested Jacana. • Provides connectivity between remnant native vegetation to the south-west and the large area of native vegetation in the east and south.
Offset Area 4	170	• Contains a vegetation type that is also present within the Project area plus one additional vegetation type. • Known to contain a number of threatened species such as the New Holland Mouse, Koala, Yellow-bellied Glider, Long-nosed Potoroo, Grey-Crowned Babbler (eastern subspecies), Varied Sittella, Masked Owl, Glossy Black-Cockatoo, Little Bentwing-bat and Eastern Bentwing-bat • Contains potential habitat for Glossy Black-Cockatoos.

Source: After Appendices E and F.

Conservation in Perpetuity

An arrangement would be made for the protection in perpetuity and management of the identified biodiversity offset areas (or equivalent) within 12 months of grant of Development Consent. A voluntary conservation agreement pursuant to section 69B of the *National Parks and Wildlife Act 1974* or similar arrangement, would be sought.

There is no intention for Yancoal mining or exploration activities to occur within the biodiversity offset areas.

Management of the Proposed Biodiversity Offset Areas

Greening Australia has been commissioned to prepare the Project Biodiversity Management Plan to facilitate the revegetation and regeneration of native vegetation and habitats and provide a framework for continued management and monitoring of the biodiversity offset areas.

Proposed management of the four biodiversity offset areas is outlined in Table 4-29.

Table 4-29
Management of the Biodiversity Offset Areas

Aspect	Description
Revegetation of cleared land to substantially increase the area of native vegetation in the area and maximise habitat diversity and a range of successional stages.	The aim of revegetation would be to establish a range of habitat niches through revegetation (including canopy, understorey and ground cover). The cleared lands would be actively managed to promote revegetation of native woodland/forest species. This would include, but not necessarily be limited to, removal of weeds, creating disturbance to the introduced grassland (via slashing or low-intensity controlled burning), and planting or seeding of flora species represented in the surrounding native vegetation communities. Local seed sources would be used.
Management of livestock grazing.	Livestock grazing would be excluded from the biodiversity offset areas through the provision of appropriate stock fencing.
Control of weeds to enable natural regeneration of native vegetation.	Weeds (including declared noxious weeds) would be controlled and monitored by an appropriately qualified contractor using standard methods.
Introduced animal management to benefit native wildlife.	Introduced animals would be controlled and monitored by an appropriately qualified contractor using standard methods.
Bushfire management.	Access tracks throughout the proposed biodiversity offset areas would be maintained for fire management. Apply fire regimes that maintain dense understorey vegetation cover. Where fire control is necessary apply mosaic pattern hazard reduction burns so the same areas are not burned continuously.
Controlling vehicular access.	Vehicular access would be controlled by fencing and signing the biodiversity offset areas. Vehicle movements would be predominately on designated vehicle tracks.
Nest box programme.	Install and monitor an appropriate number of nest boxes for the Squirrel Glider and other arboreal animals. This may include salvage of tree hollows during Project vegetation clearance activities. As a minimum a ratio of 1:1 (i.e. 1 nest boxes of appropriate size, to replace 1 hollow of similar size and properties) would be adopted.
Salvage and relocation of logs, vegetative material and rocks.	Habitat features (e.g. large hollows and some suitable logs) would be salvaged during Project vegetation clearance activities and relocated to areas where habitat enhancement is required.

Adapted source: Appendices E and F.

Offset Areas 3 and 4 include a 132 kV power line (Figure 4-22). The management of offset lands within the power line easements would be in accordance with the requirements of the power authority. This may include access roads and only limited, or no, revegetation.

Monitoring of the Biodiversity Offset Areas

A programme would be undertaken to monitor and report on the effectiveness of the measures and the performance of the revegetation in the biodiversity offset areas, with summary reporting to be carried out annually and comprehensive reporting following the independent audit of the offset areas (refer to discussion below). The monitoring would be undertaken by a suitably qualified person(s).

Terrestrial fauna surveys would also be conducted every three years to monitor the use of the biodiversity offset areas by vertebrate fauna.

Independent Audits of the Biodiversity Offset Areas

The proposed biodiversity offset areas would be independently audited at intervals agreed with relevant authorities. The audits would be conducted by a suitably qualified person(s) to:

- assess compliance with the Biodiversity Management Plan;
- assess the performance of the biodiversity offset areas;
- review the adequacy of the management measures and monitoring programme; and
- recommend actions or measures to improve the performance of the biodiversity offset areas, Biodiversity Management Plan, or monitoring programme, if required.

Conservation Bond

SCPL would lodge a conservation bond with the DP&I to ensure availability of funding for implementation of the biodiversity offset strategy in accordance with the performance and completion criteria of the Biodiversity Management Plan.

Reconciliation of the Proposed Biodiversity Offset Strategy against NSW State Requirements

Table 4-30 provides a reconciliation of the proposed biodiversity offset strategy against the OEH Offset Principles.

A reconciliation of the proposed biodiversity offset strategy against the Commonwealth Requirements is provided in Appendix H.

Table 4-30
Reconciliation of the Proposed Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2011)	Description of How the Proposed Biodiversity Offset Addresses the OEH Offset Principles
Impacts must be avoided first by using prevention and mitigation measures.	Measures to avoid and mitigate Project impacts on flora are described in Section 4.9.3, and fauna in Section 4.10.3. The proposed biodiversity offset areas are proposed to address residual impacts.
All regulatory requirements must be met.	SCPL is required to meet all statutory requirements. The proposed biodiversity offset areas are not proposed to substitute other licence/approval requirements.
Offsets must never reward ongoing poor performance.	The proposed biodiversity offset areas are proposed to address residual impacts associated with the Project only.
Offsets will complement other government programmes.	An arrangement would be made for the long-term protection and management of the identified biodiversity offset areas (or equivalent) within 12 months of grant of Development Consent (e.g. a voluntary conservation agreement pursuant to section 69B of the *National Parks and Wildlife Act 1974*, as described in contemporary major mining project conditions pertaining to biodiversity offsets). The proposed biodiversity offset areas (part of Offset Areas 2 and 3) expand on two existing areas conserved under voluntary conservation agreements (Figure 4-22). Also of note is that: • the habitat within Offset Area 3 is linked through private properties to The Glen Nature Reserve; and • the proposed Offset Area 3 is located within an OEH recognised climate change corridor (DECC, 2007b).
Offsets must be underpinned by sound ecological principles.	The biodiversity offset areas are underpinned by sound ecological principles such as: • consideration of structure, function and compositional elements of biodiversity through flora and fauna surveys; • enhance biodiversity at a range of scales through a number of proposed management measures; • measures to protect the long-term viability and functionality of biodiversity (e.g. enhancing the existing habitat as well as securing and managing the land for conservation purposes); and • in the long-term, biodiversity offset areas would facilitate connectivity between valley floor habitats and the Karuah Mountains – this link is poor at present.
Offsets should aim to result in a net improvement in biodiversity over time.	A net improvement in flora and fauna abundance and diversity is likely because: • 435 ha of cleared land would be revegetated and 10 ha of existing planted trees would be retained, linking many disjunct smaller patches of vegetation; • each vegetation type to be impacted is represented in the biodiversity offset areas; • additional fauna habitat types would be conserved to those that would be impacted, providing habitat for additional species; • additional vegetation types would be conserved to those that would be impacted; • the biodiversity offset areas (totalling 935 ha) would be conserved in perpetuity; and • measures to monitor and independently audit the biodiversity offset areas are provided.

Table 4-30 (Continued)
Reconciliation of the Proposed Biodiversity Offset Strategy against OEH Offset Principles

OEH Offset Principles (OEH, 2011)	Description of How the Proposed Biodiversity Offset Addresses the OEH Offset Principles
Offsets must be enduring. They must offset the impact of the development for the period that the impact occurs.	As mentioned above, the land tenure underlying the proposed biodiversity offset areas would be secured in perpetuity for wildlife conservation.
Offsets should be agreed prior to the impact occurring.	The biodiversity offset areas are proposed as part of the Project. The implementation of the biodiversity offset areas is likely to be a condition of Development Consent.
Offsets must be quantifiable. The impacts and benefits must be reliably estimated.	The flora and fauna in both the proposed disturbance area and biodiversity offset areas has been extensively surveyed by FloraSearch (Appendix E), Australian Museum Business Services (Appendix F) and EcoBiological (reported in Appendices E and F). This report provides an assessment of both including: • area of the biodiversity offsets and area of impact; • communities/species present and their conservation status; • connectivity and condition of habitat; and • management actions and security for the biodiversity offset areas.
Offsets must be targeted.	The biodiversity offset areas have been targeted to offset impacts on the basis of a like-for-like or better conservation outcome. The biodiversity offset areas represent ecological communities with a high conservation status. In addition, the biodiversity offset areas contain habitat with a high conservation status, as demonstrated by the presence of numerous threatened fauna species in the biodiversity offset areas (Section 4.10.4).
Offsets must be located appropriately.	The proposed biodiversity offset areas are located within the same CMA region as the Project area (i.e. the Hunter-Central Rivers CMA region) and therefore have the capacity to benefit biodiversity values in the same region as the Project. The proposed biodiversity offset areas are suitably located because it is local to the area proposed to be disturbed and has a greater chance of maintaining and improving the biodiversity that would be impacted.
Offsets must be supplementary.	The implementation of the biodiversity offset strategy is beyond existing requirements, in that the biodiversity offset areas is not subject to an existing conservation agreement.
Offsets and their actions must be enforceable through development consent conditions, licence conditions, conservation agreements or a contract.	Measures to monitor and independently audit the biodiversity offset areas are provided. The implementation of the biodiversity offset areas is likely to be a condition of Development Consent.

Adapted source: Appendices E and F.

4.10 TERRESTRIAL FAUNA

A Terrestrial Fauna Assessment has been prepared for the Project by Australian Museum Business Services (2012a) and is presented in Appendix F.

A description of the existing environment relating to fauna is provided in Section 4.10.1. Section 4.10.2 describes the potential impacts of the Project on fauna, including cumulative impacts, and Section 4.10.3 outlines fauna mitigation measures, management and monitoring. Section 4.10.4 describes the components of the Project biodiversity offset strategy relevant to fauna.

4.10.1 Existing Environment

Regional Setting

The Project area is in the Hunter-Central Rivers CMA region as well as within the North Coast Bioregion as defined in the *Interim Biogeographic Regionalisation for Australia: a Framework for Establishing the National System of Reserves* (Thackway and Cresswell, 1995; SEWPaC, 2011a).

Fauna Surveys

Past fauna surveys in the area include frog surveys (SCPL, 1994c; Murray, 1994; Mount King Ecological Surveys, 2001), general fauna surveys (Mount King Ecological Surveys, 2001), reptile surveys (SCPL, 1994c; Mount King Ecological Surveys, 2001), bird surveys (AGC Woodward-Clyde, 1994; Mount King Ecological Surveys, 2001) and bat surveys (Hoye and Finney, 1994; Hoye, 1998; Richards, 2001).

Fauna surveys have been undertaken for the Project (Ecobiological, 2011a, 2011b, 2011c; AMBS, 2011b, 2012b; Kerle, 2011; Biosphere Environmental Consultants, 2011). These reports are provided in Appendix F.

Ecobiological (2011a) undertook systematic surveys in the Project area and surrounds between 2007 and 2010. The terrestrial vertebrate fauna surveys were conducted over multiple seasons considering the relevant State and Commonwealth survey guidelines. The survey techniques included Elliot B ground trapping, cage trapping, ANABAT call recording, harp traps, pitfall traps, hair tubes, spotlighting, herpetological searches, bird surveys, nocturnal call playback and searches for tracks and traces (Appendix F).

Targeted surveys for the New Holland Mouse were undertaken by Ecobiological (2011b), AMBS (2011b) and Dr Anne Kerle (Kerle, 2011). Biosphere Environmental Consultants (2011) undertook surveys in February 2011 along Dog Trap Creek that consisted of nocturnal surveys, call playback, tadpole surveys and habitat assessments.

Targeted searches for threatened fauna species were conducted as part of the above studies. Potential habitat for threatened fauna species was evaluated based on the habitat requirements of threatened species which could possibility occur in the Project area (Appendix F).

Fauna Habitat

Six broad fauna habitat types occur within the Project area (Figure 4-23 and Appendix F) as listed below:

- Wet Sclerophyll Forest Habitat – This habitat occurs in the eastern section of the Project area and is patchily distributed.
- Grassy Woodland Habitat – Scattered in the lowland areas the grassy woodland habitat has a relatively limited and fragmented distribution within the Project area and surrounds.
- Dry Sclerophyll Forest Habitat – The most widely distributed habitat in the Project area, this habitat occurs in various patches in the Project area and along the range to the east.
- Derived Grassland/Shrub Regrowth Habitat – disturbed version of the Dry Sclerophyll Forest Habitat which occurs in the north-east of the Project area.
- Acacia Regeneration Habitat – A small patch of Acacia predominantly occurs west of the Stratford East Open Cut though a small portion occurs in the Project area.
- Cleared Land (including planted trees) - These areas generally contained scattered paddock trees, some with hollows which could provide some nesting/refuge habitat for mobile hollow dependant species.

Native Terrestrial Fauna Species Composition

A total of 276 native vertebrate species have been located within the Project area and surrounds since 1994, comprising of 20 species of frog, 31 species of reptile, 179 species of bird and 46 species of mammal (Appendix F). A comprehensive list of fauna species recorded within the Project area and surrounds is provided in Appendix F.

Introduced Terrestrial Fauna Species

A total of 13 exotic fauna species are known to occur in the area, which include four species of bird and nine species of mammal. Exotic species are considered to be uncommon, with the exception of the European Hare, which is considered to be common (Appendix F).

Threatened Fauna Species under the TSC Act

Threatened fauna species listed under the TSC Act that have been recorded in the Project area and/or surrounds are shown on Figures 4-24 to 4-26. A total of six threatened birds and five threatened mammals (three of which are bats) have been recently recorded in the Project area:

- Glossy Black-Cockatoo;
- Little Lorikeet;
- Masked Owl;
- Scarlet Robin;
- Grey-crowned Babbler (eastern subspecies);
- Varied Sittella;
- Brush-tailed Phascogale;
- Squirrel Glider;
- Little Bentwing-bat;
- Eastern Freetail-bat; and
- Eastern Bentwing-bat.

In addition to these species, the Speckled Warbler has been recorded between the Roseville West Pit and the BRNOC (Figure 4-24). The Comb-crested Jacana and Magpie Goose have been recorded at artificial wetlands (Figure 4-24).

The Grey-headed Flying-fox has been recorded in Offset Area 3, south of the Stratford East Open Cut (Figure 4-25) and the Long-nosed Potoroo has been recorded to the east of the up-catchment diversion for the Stratford East Open Cut (Figure 4-25).

State Environmental Planning Policy No. 44 – Koala Habitat Protection

An assessment of potential and core Koala habitat for the purposes of *State Environmental Planning Policy No.44 – Koala Habitat* (SEPP 44) has been undertaken for the Project. The assessment determined that some vegetation communities in the Project area meet the definition of potential Koala habitat, but the Project area does not fall within the definition of core Koala habitat (Appendix F).

Threatened Fauna Species under the Commonwealth EPBC Act

The New Holland Mouse is listed as vulnerable under the EPBC Act and is the only threatened species listed under the EPBC Act to have been recorded in the additional surface development area (Appendix F). The New Holland Mouse is not listed as a threatened species under the TSC Act.

The Grey-headed Flying-fox and Long-nosed Potoroo are also listed as threatened under the EPBC Act and have been recorded in the vicinity of the Project. Matters of National Environmental Significance under the EPBC Act are further discussed in Appendix H.

The NSW populations of Koala have been recently listed as threatened under the EPBC Act. The Koala has not been recorded in the additional surface development area, but it was recorded in the biodiversity offset areas. As described above, a SEPP 44 assessment was undertaken (Appendix F).

Migratory Species under the Commonwealth EPBC Act

Eleven migratory bird species listed under the EPBC Act have been recorded within the Stratford Mining Complex or surrounds. These include the: Fork-tailed Swift, Rainbow Bee-eater, Great Egret, Cattle Egret, Satin Flycatcher, Rufous Fantail, Black-faced Monarch, Spectacled Monarch, Double-banded Plover, Latham's Snipe and White-bellied Sea-eagle (Appendix F).

4.10.2 Potential Impacts

Fauna Habitat Removal and Modification

The area of native vegetation which would be cleared for the Project is described in Section 4.9.2.

The vegetation clearance for the Project equates to the clearance of the following broad fauna habitat types within the additional surface development area (Figure 4-23 and Appendix F):

- approximately 195 ha of Cleared Land (including planted trees);
- approximately 65 ha of Dry Sclerophyll Forest Habitat;
- approximately 19.2 ha of Wet Sclerophyll Forest Habitat;
- approximately 5.5 ha of Derived Grassland/Shrub Regrowth Habitat;
- approximately 13.5 ha of Grassy Woodlands Habitat; and
- approximately 0.5 ha of Acacia Regeneration Habitat.

The Project would result in the reduction of physical habitat connectivity. The Avon North Open Cut and the Stratford East Open Cut would physically isolate patches of dry sclerophyll forest/grassy woodland from surrounding habitat until revegetation of the post-mine landforms (Appendix F).

The Project has the potential to cause mortality of some animals as a result of direct encounters with construction works/ vehicles or through removal of habitat during clearing (Appendix F).

Hollow-bearing Trees, Dead Wood/Dead Trees, and Bush Rock

Loss of hollow-bearing trees and *Removal of dead wood and dead trees* are key threatening processes listed under the TSC Act. A range of hollow-nesting birds, bats and arboreal mammals were recorded within the Project area, including cockatoos, parrots, gliders, possums and microbats (Appendix F).

Eight threatened fauna species that nest or roost in tree hollows were recorded in the Project area (not necessarily using tree hollows): Glossy Black-Cockatoo; Little Lorikeet; Masked Owl; Brush-tailed Phascogale; Squirrel Glider; Eastern Freetail-bat; Eastern Bentwing-bat; and Little Bentwing-bat.

Bushrock removal is also a key threatening process listed under the TSC Act. Clearing in the Project area would result in removal of bushrock, although it is considered to be a relatively minor impact on fauna (Appendix F). No major or continuous rock formations are present in the Project area.

Changes to Hydrology

The *Alteration to the Natural Flow Regimes of Rivers and Streams and their Floodplains and Wetlands* is a key threatening process listed under the TSC Act and *Degradation of native riparian vegetation along New South Wales water courses* is a similar key threatening process under the NSW *Fisheries Management Act, 1994*.

No terrestrial fauna habitat is likely to be impacted by Project changes to groundwater levels and surface water flows because:

- no measureable changes in flows in the Avon River, Avondale Creek and Dog Trap Creek downstream of the Stratford Mining Complex would result from the Project (Section 4.5.2); and
- FloraSearch (2012) found that no vegetation appears to be associated with groundwater.

Introduced Fauna

Many introduced fauna pose a threat to native fauna through competition for habitat resources and direct predation. The European Rabbit, the European Red Fox and the Feral Cat are known to occur in the Project area and surrounds. *Predation by the feral cat, Competition and grazing by the feral European rabbit* and *Predation by the European red fox* are key threatening processes listed under the TSC Act. Measures to prevent and control introduced fauna are provided in Appendix F and Section 4.10.3.

Introduced Flora

Introduced flora can adversely alter habitat for native fauna species. Measures to prevent and control weeds are provided in Appendix E and Section 4.9.3.

Fauna and Noise, Dust and Artificial Lighting

There is a potential for increased disruption to fauna surrounding the Project due to dust, noise, and artificial lighting. Measures would be adopted to minimise noise (Section 4.6.3), dust (Section 4.7.3) and artificial lighting (Section 4.10.3).

Vehicular Traffic Movements

Vehicular traffic movements associated with the Project have the potential to increase the mortality of some fauna species. It is considered unlikely that wildlife mortality on roads would substantially increase as a result of the Project, given there are existing roads currently in operation, the low traffic volume and proposed management to reduce the potential for this impact to occur (Appendix F).

High Frequency Fire

As described in Section 4.9.2, the risk of high frequency fire as a result of the Project is considered to be relatively low (Appendix E) given the relatively high rainfall in the area and grazing management, supported by the observed lack of evidence of past fires.

Potential Impacts from Irrigation

The existing Stratford Mining Complex is approved to undertake irrigation on rehabilitation areas within a contained catchment. This irrigation method would be continued for the Project with the proposed irrigation areas draining directly to mine water storages. No additional impacts on existing fauna habitats are expected and no fauna species (e.g. frogs) are likely to be impacted by irrigation (Appendix F).

Fauna Interaction with the Final Voids

At the cessation of mining, final voids would remain in the Roseville West Pit Extension, Avon North Open Cut and Stratford East Open Cut (Section 2.13). The salinity of the final void water bodies is predicted to slowly increase over time (Appendix B). The final voids are unlikely to pose a significant risk to native animals given the wider availability of other (more suitable) sources of water (Appendix F).

Threatened Fauna Species under the TSC Act

A total of 33 threatened fauna species listed under the TSC Act are considered likely to be affected or have the potential to be affected to some degree by the Project, either through loss of known or potential habitat and/or direct loss of individuals (Appendix F).

All threatened fauna species known or considered likely to occur in the Project area and immediate surrounds (and therefore have the potential to be impacted by the Project) have been assessed via an Assessment of Significance under section 5A of the EP&A Act. The assessments are detailed in Appendix F.

The conclusion of the Assessment of Significance (Appendix F) was that the Project would be unlikely to significantly impact on any threatened species of fauna, with the possible exception of the Squirrel Glider, which was considered to have the potential to be significantly impacted in the short-term due to the proposed removal of habitat and a temporary increase in isolation of some known habitat areas. These impacts are not considered likely to result in the loss of the entire local population (Appendix F).

The Project incorporates a range of measures targeted specifically at maintaining the Squirrel Glider population, including a nest-box programme and monitoring. Because the Squirrel Glider is currently persisting in a few relatively small patches, the biodiversity offset strategy has the potential to improve the conservation of the local Squirrel Glider population in the medium to long-term (Appendix F).

Threatened Fauna Species under the Commonwealth EPBC Act

An assessment of the potential impacts on threatened fauna species under the EPBC Act is provided in Appendices F and H. In summary, it was concluded that the Project is not likely to significantly impact any listed threatened fauna species under the EPBC Act.

Migratory Species under the Commonwealth EPBC Act

An assessment of the potential impacts on migratory species is provided in Appendices F and H. In summary, it was concluded that the Project is not likely to significantly impact any listed migratory species under the EPBC Act.

Cumulative Impacts

The incremental impacts of the Project and the existing/approved Stratford Mining Complex in the context of the existing and past land use have been considered by Australian Museum Business Services in Appendix F. Australian Museum Business Services (Appendix F) also assesses the cumulative impacts of yet to commence developments, such as the AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project.

The incremental impacts of the Project on fauna are expected to occur as a result of additional habitat clearing, and associated impacts such as habitat fragmentation and loss of individual animals. As described in Section 4.9.2, the Project further reduces the occurrence of already highly cleared habitat types (specifically the Cabbage Gum open forest or woodland on flats of the North Coast and New England Tablelands). However, the Project biodiversity offset strategy provides for the conservation, enhancement, and revegetation of larger areas of this habitat (Appendix F). Australian Museum Business Services (Appendix F) concludes that the Project would maintain and improve biodiversity (fauna) values in the region in the medium to long-term.

4.10.3 Mitigation Measures, Management and Monitoring

Refinements to the Project Design to Minimise Land Clearance

Refinements to the Project design to minimise land clearance are described in Section 4.9.3.

Proposed Biodiversity Management Plan

As described in Section 4.9.3, SCPL would prepare and implement a Biodiversity Management Plan for the Project.

Management measures of particular relevance to terrestrial fauna are discussed below and the biodiversity offset strategy is discussed in Sections 4.9.4 and 4.10.4.

Timing Land Clearance to Minimise Harm of Fauna

Where practicable, vegetation clearing would occur during late summer or early autumn to minimise impacts to a large range of fauna breeding during spring and summer, and fauna which would hibernate during winter (e.g. microbats). If vegetation clearance is required outside of this time period, then suitably qualified personnel would assess the habitat to be disturbed and determine the appropriate vegetation clearance procedures.

The amount of vegetation cleared would be the minimum required to allow mining operations to continue for the ongoing year, where practicable, taking into consideration requirements for soil erosion control.

The construction of the up-catchment diversions east of the Stratford East Open Cut would occur in as short a time frame as practical, to minimise the period of potential disturbance to the Long-nosed Potoroo habitat where the species has been recorded to the east of the Project area.

Vegetation Clearance Procedures

As described in Section 4.9.3, a Vegetation Clearance Protocol has been developed for the Stratford Mining Complex (SCPL, 2002b). The purpose of a Vegetation Clearance Protocol is to restrict clearing to the minimum area necessary to undertake the Project and minimise the impacts on fauna present during clearing.

Trapping for Squirrel Gliders would be undertaken in the Project area and those found would be fitted with a radio tracking device as soon as practical after grant of Development Consent, to assist with the estimation of home ranges and identify important habitat resources (e.g. den trees and foraging areas). The information gathered would be used to adjust the implementation of management measures (e.g. if important den sites are identified and are due to be cleared, additional nest boxes may be installed and/or the important hollows relocated). Further measures relevant to the New Holland Mouse are described in the relevant sub-section below.

A suitably trained and qualified person(s) to the satisfaction of the Director-General would be present during vegetation clearance to manage animals that may be encountered during land clearing.

The vegetation clearance procedure in relation to fauna is further detailed in Appendix F.

Salvage and Relocation of Logs, Vegetative Material and Rocks

Habitat features (e.g. trunks, logs, large rocks, branches, small stumps and roots) would be salvaged during vegetation clearance activities and stockpiled for relocation to nearby areas (i.e. rehabilitation areas, biodiversity enhancement areas or biodiversity offset areas). When relocated, these features are likely to provide habitat resources for a range of invertebrate and ground dwelling fauna.

A description of the material salvaged and relocated would be reported in the Annual Review.

Salvage and Relocation of Tree Hollows

Some tree hollows salvaged during vegetation clearance activities would be selectively chosen for placement in areas where habitat enhancement is required. These features may be securely attached to suitable trees or placed on the ground. Tree hollows placed in trees would be monitored according to the nest box programme.

Nest Box Programme

An existing nest box programme is in place at the Stratford Mining Complex in accordance with the BRNOC Flora and Fauna Management Plan (SCPL, 2002b), to provide nesting habitat for birds, arboreal mammals, and bats. The existing programme would be expanded for the Project and documented in the Biodiversity Management Plan. Additional nest boxes would replace lost tree hollows at a 1:1 ratio.

A variety of different sized nest boxes would be installed within 12 months of grant of Development Consent. Further detail on the nest box programme is provided in Appendix F.

Once installed, the nest boxes would be monitored by suitably qualified personnel to observe fauna usage. A monitoring report would be prepared annually that includes a summary of previous monitoring reports. The monitoring results would be reported in the Annual Review.

Management of Exotic Animals

Measures to control exotic animals to be undertaken within the Project area, biodiversity enhancement area and biodiversity offset areas include:

- trapping and/or baiting of animal pests (e.g. European Rabbits and European Red Foxes); and
- follow-up site monitoring to determine the effectiveness of trapping and/or baiting programmes.

Measures to control exotic animals would be implemented by an appropriately qualified person(s). A summary of the exotic animal management and monitoring results would be reported in the Annual Review.

Management of Artificial Lighting

Potential artificial lighting impacts on fauna would minimised by the use of unidirectional lighting for new fixtures. Further discussion of lighting management is provided in Section 4.15.3.

Vehicular Traffic Movements

The on-site speed limit of 60 km/hr would continue to be applied to new haul roads and internal roads.

Biodiversity Enhancement Area

The biodiversity enhancement area is described in Section 4.9.3.

Glider poles (temporary wooden poles that a glider can move between) would be installed in the biodiversity enhancement area to assist the movement of the Squirrel Glider until natural habitat is established. Further detail is provided in Appendix F.

New Holland Mouse

The following mitigation measures are proposed to reduce potential impacts on the New Holland Mouse:

- an intensive trapping programme prior to clearing to remove any New Holland Mouse individuals from within the additional surface development area and relocate them to suitable habitat in adjoining areas;
- further discourage re-entry of individuals into the additional surface development area through habitat disturbance immediately following the trapping and clearing of individuals (e.g. low intensity fires);
- installation of temporary fencing adjacent to the clearance area to minimise movement of relocated mice back into the disturbance area prior to clearance;
- ecological burns to enhance flora species diversity and condition of the vegetation understorey within biodiversity offset areas; and
- bush regeneration in the biodiversity offset areas including planting of appropriate native species, seed dispersal and weed controls.

Glossy Black-Cockatoo

The following mitigation measures are proposed to reduce potential impacts on the Glossy Black-Cockatoo:

- planting new *Allocasuarina* spp. tubestock as a mid-storey species (in the biodiversity enhancement and biodiversity offset areas);
- fencing areas of remnant *Allocasuarina* spp. (in the biodiversity enhancement and biodiversity offset areas) to protect them from grazing cattle; and
- fire management (i.e. fire would be prevented for at least the first five years after planting tubestocks in the biodiversity offset areas).

Squirrel Glider

The following mitigation measures would ameliorate the short-term potential impacts on the Squirrel Glider relating to habitat loss and connectivity of the local population:

- installation of nest boxes, commencing within 12 months of grant of Development Consent, and relocation of cleared hollows (refer above);
- additional plantings of feed trees/shrubs for the species as soon as practical after grant of Development Consent (and within a maximum of 12 months from grant of Development Consent);
- erection of glider poles in the biodiversity enhancement and biodiversity offset areas (i.e. wooden poles erected between habitats and potentially used by gliders for movement until natural habitat is established), within 12 months of grant of Development Consent; and
- fitting of radio collars and monitoring of the local Squirrel Glider population by radio tracking as soon as practical after grant of Development Consent, and monitoring fauna use of nest boxes and glider poles (described above).

These measures (including suggested locations for glider poles) are detailed in Appendix F.

Proposed Rehabilitation Management Plan

The disturbance areas associated with the Project would be progressively rehabilitated and revegetated with species characteristic of native woodland/open forest (350 ha) and pasture with scattered trees (300 ha) (Figure 4-4). Scattered trees across the pasture areas could provide habitat for a range of fauna that use open woodland habitats.

The Stratford East Dam would be enhanced by:

- installing plain wire fencing to exclude livestock grazing from 50% of the dam perimeter;
- planting a range of submerged and fringing vegetation (rushes, shrubs, trees);
- placing a partially submerged log in the dam for use by a variety of fauna; and
- placing a log pile for refuge habitat on the dam shores.

Section 5 presents the rehabilitation objectives and provides a description of the rehabilitation works to be undertaken and the rehabilitation assessment and completion criteria.

After the revegetation programme is established, fauna monitoring surveys would be performed by the appropriately qualified personnel at three year intervals. The monitoring results would be reported in the Annual Review.

4.10.4 Biodiversity Offset Strategy

The biodiversity offset areas are described in Section 4.9.4. The proposed biodiversity offsets would constitute a suitable area to offset residual fauna impacts associated with the Project, given the existing biodiversity values of the proposed biodiversity offset areas as well as the anticipated improvement in the fauna habitat values in the medium to long-term.

Key benefits of the biodiversity offset areas in relation to fauna are listed below:

- The addition of the biodiversity offset areas as new protected areas enhances nature conservation in the region.
- The biodiversity offset areas are located adjacent to existing blocks of native vegetation, some of which are already conserved by existing conservation agreements (Figure 4-22).
- The revegetation of biodiversity offset areas is designed to provide connectivity between isolated woodland remnants. This would facilitate movement of animals between remnants and the large block of forest to the east and south of the Project area, thereby re-establishing genetic exchange across the landscape (Figure 4-4).
- Numerous threatened species are known to inhabit the biodiversity offset areas or conservation areas that directly adjoin the biodiversity offset areas (Figures 4-24 to 4-26). These include, the:
  - Comb-crested Jacana;
  - Glossy Black-Cockatoo;
  - Masked Owl;
  - Scarlet Robin;
  - Grey-crowned Babbler (eastern subspecies);
  - Varied Sittella;
  - Koala;
  - Brush-tailed Phascogale;
  - Yellow-bellied Glider;
  - Squirrel Glider;
  - New Holland Mouse;
  - Long-nosed Potoroo;
  - Grey-headed Flying-fox;
  - Eastern Freetail-bat;
  - Little Bentwing-bat;
  - Eastern Bentwing-bat; and
  - Southern Myotis.
- Each habitat type proposed to be cleared by the Project is represented in the biodiversity offset areas[5].
- When agricultural parts of the biodiversity offset areas are removed from agricultural production, remnant woodlands can be expected to begin natural regeneration and thus provide habitat for fauna.
- Cleared paddock areas would be planted strategically with appropriate tree and shrub species that would provide habitat for fauna to recolonise.
- The biodiversity offset areas support samples of all native vegetation types within the Project disturbance areas and have a greater diversity of vegetation types than occur on the Project area. Therefore, additional habitat would be available for fauna species that occur and could potentially occur in the area.

4.11 AQUATIC ECOLOGY

An Aquatic Ecology Assessment has been prepared for the Project by frc environmental (2012) and is presented in Appendix G.

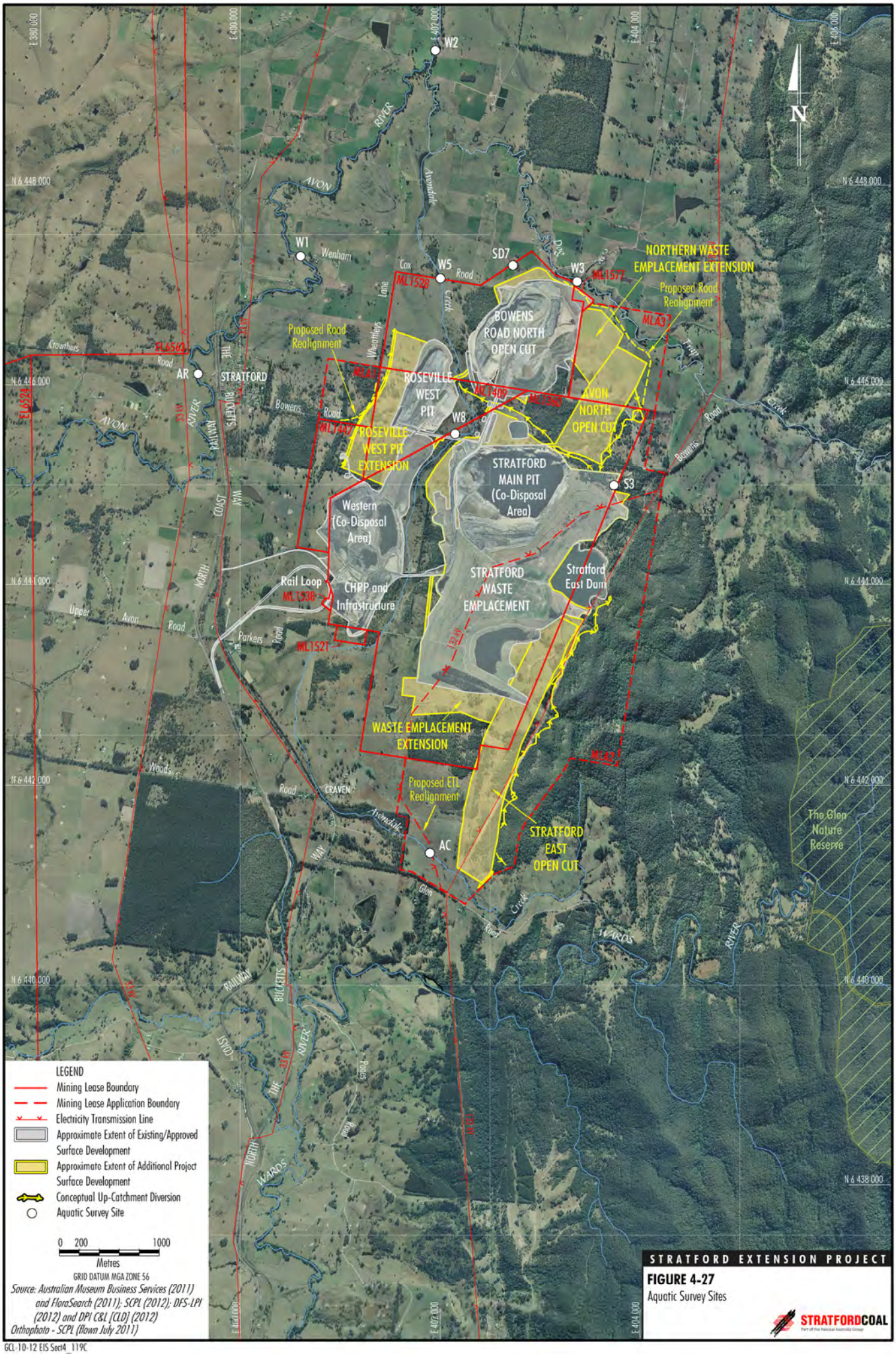
A description of the aquatic ecosystems of the Project area and surrounds is provided in Section 4.11.1. Section 4.11.2 describes the potential impacts of the Project on aquatic ecology, including cumulative impacts, while Section 4.11.3 outlines relevant mitigation measures, management and monitoring. Section 4.11.4 describes the components of the biodiversity offset strategy relevant to aquatic ecology.

4.11.1 Existing Environment

Regional and Local Setting

Regional hydrology is described in Section 4.5.1. The surface water drainage in the local area is shown on Figure 4-27. An overview of the nature of these watercourses is provided below.

[5] With the exception of Derived Grassland, which is derived as a result of previous land use activities from other habitat types recorded in the surface development area and biodiversity offset areas.



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The majority of Avondale Creek has been highly modified by past farm practices. It begins in the heavily wooded native forest to the east of the Project area but runs through predominantly cleared, grazing country in the lower sections (Figure 4-27). The mid reach of Avondale Creek currently supports permanent wetlands in the area between Bowens Road and Parkers Road, and immediately south of Parkers Road. These wetlands have been created by historical road construction (Appendix G).

Dog Trap Creek occurs to the north of the Stratford Mining Complex and drains the forested escarpment area north-east of the Project area and flows westward into Avondale Creek. The downstream portion of Dog Trap Creek is heavily impacted by cattle grazing.

The Avon River is a slow flowing river that occurs to the west of the Project area, with strong flow persistence (Appendix G and Figure 4-27).

Aquatic Ecology Monitoring

Invertebrate Identification Australasia (IIA) has undertaken the aquatic ecology monitoring programme around the Stratford Mining Complex since 2000. The monitoring programme has included sampling of physiochemical water quality and macroinvertebrates. Sampling sites include Avondale Creek, Avon River, Dog Trap Creek and a tributary of Avondale Creek. Further detail on the monitoring programme is provided in Appendix G.

Survey results show that the ecological condition of the Avon River and its tributaries has improved over the last three years and that the Stratford Mining Complex has had no adverse impacts on the Avon River and Avondale Creek. The results of the aquatic ecology monitoring undertaken by IIA have been considered in the Aquatic Ecology Assessment provided in Appendix G.

Aquatic Ecology Surveys

frc environmental (Appendix G) undertook additional aquatic ecology surveys in 2011. Avondale Creek, Dog Trap Creek, Avon River and other ephemeral creeks within the Project area, and immediately upstream and downstream of the Project area were sampled (Figure 4-27).

Aquatic habitat condition (including water quality parameters), macrophyte diversity, aquatic macroinvertebrates, fish and other aquatic vertebrates (e.g. turtle and platypus) were surveyed. Sampling was conducted according to Australian River Assessment System (AUSRIVAS) (Turak and Waddell, 2002) and bioassessment scores (Queensland Department of Natural Resources and Mines, 2001) were measured. AUSRIVAS assesses in-stream habitat condition and bioassessment scores provide an index of habitat condition, which enables a comparison of habitat quality between sites.

The potential for threatened aquatic biota listed in the schedules of the NSW *Fisheries Management Act, 1994* and EPBC Act to occur in the locality was evaluated by frc environmental (Appendix G).

Aquatic Habitats

Ephemeral Tributaries of Avondale Creek

Ephemeral creeks episodically carry runoff from the eastern range to Avondale Creek. These unnamed creeks flow when there is sufficient rainfall and provide only marginal and ephemeral aquatic habitat. The tributary of Avondale Creek located between Stratford Main Pit and BRNOC contains sections that are relatively undisturbed from an aquatic ecology perspective, although the catchment area of this creek has already been altered by the Stratford Mining Complex (Section 4.5.1). This creek is characterised by a dense native riparian zone, undisturbed stream banks, some macrophytes, substrate consisting of gravel and sand on a hard clay base.

Avondale Creek

The aquatic habitat associated with Avondale Creek varies along its length. Although the surface water flow in Avondale Creek is predominantly ephemeral, past road construction has created a permanent artificial wetland in the mid reach of the creek. The northern and southern sections of the creek are narrow, with a wider area covered by the artificial wetland area (Figure 4-21). The narrow sections are degraded, incised and provide limited aquatic habitat (Appendix G).

Photographs of Avondale Creek in the vicinity of the Project are provided on Figure 4-13.

Both run and pool habitat is present along the creek. The creek substrate (surface sediment) is dominated by silt/sand in the upper reaches and silt along the downstream reach of Avondale Creek. Boulders have also been recorded along the creek.

There is varying portions of aquatic vegetation (i.e. macrophytes), woody debris and overhanging/trailing bank vegetation, with a greater density of these habitats in the artificial wetland area in the mid reaches. Riparian vegetation has largely been removed from along the length of Avondale Creek.

The lower sections of the Avondale Creek have very high natural salinity levels as a result of saline groundwater discharges (Section 4.5). Turbidity is generally high along Avondale Creek upstream of the Project area, while pH and EC are both within the water quality guidelines for the Manning River Catchment (Appendix G). Dissolved oxygen is below the guideline range downstream of the Project area, but is within the guideline range upstream of the Project area (Appendix G).

Avondale Creek provides habitat for fish and macroinvertebrates.

Dog Trap Creek

When flowing, Dog Trap Creek is fast flowing with a course sand and gravel substrate on a clay base. The downstream area is heavily impacted by cattle grazing and has a minimal riparian zone consisting mainly of Eucalyptus and Casuarina species. The stream banks and bed are impacted by cattle activity, with areas of bank erosion.

Photographs of Dog Trap Creek in the vicinity of the Project are provided on Figure 4-14.

Most water quality parameters (turbidity, pH and EC) are within the water quality guidelines for the Manning River Catchment (Appendix G). Dissolved oxygen was the only parameter below the guideline range upstream of the Project area.

Dog Trap Creek provides habitat for fish and macroinvertebrates.

Avon River

The banks of the Avon River have a narrow riparian zone consisting of a mixture of native and introduced tree and shrub species and the surrounding catchment has largely been cleared, with cattle grazing being the main agricultural activity.

Both run and pool habitat is present along the watercourse. The riffle zone of the riverbed is characterised by course gravel and cobble riffles on a hard clay base, while the pool substrate is fine sand to silt.

Turbidity is generally high along the Avon River upstream of the Project area, while pH and dissolved oxygen are both below the water quality guidelines for the Manning River Catchment downstream of the Project area (Appendix G). EC is within the guideline range upstream and downstream of the Project area (Appendix G).

The Avon River provides habitat for macroinvertebrates and aquatic vertebrates (fish, turtles, Platypus) (Appendix G).

Macroinvertebrates

The most common and abundant macroinvertebrates sampled by frc environmental were non-biting midge larvae (sub-families Chironominae and Tanypodinae) and water boatman (family Corixidae).

Aquatic Vertebrate Fauna

Ten species of fish were caught during the survey. The most abundant and widespread species caught were the Eastern Gambusia (*Gambusia holbrooki*) (an exotic and declared noxious species) and the Firetail Gudgeon (*Hypseleotris galii*).

The number of fish species found in the community at each site ranged from one (Avondale Creek) to seven (Avon River) (Appendix G). Dog Trap Creek supported two fish species (Appendix G). Fish communities were most diverse along the Avon River. One Platypus was sighted in the Avon River, downstream of the confluence of Avon River and Avondale Creek.

Groundwater Dependent Ecosystems

There are no aquatic ecosystems (creeks or wetlands) in the Project area or surrounds that are dependent on groundwater.

Some saline groundwater inflow may occur in Dog Trap Creek and Avondale Creek, however, this is only likely to potentially influence the composition of fish and invertebrate communities (i.e. would be expected to reduce the prevalence of species that are less tolerant to naturally elevated salinity).

Stygofauna are aquatic subterranean invertebrate animals found in some groundwater systems. Two groundwater systems occur in the Project area, including the fractured rock groundwater system (associated with the Project coal resource) and the alluvial groundwater system (associated with Dog Trap Creek and Avondale Creek) (Section 4.4.1). Either of these groundwater systems could provide habitat for stygofauna, although recent sampling co-ordinated by Cardno Ecology Lab Pty Limited for the proposed Rocky Hill Coal Project, in the same types of habitat with similar salinities (EC values exceeding 3000 µS/cm), did not record any stygofauna (GRL, 2012).

Threatened Aquatic Biota

No threatened aquatic biota listed in the schedules of the NSW *Fisheries Management Act, 1994* or EPBC Act were identified by the aquatic surveys or monitoring or are considered likely to occur in the Project area or surrounds (Appendix G).

4.11.2 Potential Impacts

The Aquatic Ecology Assessment (Appendix G) provides an assessment of the potential impacts on aquatic ecology, considering key threatening processes under the NSW *Fisheries Management Act, 1994* and EPBC Act. Potential impacts on aquatic ecology were considered in terms of vegetation clearing and earthworks, changes to flow regimes, surface water quality, creek crossings and obstructions to fish passage, irrigation, threatened aquatic biota, groundwater dependent ecosystems and cumulative impacts, as described below. The Project does not involve the off-site discharge of contained water from operational areas.

Ephemeral Tributaries of Avondale Creek

Some ephemeral, first order creeks would be removed in the extent of additional surface development. These provide only marginal and ephemeral aquatic habitat (Appendix G).

Along the tributary of Avondale Creek located between Stratford Main Pit and the BRNOC, some marginal aquatic habitat would be removed or altered for the construction of a creek crossing and the proposed up-catchment diversions (Figure 2-11). In addition, the water flow in this creek would increase further as the proposed up-catchment diversions that run parallel and to the east of the Stratford East Open Cut would intercept and divert upslope runoff water into this tributary (Section 2.12; Figure 2-11).

There would be no potential for drawdown of groundwater to impact the aquatic ecology in this tributary of Avondale Creek since the creek is ephemeral.

A crossing across the tributary of Avondale Creek is for a proposed haul road to the Avon North Open Cut (Figure 2-11). Construction of the creek crossing may disturb sediment, leading to increases in localised turbidity and sediment deposition. If construction is carried out during the dry season, these impacts would be minimal or absent since the creek is ephemeral and disturbed areas would be managed with silt fences and revegetation (Appendix G).

Avondale Creek

As described in Section 2.12.1, a haul road crossing is proposed across Avondale Creek between the BRNOC and Roseville West Pit Extension (Figure 2-11).

Some marginal aquatic habitat would be removed or altered for the construction of a creek crossing. In addition the proposed up-catchment diversions would intercept and divert upslope runoff water away from the pits to Avondale Creek (Section 2.12; Figure 2-11).

The total catchment excision for the Avondale Creek is expected to increase marginally (i.e. less than 4%) and no measureable changes in flows in the creek would result from the Project (Section 4.5.2).

Dog Trap Creek

The Project would have little to no impact on the aquatic ecology in Dog Trap Creek. This creek is greater than 40 m from the road realignment and 150 m from the proposed Avon North Open Cut. However, the proposed up-catchment diversion east of the Avon North Open Cut would divert upslope water to Dog Trap Creek (Section 2.12).

The total catchment excision for Dog Trap Creek is expected to increase marginally (i.e. less than 3.5%) and no measureable changes in flows in the creek would result from the Project (Section 4.5.2). Given the existing conditions in the creek (e.g. stream banks and bed heavily impacted by cattle grazing with areas of bank erosion), the Project would be unlikely to have a significant impact on aquatic ecology (Appendix G). No creek crossings across Dog Trap Creek are proposed for the Project.

Avon River

The risk of impacts to aquatic faunal habitat in the Avon River is considered likely to be very low. The total catchment excision for the Avon River is expected to increase marginally (i.e. less than 0.6%) and no measureable changes in flows in the river would result from the Project (Section 4.5.2).

Potential sediment runoff from the Project area would be minimised via the use of sediment dams and up-catchment diversions, so the potential for impact to aquatic ecology in the Avon River would be expected to be very low (Appendix G).

The Project would not adversely impact vertebrate fauna (Platypus) within the Avon River (Appendix G).

Irrigation

Irrigation on rehabilitation areas within a contained catchment is approved for the existing Stratford Mining Complex and would continue for the Project with the proposed irrigation areas draining directly to mine water storages. No impacts on existing aquatic vegetation are likely to occur (Appendix G).

Aquatic Threatened Species under the NSW Fisheries Management Act, 1994

No threatened aquatic species listed in the schedules of the NSW *Fisheries Management Act, 1994* or EPBC Act are considered likely to occur in the Project area or surrounds (Appendix G).

Threatened Ecological Communities under the NSW Fisheries Management Act, 1994

No threatened ecological communities listed under the NSW *Fisheries Management Act, 1994* were considered to be relevant to the Project (Appendix G).

Groundwater Dependent Ecosystems

Lowering of the groundwater table could impact stygofauna if they were to occur in the groundwater system. The Project would impact upon the fractured rock groundwater system, however the fractured rock groundwater system associated with the Project is extensive and is likely to provide continuous habitat for stygofauna if present (i.e. stygofauna species that potentially occur within the Project area are also likely to occur in the surrounds). It is noted, however, that recent sampling for the proposed Rocky Hill Coal Project did not identify any stygofauna (Section 4.11.1).

Negligible drawdown in the aquifers of the alluvial groundwater system is predicted (Section 4.4.2).

Based on the above, the additional groundwater drawdown resulting from the Project is not likely to significantly impact stygofauna. Further, as described in Section 4.4.2, numerical modelling shows that the water levels in the groundwater systems would recover over time.

Cumulative Impacts on Aquatic Ecology

The incremental impacts of the Project and the existing/approved Stratford Mining Complex in the context of the existing and past land use have been considered by frc environmental in Appendix G. frc environmental (Appendix G) also assessed the potential cumulative impacts of yet to commence developments, such as the AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project.

frc environmental (Appendix G) consider that it is unlikely that the Project would result in a significant increase in cumulative adverse impacts on aquatic ecosystems.

4.11.3 Mitigation Measures, Management and Monitoring

Proposed Biodiversity Management Plan

As described in Section 4.9.3, SCPL would prepare and implement a Biodiversity Management Plan for the Project.

Management measures of particular relevance to aquatic ecology are discussed below and the biodiversity offset strategy is discussed in Section 4.11.4.

Construction and Design of Creek Crossings

The new creek crossings would follow the NSW *Policy and Guidelines for Fish Friendly Waterway Crossings* (DPI, 2004) and *Policy and Guidelines for Aquatic Management and Fish Conservation* (DPI, 1999), and be regularly maintained.

Design principles would be adopted as listed below:

- Creek crossings to be located at least 100 m from any other creek crossing in order to minimise cumulative effects.
- *Ask First: A Guide to Respecting Indigenous Heritage Places and Values* (Australian Heritage Commission, 2002).

- Culverts would be as short (i.e. along the length of the stream) and as wide (i.e. across the stream channel) as practicable, to allow the passage of anticipated flood volumes and associated debris, and to allow enough water depth within the culvert to facilitate fish movement.
- Culverts would be open-bottomed, where practicable, to retain the natural morphological features of the stream. If this is not practical, culverts should be countersunk below the stream bed and natural materials such as rocks secured to the base of the culvert to increase roughness and reduce water velocity.
- Native vegetation would be planted around the culvert after construction to stabilise banks, provide food and habitat for fauna and prevent predation of aquatic fauna by birds.

The culverts would be checked and maintained annually for debris or plant growth that impedes fish passage.

Timing Land Clearance to Minimise Harm of Fauna

Creek crossings would be installed at the driest time of the year, where practical.

Monitoring Aquatic Ecology

SCPL would continue to annually monitor aquatic ecosystems around the Project. If any unpredicted material adverse impact is detected, SCPL would undertake an investigation into the source of the impact and potential remediation.

Proposed Rehabilitation Management Plan

Section 5 presents the rehabilitation objectives and provides a description of the rehabilitation works to be undertaken and the rehabilitation assessment and completion criteria.

Proposed Site Water Management Plan

Erosion and sediment control measures to be undertaken as part of the Project are described in Section 4.3.3.

Geomorphological surveys would also be undertaken at two yearly intervals of the tributary of Avondale Creek (Section 4.5.3). The surveys would determine whether works are required to stabilise the tributary. As a result of any works that may be required, potential impacts to aquatic habitat would be minimised.

Other Management Measures Relevant to Aquatic Ecology

Operation and maintenance of vehicles and equipment would be conducted in a manner to substantially reduce, if not eliminate risks associated with the spillage of fuels and other contaminants.

4.11.4 Biodiversity Offset Strategy

The biodiversity offset areas are described in Section 4.9.4. The biodiversity offset areas also contain a number of drainage lines that would be subject to conservation and enhancement:

- two reaches of the Wards River occur in the proposed Offset Area 3 (approximately 0.5 km and 0.65 km);
- upper reach of the Avondale Creek in the proposed Offset Area 3 (approximately 4.4 km); and
- other drainage lines.

4.12 ABORIGINAL HERITAGE

An Aboriginal Cultural Heritage Assessment was undertaken for the Project by Kayandel Archaeological Services (2012) and is presented in Appendix I.

The Aboriginal Cultural Heritage Assessment for the Project has been undertaken in accordance with the following guidelines:

- *Aboriginal Cultural Heritage Consultation Requirements for Proponents 2010* (DECCW [now referred to as the OEH], 2010a).
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010b).
- Clause 80C of the NSW *National Parks and Wildlife Regulation, 2009*.
- *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC, 2005b).
- The Australian International Council on Monuments and Sites (ICOMOS) *Burra Charter* (Australia ICOMOS, 1999).
- *Aboriginal Cultural Heritage: Standards and Guidelines Kit* (NSW National Parks and Wildlife Service, 1997).

- *NSW Minerals Industry Due Diligence Code of Practice for the Protection of Aboriginal Objects* (NSW Minerals Council, 2010).

A description of Aboriginal heritage in the vicinity of the Project is provided in Section 4.12.1. Section 4.12.2 describes the potential impacts of the Project on Aboriginal Heritage, including cumulative impacts, and Section 4.12.3 outlines mitigation measures, management and monitoring.

4.12.1 Existing Environment

Aboriginal History

The Project area is located on lands which include the border of the Birpai (or Birripai) tribe and the Worimi tribe (Tindale, 1974). The Birpai tribe occupied the area from the mouth of the Manning River at Taree and inland to near Gloucester (South Australian Museum, undated). The Worimi tribe were located from the Hunter River to Forster near Cape Hawke along the coast, at Port Stephens and inland to near Gresford (South Australian Museum, undated).

ERM Mitchell Cotter Pty Ltd (1995) indicates that the historical literature contains evidence of contact between Aboriginal groups living in the region. Regular gatherings or corroborees were described indicating that songs, dances and stories were exchanged and wives sought (ERM Mitchell McCotter Pty Ltd, 1995). There was also inter-tribal participation in specific rituals such as food increase rites and initiation ceremonies (ERM Mitchell McCotter Pty Ltd, 1995).

Leon and Feeney (1998) indicate that the Worimi people had a distinctive way of life and periodically visited the coast, which corresponded with seasonal movements of seafood. The Worimi people also attended various locations for ceremonial purposes. Natural stone material used for manufacturing tools was obtained within the Worimi area and also through trade with neighbouring tribal groups (Leon and Feeney, 1998).

Natural Resources

Water sources were available to Aboriginal groups in the drainage lines and creeks located within and surrounding the Project area, with permanent water (i.e. Avon River) located to the west of the Project area.

Variable climatic conditions affected the availability of water and may have subsequently influenced the way Aboriginal people moved through the landscape over time.

A range of floral and faunal resources are available in the Project area and these were potentially seasonally exploited by Aboriginal communities. Sections 4.9, 4.10 and 4.11 and Appendices E, F and G provide information on the terrestrial flora and fauna and aquatic ecology attributes of the Project area and surrounds.

Previous Archaeological Investigations

A number of Aboriginal heritage surveys and assessments have previously been undertaken in the Project area and surrounds, including:

- Brayshaw (1984) *Archaeological Survey of Coal Lease Area, Stratford NSW*;
- Brayshaw McDonald Pty Ltd (1994) *Stratford EIS Updated Archaeological Assessment*; and
- Heritage Search (2000) *Bowens Road North Project, Stratford, NSW: Assessment of Aboriginal and Non-Aboriginal Heritage.*

In addition to the above, a number of relevant investigations have been undertaken in the wider region, including: Brayshaw (1981); Griffith (1992a, 1992b), Kuskie (1993a, 1993b); ERM Mitchell McCotter (1995); Leon and Feeney (1998); Leon (1998); Dallas (1998); McCardle Cultural Heritage Pty Ltd (2008); ENSR Australia Pty Ltd (2008); McCardle Cultural Heritage Pty Ltd (2009); Kayandel Archaeological Services (2009) and Yettica (2010) (Appendix I).

An Aboriginal Heritage Information Management System (AHIMS) database request was also completed for the Project area and surrounds.

This extensive body of existing information assisted with providing a regional context for the Project area and in developing a model of the likely archaeological and cultural significance of the Project area (Appendix I).

Cultural Heritage Assessment Programme

The Aboriginal Cultural Heritage Assessment used relevant information from previous assessments and the results of Project field surveys and associated consultation with the Aboriginal community. Table 4-31 summarises the main stages of the Aboriginal heritage consultation/survey programme undertaken as part of the Project.

The seven Aboriginal stakeholders who registered an interest in being consulted in relation to the Aboriginal Cultural Heritage Assessment process were:

- Cultural Consulting Services;
- Do-Wa-Kee Culture & Heritage Surveys;
- Forster LALC;
- Gloucester Worimi First People;
- Karuah LALC;
- Maaingal Group Worimi Nation; and
- Mookibakh Aboriginal Traditional Owners.

Archaeological Findings

Previous archaeological investigations identified three Aboriginal heritage sites within the Project area and surrounds. These sites include one isolated find and two artefact scatters. Targeted surveys for these three sites were undertaken for the Project.

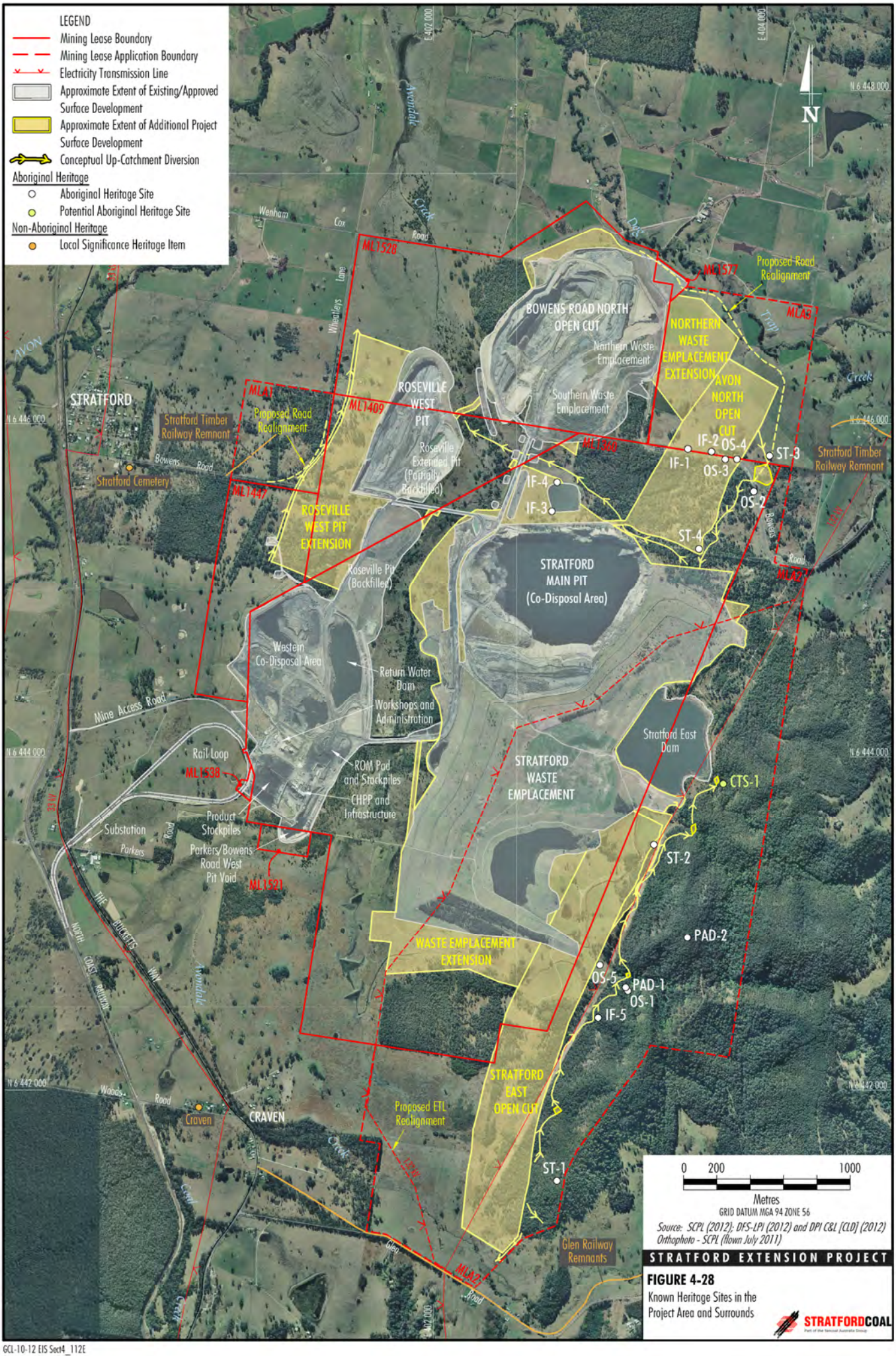
The Stratford 2 Open Site and the Isolated Find (IF-5) recorded by Brayshaw in 1984 could not be located despite targeted surveys. The sites are not listed on the AHIMS database and no co-ordinates for the sites are provided in previous archaeological reports. The location of the Stratford 2 Open Site is not shown on Figure 4-28. The approximate location of IF-5 is shown on Figure 4-28, based on a description of its location provided in Brayshaw (1984).

Surveys undertaken for the Project identified an additional 12 sites including four isolated finds, four artefact scatters and four scarred trees (Figure 4-28). Two potential archaeological deposits (PADs) and one potential cultural site were also identified during the surveys (Figure 4-28). Further description of these sites is presented in Appendix I.

Table 4-31
Summary of the Project Aboriginal Heritage Consultation/Survey Programme

Date	Consultation/Survey Conducted
23 June 2011	Letters requesting the names of Aboriginal parties or groups that may have been interested in registering in the consultation process were sent to the Forster LALC, Karuah LALC, Office of the Registrar *Aboriginal Land Rights Act, 1983*, NTS Corp, OEH Coffs Harbour EPRG, the National Native Title Tribunal, Hunter-Central Rivers CMA and the GSC to identify Aboriginal parties.
12 July 2011	Letters seeking registrations of interest were sent to Aboriginal parties or groups identified by the above step.
13 July 2011	Public advertisement published in the Gloucester Advocate, Great Lakes Advocate and Dungog Chronicle inviting interested Aboriginal parties or groups to register.
24 August 2011	Record of names of registered stakeholders provided to OEH Coffs Harbour EPRG, Forster LALC and Karuah LALC in accordance with DECCW (2010a).
29 August 2011	Provision of a draft methodology for undertaking the Aboriginal Cultural Heritage Assessment distributed to registered stakeholders.
September 2011	Feedback from the registered stakeholders in regard to the proposed methodology received. Consideration given to all comments received on the proposed methodology.
26 September 2011	On-site Project information session held at the SCM with representatives from the following registered stakeholders attending: Do-Wa-Kee Cultural & Heritage Surveys, Gloucester Worimi First People, Forster LALC and Mookibakh Aboriginal Traditional Owners.
27 September 2011	Record of outcomes from the Project information session provided to all registered stakeholders.
27 September 2011	Invitation to registered stakeholders to attend the Aboriginal cultural heritage survey and inspection.
10-14 October 2011	Aboriginal and cultural heritage survey and inspection. Cultural significance of the area and Aboriginal heritage sites discussed with the Aboriginal participants.
October/November 2011	Inspection of potential cultural site identified during field surveys by representatives of registered Aboriginal stakeholders.
18 November 2011	Draft Aboriginal Cultural Heritage Assessment issued to the registered stakeholders for review, including survey results, archaeological and cultural significance assessment (based on feedback received during consultation and fieldwork), potential impacts and proposed management and mitigation measures.
November/December 2011	Written and/or verbal feedback and advice received from registered stakeholders (including comments on the consultation, survey, assessment and proposed management and mitigation measures).
December 2011	Comments received from registered stakeholders on the draft Aboriginal Cultural Heritage Assessment (in relation to cultural heritage) were considered and/or addressed in the Aboriginal Cultural Heritage Assessment.

Source: After Appendix I.



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Archaeological and Cultural Heritage Values

The archaeological significance rankings of the 12 sites recorded by the Project surveys, and three sites previously recorded within the Project disturbance area and surrounds, are provided in Table 4-32. The archaeological significance of the two PADs and the potential cultural site are discussed below.

Table 4-32
Archaeological Significance of Relevant Aboriginal Heritage Sites[1]

Archaeological Significance Ranking	Aboriginal Heritage Site Code	Number of Sites
High	-	-
Moderate	ST-1, ST-2, ST-3, ST-4	4
Low	OS-1, OS-2, OS-3, OS-4, OS-5, IF-1, IF-2, IF-3, IF-4, IF-5, Stratford 2 Open Site	11

Source: After Appendix I.

1 Includes sites recorded by the Project surveys and previously recorded sites.

No Aboriginal heritage sites of high archaeological significance were recorded, however, four sites of moderate archaeological significance (all scarred trees, ST-1 to ST-4) and 11 sites of low archaeological significance were identified (Table 4-32) (Appendix I).

No Aboriginal heritage sites within the Project area or immediate surrounds are listed on the NSW State Heritage Inventory or the Australian Heritage Database.

Subject to the presence and nature of artefactual material (and assuming a similar artefact distribution, density and type to the recorded scatters), the PADs would be assessed as having low to moderate archaeological significance.

A number of representatives of the Aboriginal community identified a location adjacent to the Stratford East Dam (shown as CTS-1 on Figure 4-28) as a potential culturally significant site. Other representatives concluded that the location had no cultural significance. More detail regarding this site is provided in Appendix I.

Aboriginal heritage sites within or surrounding the Project area have been identified as being of cultural significance to registered stakeholders.

Comments received from the registered stakeholders in relation to cultural significance of the Project area and surrounds are detailed in Appendix I. In summary, the Aboriginal community identified that:

- the ridgeline located to the east of the subject area would likely have been used as a travelling route for Aboriginal people moving through the area;
- the wide saddle to the east of the Project area along the ridgeline would have been good temporary camp site for Aboriginal people moving through the area; and
- there were a number of plants growing in the Project area and surrounds including “geebung fruit” and “pudding vine” that would have been traditionally gathered and utilised as bush tucker.

There are a number of culturally significant sites located in the wider region including burials, initiation sites, bora grounds and a corroboree ground (Appendix I).

4.12.2 Potential Impacts

Potential Direct Impacts

The Project would result in the disturbance of 10 known Aboriginal Heritage sites. These sites include two sites of moderate archaeological significance (i.e. ST-2 and ST-4) and eight sites of low archaeological significance (i.e. OS-3, OS-4, OS-5, IF-1, IF-2, IF-3, IF-4).[6]

These sites are located either within the footprint of the Project open cuts, waste rock emplacements, up-catchment diversions or road realignments (Figure 4-28).

6 The type of harm and potential for harm to Stratford Open Site 2 is unknown. Review of historical reference material in association with findings of the field surveys was unable to accurately determine the location of this site. For the purpose of the assessment, this site is conservatively assumed to be located within the proposed disturbance area.

Potential Indirect Impacts

The remaining five known sites, two PADs and the potential cultural site would not be directly impacted by the Project. Possible indirect impacts for sites in close proximity to Project works include:

- accidental damage during construction (e.g. road realignments) (site ST-3); and
- damage due to blast vibration (site CTS-1).

The potential cultural site, CTS-1 contains physical attributes (i.e. rock features) which may potentially be susceptible to damage from blast vibration. SLR Consulting has undertaken a blast impact assessment for the Project and the maximum vibration level at CTS-1 is less than 80 mm/s (Appendix C). Project blasting is not expected to adversely affect this site.

Cumulative Impacts

Kayandel Archaeological Services (2012) concluded that given the nature and scale of the Project, it would not substantially increase cumulative impacts on Aboriginal heritage in the region (Appendix I).

4.12.3 Mitigation Measures, Management and Monitoring

The mitigation, management and monitoring measures detailed below have been developed in consultation with the registered Aboriginal stakeholders. The Project consultation process with registered Aboriginal stakeholders is described in Appendix I.

A Heritage Management Plan would be developed in consultation with the Aboriginal community and the OEH (to the satisfaction of DP&I). The Heritage Management Plan would be developed and would include a description of the management of sites disturbed by the Project.

A summary of measures expected to be included in the Heritage Management Plan and implemented over the life of the Project are provided below. Further detail is provided in Appendix I.

Surface Disturbance

The following list provides measures that would be undertaken to manage the impact of Project surface disturbance works on Aboriginal heritage sites:

- Where practicable, known Aboriginal heritage sites would be avoided during Project construction and operation works.
- Where avoidance of known Aboriginal heritage sites is not practicable (e.g. sites OS-3, OS-4, OS-5, ST-2, ST-4, IF-1, IF-2, IF-3 and IF-4), site(s) would be subject to salvage for safekeeping in consultation with the Aboriginal community. Salvage of sites would include completing an Aboriginal Site Impact Recording Form (or its equivalent) and submitting it to the AHIMS Register.
- Sites located outside (but in close proximity) of Project disturbance areas would be suitably demarcated (e.g. signage and/or fencing) to reduce the risk of accidental damage.
- Site ST-3 is located in close proximity to the proposed road realignment and up-catchment diversion. The design of the road would be such that the scarred tree would not be directly impacted.

During development of the Heritage Management Plan, the Aboriginal community would be requested to provide advice on the storage of collected artefacts, management of artefacts at the completion of Project activities (e.g. artefact replacement onto the post-mining landscape) and the implementation of management measures for any salvaged scarred trees.

General Management Measures

The following listed general management measures would be undertaken throughout the life of the Project as detailed in the Heritage Management Plan:

- Ongoing consultation with the Aboriginal community and appropriate Aboriginal representation during archaeological fieldwork (e.g. collection of artefacts prior to disturbance).
- SCPL would facilitate access for Aboriginal community to known Aboriginal sites located on Yancoal-owned land (e.g. for cultural reasons or as part of scheduled field activities).
- Erosion and sediment control works would be undertaken in accordance with the requirements of the Development Consent and in consideration of Aboriginal cultural heritage sites and management measures.
- Any new Aboriginal heritage sites identified during development of the Project would be registered with the OEH in consultation with the Aboriginal community.

- Any new Aboriginal heritage sites identified during development of the Project would be managed consistent with the measures detailed in the Heritage Management Plan.
- As part of the Stratford Mining Complex induction programme, guidance would be provided on Aboriginal cultural heritage matters to mining employees and contractors who, as a consequence of their roles at site, have the potential to disturb surface and near surface soils.
- In consultation with the Aboriginal community and OEH, consideration would be given to the use of artefactual material salvaged on-site to aid in the education and Stratford Mining Complex induction of mine employees and contractors.
- Access to known Aboriginal sites would be restricted to those undertaking specific authorised activities.
- Monitoring (vibration and photographic) at CTS-1 would be conducted when blasting is undertaken within 1 km of the site.
- Access to CTS-1 would be restricted.
- Inspecting topsoil stripping (for archaeological material) would be undertaken as part of the construction of the Wenham Cox Road realignment adjacent to Dog Trap Creek.

4.13 NON-ABORIGINAL HERITAGE

A Non-Aboriginal Heritage Assessment for the Project was undertaken by Dr Michael Pearson of Heritage Management Consultants (2012) and is presented as Appendix J.

The assessment was prepared in consideration of the relevant principles and articles contained in the *Burra Charter* (Australia ICOMOS, 1999) and the *NSW Heritage Manual* (NSW Heritage Office and NSW Department of Urban Affairs and Planning, 1996).

A description of existing non-Aboriginal heritage within the Project area and surrounds is provided in Section 4.13.1. Section 4.13.2 describes the potential impacts of the Project on non-Aboriginal Heritage, while Section 4.13.3 outlines mitigation and management measures.

4.13.1 Existing Environment

Historical Overview

The Project area was part of a very large land grant held from the early 19th Century by the Australian Agricultural Company that extended from Port Stephens to the Manning River (Appendix J).

Stroud was first developed as a sheep run outpost in 1827. The Wards River/Johnsons Creek area immediately to the south of the Project area seems to have been grazed by Australian Agricultural Company sheep from around 1828. However, the valley in the Project area appears to have been largely wooded during the Australian Agricultural Company period and was only cleared for dairying in the early 20th Century (Appendix J).

In 1903 the first 37 lots in Stratford were auctioned, together with 26,000 acres of farming land in the upper Avon. Stratford subsequently doubled in size in 1905-06 (Appendix J). The railway line and the railway station at Stratford opened in 1913.

The first settlers in Craven were the Blanch family who bought three blocks totalling 450 acres from the Gloucester Estate Company in 1906. Subsequently J.H. Sheddon purchased the Gloucester sawmill in 1913 and set up a second sawmill at Craven in 1913-14 (Appendix J). Ten cottages were built to house mill workers, forming the core of Craven.

Further discussion on the early European settlement and the pastoral history of relevance to non-Aboriginal items in the vicinity of the Project is provided in Appendix J.

Heritage Items of Relevance to the Project

Heritage Management Consultants completed historical and archival research and review of heritage registers prior to survey of the Project area.

No items of state or regional non-Aboriginal heritage significance were identified in the vicinity of the Project (Appendix J).

Items with identified heritage values in the vicinity of the Project in the Gloucester LEP included:

- The Glen, Craven Logging Tramline (parts of); and
- Avon Valley Colliery Site.

Both of these items are listed as being of local significance in Schedule 5 of the Gloucester LEP and are located outside of the Project area (Appendix J).

Five items identified in the site survey were assessed as having local heritage significance, *viz.* the Stratford Timber Railway (cutting and routes 1 and 2), the Glen Timber Railway, the Stratford Cemetery and the Craven Village. These items are all located outside of the Project disturbance area (Figure 4-28) and are described below.

The Stratford Timber Railway was a timber-railed haulage way built to transport logs to a sawmill south of Stratford on the North Coast Railway. Two sections of the railway were identified during the Project survey *viz*. east of Stratford and on Dog Trap Creek (Figure 4-28). No physical evidence of the railway was located by the survey across the Project area (Appendix J).

The Glen Railway was built in 1918-19, and appears to have operated until 1933. The rails and rolling stock were removed in the mid-1930s. The alignment of the Glen Railway is, however, still intermittently traceable from Craven to a point approximately 6 km to the east (Appendix J). The railway ran along the alignment of the present Glen Road (Figure 4-28) and is located approximately 300 m south of the Stratford East Open Cut. Several lots associated with remnants of the Glen Railway are listed on the Gloucester LEP. These lots are located approximately 7 to 13 km east of the Stratford East Open Cut and would not be impacted by the Project.

The Stratford Cemetery is located outside of the Project disturbance area and approximately 1 km west of the Roseville West Pit Extension (Figure 4-28). The cemetery serves as a record of the development of the Stratford area from the early 20th Century and is valued for its strong associations with a number of the early settler families, descendants of whom still reside in the area (Appendix J).

Craven is situated approximately 1.2 km from the Stratford East Open Cut (Figure 4-28). Craven was created to service the Craven sawmill in 1914, as was the Glen Railway. Seven cottages and the church relate to the early development of the village, and the Craven sawmill site survives as an archaeological site. Craven is representative of a relatively intact industrial settlement of the early 20th Century (Appendix J).

Landscapes

The Project is located within the Vale of Gloucester Landscape Conservation Area which was registered by the National Trust of Australia (NSW) in 1976. The listing was revised and extended by the National Trust in 1981, and revised and extended again as the 'Stroud Gloucester Valley Incorporating the Vale of Gloucester' in March 2011 (i.e. the Stratford Mining Complex was operational during the recent listing revision). The listing is not recognised in either the Gloucester LEP or the *Great Lakes Local Environmental Plan 1996* (Appendix J).

4.13.2 Potential Impacts

The Glen Railway and the Stratford Timber Railway are represented by surviving robust earthworks, either cuttings, embankments or flattened areas on level ground. These features would not be susceptible to indirect impacts such as blasting vibration (Appendix J). Remnant landforms associated with the Glen Railway may potentially be disturbed by ancillary works associated with the Project such as the realignment of the existing 132 kV power line to the south-west of the Stratford East Open Cut.

There is some limited potential for indirect blasting related impacts (i.e. associated with blast vibration) on the Stratford Cemetery and buildings within Craven. However, SLR Consulting (2012) conclude that blast vibration resulting from the Project would be less than the relevant building damage criteria at Stratford Cemetery and at all relevant buildings within Craven (Section 4.6 and Appendix C).

Craven would not be directly impacted by mining activities, however, other impacts on Craven (i.e. associated with disuse of buildings) could potentially occur, as many of the residential blocks are now owned by Yancoal.

The Project would not have an adverse affect on the Stroud Gloucester Valley Incorporating the Vale of Gloucester that has been considered by the National Trust to have some cultural landscape value (Appendix J). Potential visual impacts of the Project on the Stroud Gloucester Valley Incorporating the Vale of Gloucester are considered in Section 4.15 and Appendix O.

Cumulative Impacts

Given there would not be any material Project effects on non-Aboriginal heritage values, the Project would not materially contribute to local or regional cumulative impacts on non-Aboriginal heritage.

4.13.3 Mitigation and Management Measures

The Stratford Timber Railway and Glen Railway are located some distance from the major Project disturbance areas, and are of a nature that greatly reduces any potential for adverse impact from mining activities. Notwithstanding, any associated ancillary infrastructure developments such as the realignment of the 132 kV power line would be designed to avoid any impact on the identified sites where practicable.

Blasting management and monitoring measures are provided in Section 4.5.3.

In addition, SCPL would maintain Yancoal-owned buildings within Craven to a standard consistent with the condition of the building/residence when acquired by Yancoal and facilitate occupation of the buildings, if in a suitable condition.

4.14 ROAD TRANSPORT

A Road Transport Assessment for the Project was undertaken by Halcrow (2012) and is presented as Appendix N.

The assessment was prepared in accordance with the *Guide to Traffic Generating Developments* (NSW Roads and Traffic Authority [RTA], 2002), and where relevant, makes reference to the RTA's (1996) *Road Design Guide* and Austroads standards.

Section 4.14.1 provides a description of the existing road network and traffic volumes. Section 4.14.2 provides an assessment of the potential impacts of the Project on the road network in the vicinity of the Stratford Mining Complex, including cumulative impacts. Section 4.14.3 provides relevant mitigation and management measures for road transport.

4.14.1 Existing Environment

Road Hierarchy and Conditions

Regional Roads

The Bucketts Way (Main Road 90) provides access to the Project area. It extends from the Pacific Highway (State Highway 10) at Karuah in the south, to Gloucester in the north and then to the Pacific Highway at Nabiac in the east (Figure 4-1). The Pacific Highway provides access to Newcastle and Sydney from the Project.

The Bucketts Way is a sealed two lane road and in the vicinity of the Project has a posted speed limit of 100 km/hr. Upgrades of The Bucketts Way have recently been undertaken and the road is typically 7 m wide and has sealed shoulders of varying widths (Appendix N).

Local Roads

Bowens Road is a public road that extends eastwards from The Bucketts Way to the south of Stratford (Figure 4-29). It is broken into two sections, the western section terminates at its intersection with Wheatleys Lane and the eastern section commences at its intersection with Wenham Cox Road to the east of the BRNOC (Figure 4-29).

The western section of Bowens Road has a sealed surface varying in width with a minimum of 5.5 m (Appendix N). It has a posted speed limit of 50 km/hr near The Bucketts Way, increasing to 60 km/hr approximately 400 m from The Bucketts Way (Appendix N).

The eastern section of Bowens Road initially has a sealed surface which then changes to an unsealed surface. The width of the eastern section varies and typically has a single lane width with opportunities for vehicles to pass at low speeds (Appendix N).

Wenham Cox Road is a public road that extends eastwards from The Bucketts Way to the north of Stratford (Figure 4-29) and provides access to a limited number of private properties. It is sealed for approximately 5 km east of The Bucketts Way and has a minimum width of 6 m (Appendix N). It has adequate sight distances and opportunities for vehicles to pass at speed (Appendix N).

Wheatleys Lane extends in a north-south direction between Bowens Road and Wenham Cox Road (Figure 4-29). It has a sealed surface and is typically 5.5 m to 6 m wide with no linemarking (Appendix N). There are opportunities for vehicles to pass at low speeds (Appendix N).

The Stratford Mining Complex access road is a private road that extends eastward from The Bucketts Way (Figure 4-29). It has a single lane in each direction and is typically 7 to 7.5 m wide (Appendix N). The Stratford Mining Complex access road has a posted speed limit of 60 km/hr (Appendix N).

STRATFORD EXTENSION PROJECT

FIGURE 4-29

Relevant Local Road Network and Traffic Survey Locations

STRATFORDCOAL

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The Bucketts Way is widened at the intersection with the Stratford Mining Complex access road to provide a separate 130 m right turn deceleration lane and a separate 130 m left turn deceleration lane. This is consistent with a type "CHR" channelised right turn treatment and type "AUL" auxiliary left turn lane treatment as set out in the *Road Design Guide* (RTA, 1996) (Appendix N). Sight distances at the intersection are good (Appendix N).

Existing Traffic Volumes

Available traffic flow data was reviewed and additional traffic counts were conducted in March 2011. Relevant traffic counter locations are shown on Figure 4-29 and the existing daily traffic volumes are summarised in Table 4-33.

Table 4-33
Two-way Estimated Weekday 2011
Traffic Volumes

Road and Location[1]	Daily Traffic Volume
The Bucketts Way (north of the Stratford Mining Complex Access road)	2,190
The Bucketts Way (south of the Stratford Mining Complex Access road)[2]	2,092
Wenham Cox Road (east of Wheatleys Lane)	156
Bowens Road	59
Stratford Mining Complex Access Road	446

Source: After Appendix N.

1 Refer to Figure 4-29.

2 Traffic volumes calculated from the Stratford Mining Complex access road and The Bucketts Way (north of the Stratford Mining Complex access road) surveys.

Roadway Capacity

Austroads (2009) defines a Level of Service as a qualitative measure describing operational conditions within a traffic stream (in terms of speed, travel time, freedom to manoeuvre, safety and convenience) and their perception by motorists and/or passengers. Level of Service A provides the best traffic conditions, with no restriction on desired travel speed or overtaking. The existing Level of Service at each of the survey locations in Table 4-33 is A (Appendix N).

Road Safety

A review of RMS road accident data in the vicinity of the Stratford Mining Complex for the period July 2005 to June 2010 has been undertaken by Halcrow (2012) as a component of the Road Transport Assessment. The review of the RMS accident data identified no particular accident pattern or causation factors in the local area (Appendix N).

SCPL Contributions to GSC and Great Lakes Council

SCPL currently makes annual financial contributions to the GSC to assist in the maintenance of the roads in accordance with Condition 15 Schedule 3 of the SCM Development Consent (DA 23-98/99) and Condition 11.2 Schedule 2 of the BRNOC Development Consent (DA 39-02-01).

In addition, Yancoal currently makes annual financial contributions to the Great Lakes Council and GSC in accordance with Condition 17, Schedule 2, of Project Approval 08_0203 for the DCM.

4.14.2 Potential Impacts

Potential traffic impacts of the Project on traffic generation, roadway capacity and safety are assessed in Appendix N and summarised below.

Project Traffic Generation

Table 4-34 summarises the estimated existing and predicted Project daily vehicle movements (traffic in both directions). As shown in Table 4-34, Project traffic generation would be highest in Year 1. The Project is not expected to generate any additional traffic on Wenham Cox Road or Bowens Road.

Table 4-34
Existing Stratford Mining Complex and
Predicted Project Two-way Weekday Traffic

Vehicle Type	Existing	Year 1 (2013)	Year 11 (2024)
Light Vehicles	349	621	561
Heavy Vehicles	39	47	47
Total Vehicles	**388**	**668**	**608**

Source: After Appendix N.

Cumulative Traffic Increases

The Project life would be approximately 11 years. In order to conservatively consider the potential impacts of the Project in the context of potential background traffic growth and traffic growth associated with other approved and proposed projects, an annual baseline growth rate and the expected traffic generation from key projects has been considered.

Based on an analysis of RMS traffic volume data, a 3% per annum baseline traffic growth rate was applied to the existing traffic volumes on The Bucketts Way (Appendix N). In addition, the expected traffic movements generated from the Duralie Extension Project, AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project have been estimated.

Table 4-35 presents the predicted traffic flows in 2013 and 2024 on key roads including additional Project traffic flows, traffic flows from these other projects and estimated background traffic growth.

Table 4-35
Predicted Cumulative 2013 and 2024
Two-way Weekday Traffic

Road and Location[1]	Existing	Year 1 (2013)	Year 11 (2024)
The Bucketts Way (north of the Stratford Mining Complex Access road)	2,190	2,898	3,333
The Bucketts Way (south of the Stratford Mining Complex Access road)[2]	2,092	2,668	3,139
Wenham Cox Road (east of Wheatleys Lane)	156	482*	194*
Bowens Road	59	113*	79*
Stratford Mining Complex Access Road	446	726	666

Source: After Appendix N.

1 Refer to Figure 4-29.

* Cumulative increases associated with the AGL Gloucester Gas Project only (i.e. no additional Project contributions).

It is expected that for all survey locations in Table 4-35 the Level of Service would remain unchanged for the future scenarios assessed (i.e. Level of Service A) (Appendix N).

Intersection Performance

The Project would increase traffic volumes at the intersection of The Bucketts Way and the Stratford Mining Complex access road and to a lesser extent The Bucketts Way/Bowens Road and The Bucketts Way/Wenham Cox Road intersections.

There is expected to be no capacity concerns regarding the future operation of intersections and the Project would not impact significantly on the efficiency of the road system (Appendix N).

Proposed Road Realignments

The extent of the Project open cut and waste rock emplacements would require realignments of sections of local roads for continued public road accessibility around the northern extent of the Project (Figure 4-29). The road realignments would generally involve the construction of:

- a 400 m sealed two-lane road realignment of Wheatleys Lane and Bowens Road around the western extent of the proposed Roseville West Pit Extension and up-catchment diversion; and
- a 1.7 km sealed two-lane road realignment of Wenham Cox/Bowens Road around the north-eastern extent of the proposed Northern Waste Emplacement Extension and Avon North Open Cut.

The detailed design of the road realignments would be undertaken in accordance with RTA's (1996) *Road Design Guide* to the satisfaction of the GSC.

Level Crossings

Rail level crossings are located on local roads in the vicinity of the Stratford Mining Complex.

Halcrow (2012) considered the incremental risk of road and rail traffic interaction associated with the cumulative increase in rail movements from the Project and the proposed Rocky Hill Coal Project at these local road level crossings and concluded the risk would be low (Appendix N).

Road Safety Review

The Road Transport Assessment (Appendix N) found that there were no identifiable accident causation factors in the vicinity of the Project. As the increases in traffic resulting from the Project would be moderate, Halcrow (2012) considers that the Project is unlikely to result in safety concerns on the surrounding road network.

Temporary Road Closures Associated with Blasting

When blasting is undertaken within 500 m of Bowens Road, Wheatleys Lane, Wenham Cox Road or Glen Road, temporary closure for short periods (i.e. approximately 30 minutes) would be required.

Oversize Traffic

A small number of overwidth, overheight, or overweight loads would be generated during the life of the Project. It is expected that the majority of oversize vehicles would approach the Project from the south via The Bucketts Way. All such loads would be transported with the relevant permits, licences and escorts as required by the regulatory authorities. The proposed route would be negotiated with the relevant local councils on a case-by-case basis.

4.14.3 Mitigation and Management Measures

No significant impacts on the performance, capacity, efficiency and safety of the local road network are expected as a result of the Project, and no specific monitoring or mitigation measures are considered warranted (Appendix N).

Notwithstanding, SCPL would implement the following road transport management measures:

- Temporarily close Bowens Road, Wheatleys Lane, Wenham Cox Road or Glen Road when blasting is undertaken within 500 m of the road (Section 4.13.2). The existing Road Closure Management Plan would be updated for the Project in consultation with GSC and would include:
  - road closure procedures;
  - public safety management measures;
  - procedures for emergency services access during closure periods;
  - details of post-blast road inspections; and
  - notification process.
- All oversized vehicles would have the relevant permits, licences and escorts, as required by the regulatory authorities and the proposed route would be negotiated with the relevant local councils.
- All oversize vehicles loads would be appropriately secured and/or covered.
- The road realignments would be undertaken in accordance with RTA's (1996) *Road Design Guide* to the satisfaction of the GSC.

As described in Section 4.14.1, SCPL currently makes annual financial contributions to the GSC and Great Lakes Council. It is anticipated that similar contributions to the GSC and Great Lakes Council would continue in accordance with the Development Consent, should the Project be approved.

4.15 VISUAL CHARACTER

A Visual Assessment for the Project was undertaken by Resource Strategies (2012) and is presented in Appendix O.

A description of the existing visual setting of the Project is provided in Section 4.15.1. Section 4.15.2 describes the potential visual impacts of the Project, including cumulative impacts, and Section 4.15.3 outlines visual impact mitigation and management measures.

4.15.1 Existing Environment

Views of the Stratford Mining Complex from the surrounding area are generally screened by topography and vegetation, except for some areas to the north and west (Appendix O).

The Project area and surrounds comprise a number of distinct land use types and landscape units, including the existing Stratford Mining Complex, reserved lands, agricultural lands and topographic features. Land use and key landscape features that contribute to visual character and scenic quality are described below in the context of the regional, sub-regional and local settings.

The Project is located within the Stroud Gloucester Valley Incorporating the Vale of Gloucester area is registered by the National Trust of Australia (NSW) for its historical and scenic values.

Topographic features in the vicinity of the Project are described in Section 4.3.1.

Regional Setting (>5 km)

The regional setting has attributes of moderate to high scenic quality due to the presence of the geographical features such as Monkerai Mountain, Brogden's Pinnacles and Lawlers Range, as well as the Gloucester Valley (Appendix O). The valley is a strongly defined landform that is visually enclosed and comprises a combination of natural features and rural land uses.

A number of reserved areas (e.g. Barrington Tops National Park and the Avon River State Forest) are located in the regional setting.

Sub-regional Setting (1 to 5 km)

The sub-regional setting comprises similar features to that found within the regional and local settings. These features include elements of low to high scenic quality such as cleared pastoral land, undulating topography and scattered remnant vegetation (Appendix O).

Local Setting (<1 km)

The ridgeline to the east of the Project area rises to approximately 470 m AHD, is predominantly vegetated and is of moderate scenic quality (Appendix O).

Settlements located within the local setting include Stratford and Craven (Figure 4-30).

4.15.2 Potential Impacts

The major aspects of the Project considered to have the potential to impact on the visual landscape include (Appendix O):

- additional clearance or disturbance of vegetation within the Project area;
- modification of topographic features including expanded placement of waste rock in the Stratford Waste Emplacement (including backfilling of the Stratford Main Pit) and Northern Waste Emplacement;
- an extension of the existing Roseville West Pit and development of the new Avon North and Stratford East Open Cuts;
- progressive rehabilitation of completed landforms; and
- lighting associated with night-time mining operations.

The Stratford Waste Emplacement would be lifted to a maximum height of 196 m AHD. The Northern Waste Emplacement would be lifted to a maximum height of 165 m AHD.

Visual Assessment Methodology

Potential visual impacts were assessed by evaluating the level of visual modification of the Project in the context of the visual sensitivity of relevant surrounding land use areas.

The degree of visual modification of a proposed development can be measured as an expression of the visual interaction, or the level of contrast between the development and the existing visual environment, and is generally considered to decrease with distance (Appendix O).

Visual (viewer) sensitivity is a measure of how critically a change to the existing landscape would be viewed from various use areas, where different activities are considered to have different sensitivity levels (Appendix O). Visual impacts were determined generally in accordance with the matrix presented in Table 4-36.

Table 4-36
Visual Impact Matrix

Visual Modification \ Viewer Sensitivity	H	M	L
H	H	H	M
M	H	M	L
L	M	L	L
VL	L	VL	VL

H = High
M = Moderate
L = Low
VL = Very Low

Source: Appendix O.

Visual Impact Assessment

Visual simulations were prepared for the locations identified in Table 4-37 and shown on Figure 4-30. As these simulation locations are proximal to differing components of the Project, different years would be the most relevant to evaluating potential visual impacts. The Project development simulations therefore vary between Years 2, 4, 7 and 10 to illustrate the period when the landforms would be at their maximum heights and not yet fully rehabilitated and/or when development would be closest to the respective viewpoint. Where relevant, post-mining simulations have been prepared to illustrate the conceptual Project landform following completion of mining and rehabilitation activities.

Predicted visual impacts at the five locations are summarised in Table 4-38 and discussed below.

Dwellings

The potential visual impacts of the Project on two dwellings in the sub-regional setting and one dwelling in the local setting were assessed as part of the visual assessment (Figure 4-30).

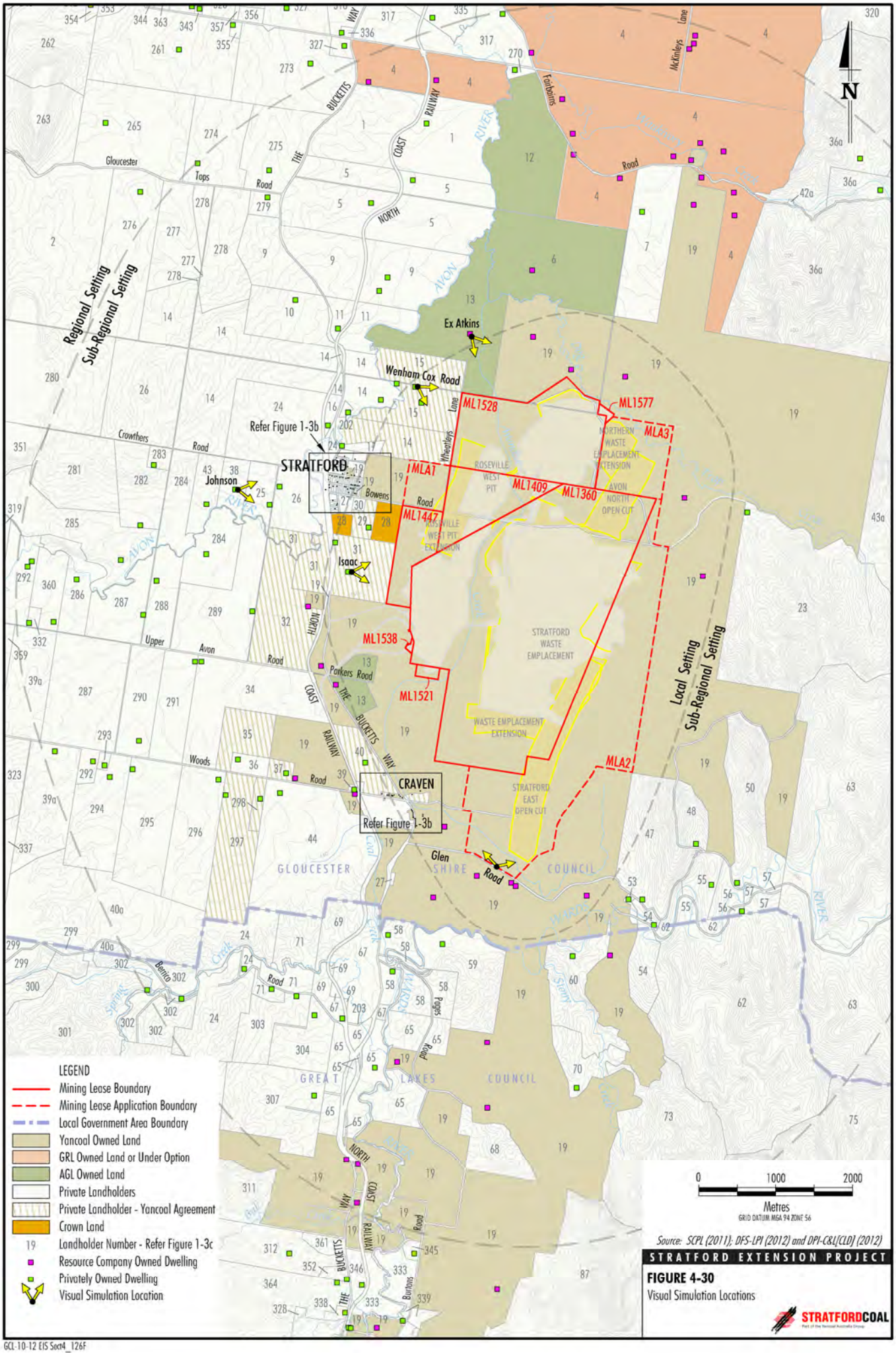

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Table 4-37
Locations of Visual Simulations

Visual Simulation Location	Potential View of Project Landforms	Visual Simulation Figure
Adjacent to the "Johnson" Dwelling (privately-owned)	View towards Stratford Waste Emplacement and Roseville West Pit Extension.	Figure 4-31
Adjacent to the "Ex Atkins" Dwelling (AGL-owned)	View towards Stratford Waste Emplacement, Northern Waste Emplacement Extension and Roseville West Pit Extension.	Figure 4-32
Adjacent to the "Isaac" Dwelling (privately-owned)	View towards Stratford East Open Cut and Stratford Waste Emplacement.	Refer Appendix O
Glen Road	View towards Stratford East Open Cut and Stratford Waste Emplacement.	
Wenham Cox Road	View towards Stratford Waste Emplacement, Northern Waste Emplacement Extension and Roseville West Pit Extension.	

Source: After Appendix O.

The low level of visual modification associated with the Project coupled with the high visual sensitivity at the "Johnson" dwelling and the AGL-owned "Ex Atkins" dwelling indicates a moderate level of potential visual impact would be expected (Table 4-38). With rehabilitation, the level of potential visual impact associated with the Project would reduce to low (Figures 4-31 and 4-32) (Appendix O).

Whilst some isolated viewing locations are located within the sub-regional setting, the intervening topography and distance to the Project means that any potential views would represent only a small proportion of the overall viewscape. The level of potential visual impact at other dwellings with views of the Project in the sub-regional setting would generally be expected to be equivalent to or less than the impacts predicted at the "Johnson" and "Ex Atkins" dwellings.

The low level of visual modification associated with the Project coupled with the high visual sensitivity at the "Isaac" dwelling indicates a moderate level of potential visual impact would be expected (Table 4-38). With rehabilitation, the level of potential visual impact associated with the Project would reduce to very low (Appendix O).

Roads

SCPL has already established vegetation screens along The Bucketts Way in the vicinity of the Project.

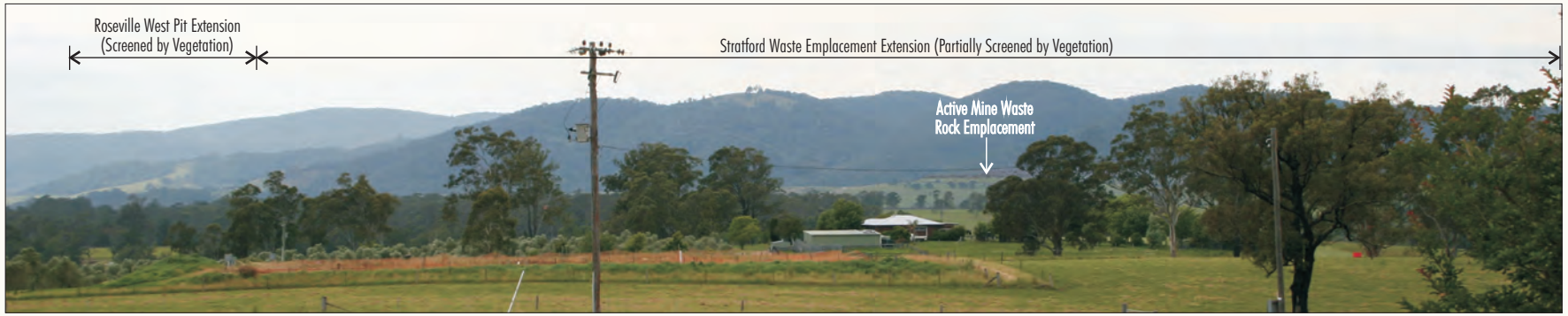
The potential visual impacts of the Project from Glen Road to the south of the Project and Wenham Cox Road to the north-west of the Project were assessed as part of the Visual Assessment. Given the moderate level of visual modification associated with the Project coupled with the low level of visual sensitivity of users of Glen Road, a low level of potential visual impact would be expected (Table 4-38). With progressive and final rehabilitation, tree plantings and revegetation as part of the Project biodiversity offset strategy, the level of potential visual impact associated with the Project would remain low (Table 4-38).

Given the low level of visual modification associated with the Project coupled with the low level of visual sensitivity of users of Wenham Cox Road (Figure 4-30), a low level of potential visual impact would be expected (Table 4-38). With progressive and final rehabilitation, the level of potential visual impact associated with the Project would reduce to very low (Appendix O).

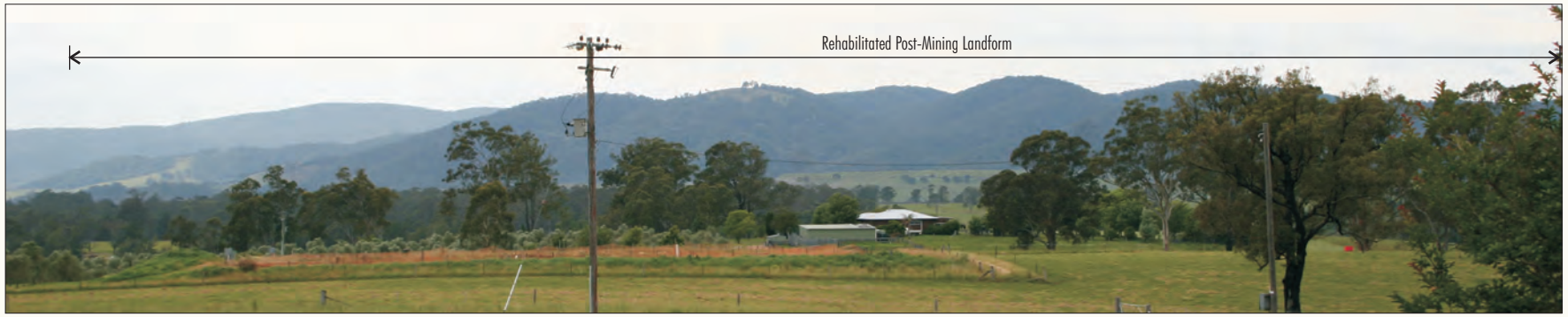
The level of potential visual impact at other roads in the local, sub-regional and regional setting where partial views of the Project may be available (including The Bucketts Way) would generally be expected to be equivalent to, or less than, the impacts predicted for Wenham Cox Road and Glen Road (Appendix O).

Although views towards the Project along Wenham Cox/Bowens Road realignment would be available, only one privately-owned residence is located to the east of the realignment (Figure 2-8). Furthermore, users of this road would already be accustomed to the existing modified landscape that includes views of the Stratford Mining Complex. Notwithstanding, a visual simulation from the "Ex Clarke" residence located along Bowens Road, approximately 400 m east of the realignment is provided in the Visual Assessment (Appendix O).

Existing View



Development Simulation (Year 7)



Post-Mining Simulation

Source: Marc & Co (2012)

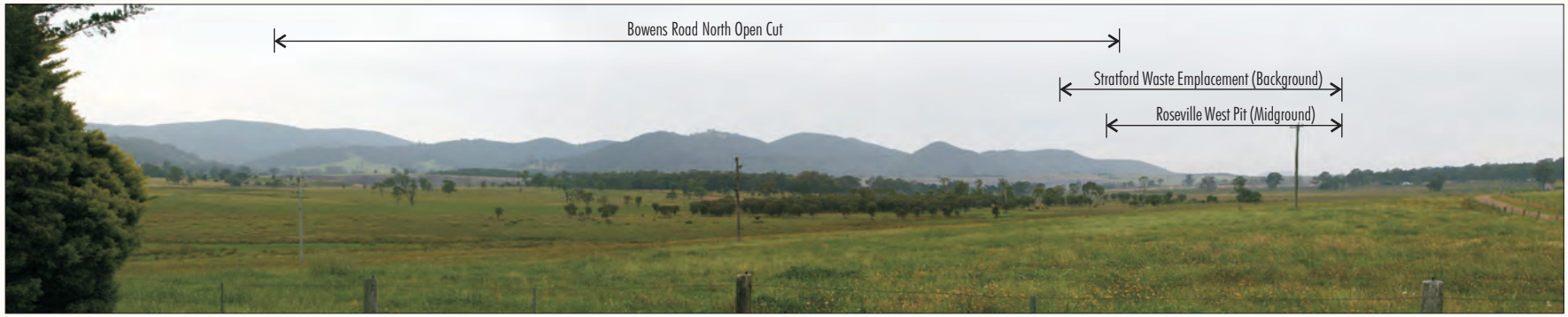
STRATFORD EXTENSION PROJECT

FIGURE 4-31

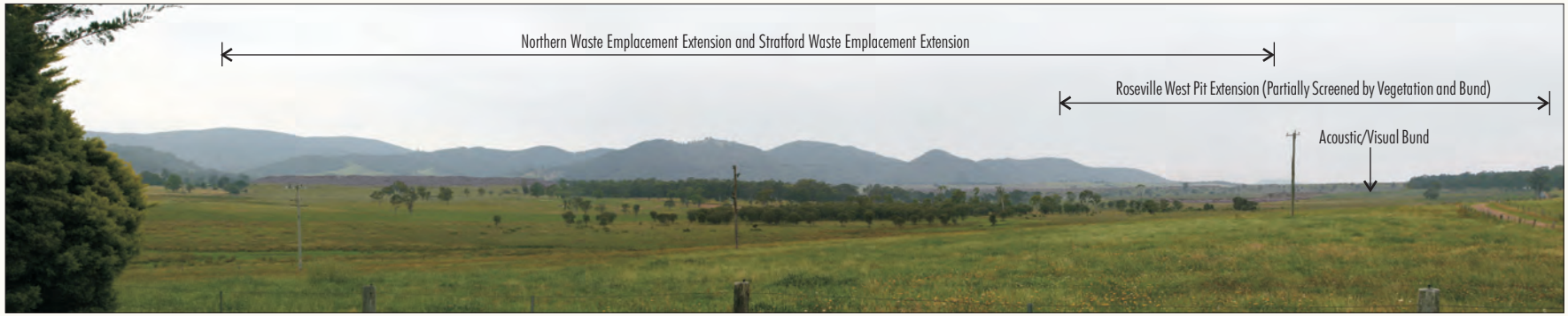
Existing View and Visual Simulations - "Johnson" Dwelling

STRATFORDCOAL

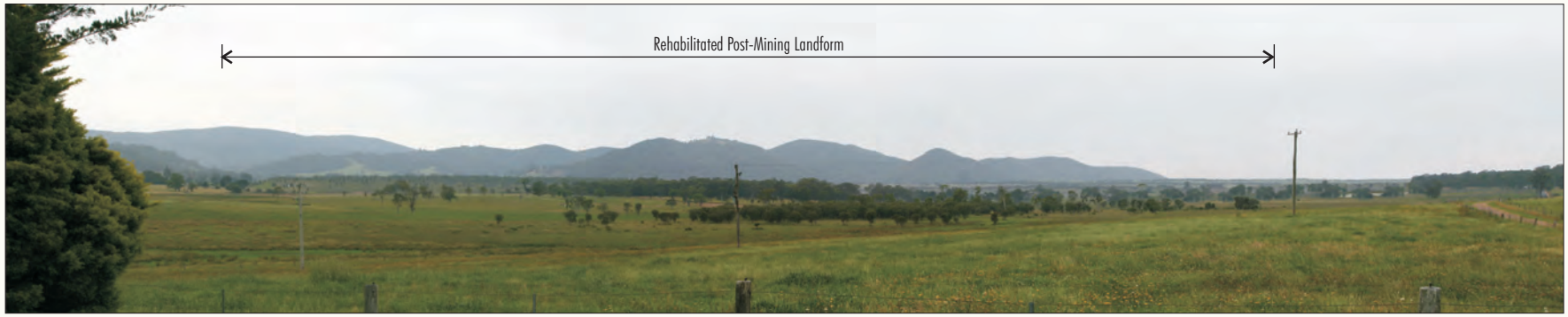
GCL-10-02 EIS Sect4_006C



Existing View



Development Simulation (Year 4)



Post-Mining Simulation

Source: Marc & Co (2012)

STRATFORD EXTENSION PROJECT

FIGURE 4-32

Existing View and Visual Simulations - "Ex Atkins" Dwelling

STRATFORDCOAL

GCL-10-02 EIS Sect4_007C

Table 4-38
Summary of Visual Assessment

Location	Visual Sensitivity	Visual Modification Level	Potential Impact	Potential Impact After Final Amelioration
Sub-Regional Setting (1 to 5 km)				
"Johnson" Dwelling	H	L	M	L
"Ex Atkins" Dwelling (AGL-owned)	H	L	M	L
Local Setting (<1 km)				
"Isaac" Dwelling	H	L	M	VL
Glen Road	L	M	L	L
Wenham Cox Road	L	L	L	VL

Source: Appendix O.

H – High, M – Moderate, L – Low, VL – Very Low.

Night-Lighting

The intensity of the glow produced by night-lighting at the Stratford Mining Complex is likely to increase at various stages over the life of the Project as a result of night-time mining operations. There may also be an increase in night-lighting from mobile equipment and vehicle-mounted lights. Visual effects of lighting associated with the CHPP and infrastructure areas would be similar to existing levels (Appendix O).

Stroud Gloucester Valley Incorporating the Vale of Gloucester

Including the existing ML and proposed MLA areas, the Project has conservatively been estimated to represent a small proportion (i.e. approximately 3%) of the Stroud Gloucester Valley Incorporating the Vale of Gloucester area and would not detract from the scenic or rural values described in the National Heritage Trust of Australia (NSW) listing (Appendix O).

Cumulative Impacts

The assessment of cumulative visual impacts has considered the combined effects of the Project with the effects of existing and proposed operations in the Gloucester Valley, including:

- the existing DCM;
- the AGL Gloucester Gas Project;
- the proposed Rocky Hill Coal Project; and
- the Stroud to Lansdowne Project.

Based on the existing area of the Stroud Gloucester Valley Incorporating the Vale of Gloucester, no significant cumulative visual impacts are anticipated to arise from the coincident development of the Project, approved DCM and AGL Gloucester Gas Project, proposed Rocky Hill Coal Project, or proposed Stroud to Lansdowne Project should these be approved (Appendix O).

If approved, the proposed Rocky Hill Coal Project would also involve evening and (potentially) night-time mining operations and as such, would result in night-lighting impacts (i.e. night-time lighting effects similar to the existing Stratford Mining Complex) that may result in cumulative impacts. For example, there may be increased night-time lighting effects at dwellings situated between the Project and the proposed Rocky Hill Coal Project or at elevated locations where views are currently available across the wider Gloucester Valley landscape (Appendix O).

4.15.3 Mitigation and Management Measures

The mitigation and management measures that would be implemented for the maintenance of visual amenity at the Project are described below.

Progressive Rehabilitation

Progressive backfilling of open cuts and rehabilitation of the Northern Waste Emplacement, Stratford Waste Emplacement, and other mine disturbance areas would be undertaken in order to reduce the contrast between the Project landforms and the surrounding environment. At the end of the Project life, the Avon North Open Cut void, Stratford East Open Cut void and Roseville West Pit Extension void would remain (Figure 4-4).

Rehabilitation would be conducted in accordance with the Rehabilitation Strategy presented in Section 5.

Biodiversity Offsets

The biodiversity offset strategy for the Project includes measures such as revegetation of cleared areas (e.g. between Glen Road and the Stratford East Open Cut void in Offset Area 3) (Figure 4-22). The tree plantings/revegetation would progressively limit potential views of the Project from some viewpoint locations (e.g. Glen Road).

Visual Screening

Upon receiving a request from an owner of any privately-owned dwelling which has significant direct view so the Project, SCPL would implement visual mitigation measures (e.g. vegetation screening) in consultation with the owner to minimise the visibility of the Project from the dwelling.

Night-Lighting

Whilst ensuring that operational safety is not compromised, SCPL would minimise light emissions from the Project by select placement, configuration and direction of lighting so as to reduce off-site nuisance effects where practicable.

Establishment of the permanent visual barrier adjacent to the Roseville West Pit Extension (Figure 2-9) and use of temporary bunding on top of the Stratford Waste Emplacement would also minimise direct views of light sources during night-time mining operations.

Measures that would be employed to mitigate potential impacts from night-lighting would include:

- Compliance with AS 4282: 1997 - *Control of the Obtrusive Effects of Outdoor Lighting* for all external lighting associated with the Project.
- Restriction of night-lighting to the minimum required for operational and safety requirements.
- Use of directional lighting to direct light away from sensitive viewpoints.
- Planting of trees at nearby dwellings to help screen any potential night-time lighting impacts, in consultation with the landholder.

4.16 REGIONAL ECONOMY

A Socio-Economic Assessment (including a regional economic impact assessment) was undertaken for the Project by Gillespie Economics (2012) and is presented in Appendix P.

The regional economic impact assessment was conducted at two different scales to assess the potential impact of the Project on the region and in NSW. The region adopted for the Project was the combined Gloucester and Great Lakes LGAs.

Regional economic impact assessment is primarily concerned with the effect of a proposal on an economy in terms of specific indicators, such as gross regional output (business turnover), value-added, income and employment. The regional economic assessment is based on analysis of 2006 input-output table developed by Gillespie Economics for the region, and analysis of a 2006 input-output table developed by Monash University for NSW.

A summary of the existing regional and NSW economy is provided in Section 4.16.1. The potential impacts of the Project on the regional and NSW economies are described in Section 4.16.2, while mitigation and management measures are provided in Section 4.16.3.

4.16.1 Existing Environment

The gross regional product for the regional economy (i.e. Gloucester and Great Lakes LGAs) is estimated at $1,009M, comprising $517M to households as wages and salaries (including payments to self employed persons and employers) and $492M in other value-added contributions (Appendix P).

The agriculture, forest and fishing, mining (value-added only), and building sector are of greater relative importance to the regional economy than to the NSW economy (Table 4-39), while the manufacturing, utilities and service sectors are of less relative importance than they are to the NSW economy (Table 4-39).

In terms of gross regional output, gross value-added and income, the business services, building/construction and retail trade sectors are the most significant sectors of the regional economy. The retail trade sector is the most significant sector for regional employment (Appendix P).

The retail trade, business services and building/construction sectors and are the most significant sectors of the regional economy for imports, while the retail trade, business services and ownership of dwellings sectors are the most significant sectors for exports (Appendix P).

4.16.2 Potential Impacts

The regional economic impact assessment in Appendix P included consideration of the impacts of the Project on both the regional (i.e. Gloucester and Great Lakes LGAs) and NSW economies, and also potential impacts at the cessation of the Project.

The operation of the Project would provide additional direct employment for 125 people during operations (i.e. Yancoal staff and on-site contractors) (Section 2.17).

The operation of the Project is estimated to provide up to the following average annual economic activity to the regional economy over the life of the Project (Appendix P):

- $215M in annual direct and indirect output;
- $89M in annual direct and indirect value added;
- $24M in annual direct and indirect household income; and
- 250 direct and indirect jobs.

Flow-on impacts from the Project are likely to affect a number of different sectors of the regional economy. The sectors most impacted by output, value-added and income flow-ons are likely to be the other property services; retail trade; accommodation, cafes and restaurants; scientific research, technical and computer services; and the health services sectors (Appendix P).

The operation of the Project is estimated to provide up to the following average annual economic activity to the NSW economy over the life of the Project (Appendix P):

- $340M in annual direct and indirect output;
- $175M in annual direct and indirect value added;
- $72M in annual direct and indirect household income; and
- 714 direct and indirect jobs.

End of Project Life

The establishment and operation of the Project would stimulate demand in the regional and NSW economy leading to increased business turnover in a range of sectors and increased employment opportunities. Cessation of the mining operations would result in a contraction in regional economic activity.

The magnitude of the regional economic impacts of cessation of the Project would depend on a number of interrelated factors, including the movements of workers and their families, alternative development opportunities and economic structure and trends in the regional economy at the time (Appendix P).

New mining resource developments in the region would help broaden the region's economic base and buffer against impacts of the cessation of individual activities (Appendix P). The region is a prospective location with a range of coal and CSG resources (Appendix P).

4.16.3 Mitigation and Management Measures

SCPL would develop a Final Void and Mine Closure Plan for the Project which would include details of the mine closure strategy (Section 5.6). The plan would be developed in consultation with the GSC and the Great Lakes Council, DP&I and the local community, and would include consideration of amelioration of potential adverse socio-economic effects due to the reduction in employment at Project closure.

Table 4-39
Contributions to Employment, Gross Regional Product and Output by Industry Sector – Regional and NSW Economies (2005 to 2006)

Sector	Total Employment (%)		Contribution to GRP (%)		Contribution to Output (%)	
	Regional	NSW	Regional	NSW	Regional	NSW
Agriculture, Forestry and Fishing	8	3	6	2	6	2
Mining	1	1	3	2	2	2
Manufacturing	6	11	8	11	11	19
Utilities	1	1	2	2	3	3
Building	9	7	9	6	13	9
Services	75	77	67	71	64	65

Source: After Appendix P.
Note: Rows may not sum to 100% due to rounding.

4.17 EMPLOYMENT, POPULATION AND COMMUNITY INFRASTRUCTURE

Gillespie Economics (2012) has considered the potential impacts of the Project on existing regional community infrastructure as a result of employment and population change (Appendix P).

The Project contributions to regional employment, population and community infrastructure demand are likely to be modest in terms of the total existing populations in the Gloucester and Great Lakes LGAs, as the additional Project workforce demand would be moderate (Section 2.17).

The Project would however potentially occur in the context of other regional employment, population and community infrastructure demands, in particular demands associated with the AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project.

For the purposes of the employment, population and community infrastructure assessment, the combined Gloucester and Great Lakes LGAs were considered to be the region.

Potential estimated Project only and cumulative employment, population and community infrastructure demands are described in Section 4.17.2. Proposed Project mitigation and management measures are provided in Section 4.17.3.

4.17.1 Existing Environment

Approximately 125 people (including Yancoal staff and on-site contractor's personnel) are employed at the Stratford Mining Complex (Section 2.17). Approximately 58% of the existing workforce resides within the Gloucester and Great Lakes LGAs (Appendix P).

SCPL plays an active role in local community through sponsorships of community organisations and direct community contribution payments to the GSC (Sections 3.3.4 and 3.3.5).
The Gloucester LGA population increased by 0.63% to 4,800 and the Great Lakes LGA population increased by 1.23% to 32,764 between 2001 and 2006, respectively (Appendix P).

A description of the existing population profile, employment, housing, health and education resources in the Gloucester and Great Lakes LGAs is provided in Appendix P.

4.17.2 Potential Impacts

As the impacts of Project construction on regional employment and population would be modest, the following discussion focuses on population and community infrastructure effects during the operation of the Project. Further detail on Project construction community infrastructure effects is provided in Appendix P.

Based on workforce projections and assumptions detailed in Appendix P, Gillespie Economics (2012) has estimated the operational workforce demand, population change and potential impacts on community infrastructure that may arise from the AGL Gloucester Gas Project, the proposed Rocky Hill Coal Project and the Project as described below.

Workforce Demand

The operation of the Project would require an additional workforce of some 125 employees, increasing the total operational workforce at the Stratford Mining Complex from 125 to 250.

The direct non-local workforce demand of the proposed Rocky Hill Coal Project is expected to be 150 additional operational employees (Appendix P).

The direct non-local workforce demand of the AGL Gloucester Gas Project is expected to be 40 additional operational employees (Appendix P).

Table 4-40 summarises the incremental operational workforce associated with the three resource projects operations (i.e. 2014 [Project Year 2] onwards).

Table 4-40
Direct Incremental Operational Workforce Requirements

Proposal	Incremental Workforce
Proposed Rocky Hill Coal Project	150
AGL Gloucester Gas Project	40
Project	125
Total	**315**

Source: After Appendix P.

Table 4-40 indicates the Project operational workforce demand (125 people) would comprise approximately 40% of the direct cumulative operational workforce demand of the three resource projects. The proposed Rocky Hill Coal Project is the largest contributor to the total estimated cumulative workforce demand (Table 4-40).

Approximately 10% of the additional Project workforce is assumed to already reside in the Gloucester and Great Lakes LGAs (Appendix P). The remaining employees are assumed to move to the Gloucester and Great Lakes LGAs or commute to the Project, based on the existing distribution of Stratford Mining Complex employees (Appendix P).

Operational direct non-local workforce demands also potentially increase the regional population when new workers bring spouses and children with them to the region, which is less common during construction activities.

In addition, during operations indirect employment generation from the three resource projects would be expected to result in more flow-on jobs in the region, a proportion of which are expected to be filled by non-locals.

These employment and population flow-on effects have been estimated in the Socio-Economic Assessment (Appendix P), and are summarised below.

Population Effects

The Project maximum direct and indirect population change to the region is estimated to be approximately 269 people (Appendix P).

Table 4-41 illustrates Gillespie Economics (2012) upper level estimates of the total population effects that may arise as a result of the operation of the Project, AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project, based on conservative assumptions regarding residential location, indirect employment, availability of local labour and incoming family size.

Table 4-41
Estimated Upper Bound Cumulative Operational Regional Population Change

Location	Direct Population	Indirect Population	Total Population
Gloucester LGA	291	208	499
Great Lakes LGA	154	109	263
Region Total	**445**	**317**	**762**

Source: After Appendix P.

Note: Totals may have minor discrepancies due to rounding.

It is noted that the Project contribution to this estimated population increase is approximately 35% of the cumulative total.

Community Infrastructure Effects

Housing

Cumulative direct and indirect demand for housing of up to 293 accommodation units (e.g. houses, units, hotel rooms) would be required in the region as a result of the combined direct and indirect effects of the three resource projects at maximum operational employment levels (Appendix P).

The Project housing demand (104) represents approximately 35% of the estimated total cumulative direct and indirect demand for housing (Appendix P).

The Project only direct and indirect demand for housing would be more significant in the Gloucester LGA, which has a lower population relative to the Great Lakes LGA (Section 4.17.1).

Where housing supply is insufficient to meet demand, even temporarily, this may manifest itself in increased property prices and higher rent prices. While this may be seen as beneficial for property owners, it can adversely affect existing tenants, particularly those on lower incomes who can be priced out of the market (Appendix P).

Because of higher relative wages in the mining sector, the demand for rental accommodation and to purchase is likely to be at the higher end of the market, where supply is more limited (Appendix P).

There is scope for an increased proportion of workers to locate in the Great Lakes LGA if there is insufficient housing or other facilities in the Gloucester LGA, which would reduce accommodation demand on the smaller Gloucester LGA (Appendix P).

Approximately 42% of the existing Stratford Mining Complex workforce currently reside outside of the Gloucester and Great Lakes LGAs and commute to the site. Alternative accommodation options, therefore, are also available in other nearby LGAs, such as Dungog, Greater Taree, Port Stephens, Maitland and Newcastle, if insufficient accommodation is available in the Gloucester and Great Lakes LGAs (Appendix P).

Education and Training

Cumulative potential developments in the region would contribute to greater demand for education in both the public and private sectors (Appendix P).

Provision of education services is primarily the responsibility of the public sector, although there is an increasing role for the private sector, with planning and development driven by population changes (Appendix P).

In other regions where mining has resulted in rapid population growth, it has been suggested that increasing child aged population has ultimately had positive education benefits such as more teachers, reduced class sizes and broader curriculum (Appendix P).

The direct and indirect increase in demand for educational facilities for the Project in isolation in the Gloucester LGA is generally less than the decline in demand for education places between 2001 and 2006. The main potentially significant relative demand arising from the Project would be in relation to pre-school places where demand representing 3-years intercensal growth in enrolments may arise (Appendix P).

The direct and indirect increase in demand for educational facilities for the Project in isolation in the Great Lakes LGA is also less than the decline in demand for education places between 2001 and 2006 or is small in the context of total enrolments (Appendix P).

The three resource projects in the region would contribute greater demand for education in both the public and private sectors in the region (Appendix P).

Health

There is potential for the Project to increase the demand for public health facilities in the region via the anticipated increase in population during the operational phase of the Project. Although the predicted Project only population increase is relatively small compared to the total population of the region, any increase is likely to place some additional demand on existing medical services (Appendix P).

The estimated cumulative changes in population levels (Table 4-41) would increase demand for health services and facilities in the region (Appendix P).

Provision of health services is primarily the responsibility of the public sector, although some aspects of these services are also provided by the non-government sector (Appendix P).

It is recognised that there may be a lag between population growth and the provision of additional health services resulting in temporary health care access issues, but ultimately increased populations result in the provision of more health facilities for the community (Appendix P).

There is also the potential to indirectly positively impact on public health through the provision of employment opportunities and the reduction in unemployment (Appendix P).

Community Services and Recreation Facilities

The maximum direct and indirect increase in population from the Project in isolation is reasonably small in the context of the existing population of the region (Appendix P).

From a cumulative impact perspective there may be a more significant increase in demand for community services and recreation facilities that would require some planning by Local and State Government agencies (Appendix P).

Social/General Community

The demand for mining labour can result in skilled labour being bid away from other professions (e.g. domestic trade services) which can result in shortages of these services in the region (Appendix P).

The impact of the Project on skills shortages in the region is likely to be negligible. However, it is anticipated that there may be impacts from the cumulative effects of prospective projects in the region (Appendix P).

A changing sense of place for existing residents may also be caused by cumulative influxes in populations associated with mining projects, as towns move away from their historical focus on servicing agricultural and forestry enterprises, to an increased focus on servicing mining activities (Appendix P).

The high wages in the mining sector relative to other sectors can also potentially result in social divisions between those involved in the mining sector and those who are not (Appendix P).

Both these effects can be heightened during construction of projects, when there are unattached construction workforces, who may only partially integrate into the community (Appendix P).

End of Mine Life

Potential socio-economic impacts associated with the end of Project life are described in Section 4.16.2.

4.17.3 Mitigation and Management Measures

As described in Section 4.17.2, some population growth would occur as a result of the Project employment and associated flow on effects.

Appendix P indicates that the community infrastructure impacts of the Project, alone, are not likely to be substantial but have the potential to be most significant in the Gloucester LGA. However, cumulative impacts with the AGL Gloucester Gas Project and the proposed Rocky Hill Coal Project would be more significant should the various approved and proposed developments coincide (Appendix P).

SCPL would work in partnership with the GSC, the Great Lakes Council and the local community so that the benefits of the projected economic growth in the region are maximised and impacts minimised.

In this respect, a range of general and specific social impact mitigation and management measures are proposed and would include:

- early provision of information to the GSC, the Great Lakes Council and relevant State Government agencies regarding employment and population level changes to facilitate early community infrastructure provision responses;
- continuation of the current community sponsorships and community support programmes (Section 3.3.5) which supports education, health and community causes;
- employ local residents preferentially where they have the required skills and experience;
- purchase local non-labour inputs to production preferentially where local producers can be cost and quality competitive; and
- include a code of conduct for construction workers with regard to behaviour in Stratford Mining Complex induction programmes.

It is expected that as with other recent coal mining projects in NSW, a planning agreement in accordance with Division 6 of Part 4 of the EP&A Act would be required by the Development Consent for the Project. The planning agreement would be negotiated between SCPL, the DP&I, GSC and Great Lakes Council.

4.18 HAZARD AND RISK

A PHA to evaluate the potential hazards associated with the Project was conducted by a multi-disciplinary team, including technical advisors from SCPL. The PHA was conducted in accordance with the general principles of risk evaluation and assessment outlined in the DP&I *Multi-Level Risk Assessment* (DP&I, 2011).

The PHA also addresses the requirements of *State Environmental Planning Policy No. 33 (Hazardous and Offensive Development)* (SEPP 33) and has been assessed in general accordance with *Hazardous Industry Planning Advisory Paper No. 6: Hazard Analysis* (Department of Planning [DoP], 2011).

Potential incidents and hazards identified for the Project are described in Section 4.18.1. Proposed preventative and control measures to address potential hazards are discussed in Section 4.18.2.

4.18.1 Hazard Identification and Risk Assessment

Potentially hazardous materials handled at the Project include hydrocarbons (petrol, diesel, oils, greases, degreasers and kerosene), explosives and chemicals (Appendix Q).

In accordance with DP&I (2011), the PHA specifically covers the risks from fixed installations. As such, the main focus of the assessment was the on-site storage of potentially hazardous materials (Appendix Q).

Notwithstanding, because Project mining operations would, in some cases, be located in proximity to public roads, some additional risks relating to mining operations (e.g. blasting, open pit slumping and uncontrolled mobile plant excursions off-site) were included in the PHA (Appendix Q).

The following generic classes of incident associated with on-site storage were identified:

- leaks/spills;
- fire;
- explosion;
- theft;
- excessive vibration; and
- unplanned movement off-site.

Following identification of the potential hazards associated with the Project, a qualitative assessment of the risks to the public, property and the environment associated with the Project was undertaken (Appendix Q).

An assessment of the combination of the consequence and probability rankings concluded that the overall risk rankings for the identified hazards would be low, and therefore tolerable (Appendix Q).

4.18.2 Hazard Prevention and Mitigation Measures

A number of hazard control and mitigation measures are in-place for the existing Stratford Mining Complex, and are described in the following existing documents:

- Blasting/Vibration Management Plan.
- Gloucester District Bush Fire Management Plan.
- Water Management Plan (incorporating Surface Water and Groundwater Management Plans).
- Life of Mine Rejects Disposal Plan.
- Environmental Management Strategy;
- Contractor Management Plan;
- Emergency Management Plan;
- Fitness for Work Management Plan;
- Explosives Management Plan;
- Inspection Program Scheme;
- Spill Response Procedures; and
- Pollution Incident Response Management Plan.

Additional hazard control and mitigation measures would be incorporated into existing management plans or new management plans where required for the Project.

In addition, the following hazard treatment measures would be adopted for the Project (Appendix Q):

- Engineering Structures – Mining and civil engineering structures would be constructed in accordance with applicable codes, guidelines and Australian Standards. Where applicable, SCPL would obtain the necessary licences and permits for engineering structures.
- Contractor Management – All contractors employed by SCPL would be required to operate in accordance with the relevant Australian Standards and NSW legislation.
- Storage Facilities – Storage and usage procedures for potentially hazardous materials (i.e. fuels and lubricants) would be developed in accordance with Australian Standards and relevant legislation.
- Emergency Response – Emergency response procedures manuals and systems would continue to be implemented.