

NORTHERN COAL LOGISTICS PROJECT

RESPONSE TO SUBMISSIONS



Centennial Coal

Northern Coal Logistics Project

Response to Submissions

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Centennial Northern Coal Services Pty Limited

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1 Introduction

Centennial Northern Coal Services Pty Limited (Northern Coal Services) proposes the Northern Coal Logistics Project (the Project) on the western side of Lake Macquarie approximately 140 kilometres north of Sydney in New South Wales (NSW). The Project, which is classed as a State Significant Development (SSD 5145), comprises both a continuation of existing approved surface operations and an upgrade to the existing approved surface coal handling and processing facilities at the Newstan Colliery Surface Site and Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site), along with existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Extension of Mining Project (SSD 5142) and Mandalong Southern Extension Project (SSD 5144)) into domestic and export markets.

An Environmental Impact Statement (EIS) was submitted to the NSW Department of Planning and Environment (DP&E) in October 2014 for the Project. The exhibition period for the EIS commenced on 17 October 2014 and ended on 17 November 2014.

1.1 Scope

This Response to Submissions (RTS) has been prepared in accordance with section 75H(6) of the Environmental Planning and Assessment Act 1979 (EP&A Act) and considers the matters raised in submissions received by DP&E during the public exhibition of the EIS. This report builds on information presented in the EIS and is to be read in conjunction with the EIS.

The electronic version of the EIS can be found on the DP&E website (www.planning.nsw.gov.au) or the Centennial Coal website (www.centennialcoal.com.au).

Subsequent to the EIS, additional reports have been prepared as part of this RTS to support the Project. These additional Assessments comprise:

- A revised Air Quality Impact Assessment (**Appendix 5**)
- A revised Clean Water Treatment Plant Ecotoxicology Assessment (**Appendix 3**)
- An Aquatic Monitoring and Ecotoxicology Assessment Summary Report (**Appendix 4**)

In addition, a revised Flora and Fauna Impact Assessment has been provided which addresses additional information requested by the Commonwealth Department of the Environment (DotE) as part of their assessment of the preliminary documentation provided to support a referral made under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). A copy of the DotE request for additional information is provided in **Appendix 6** to this RTS with the revised Flora and Fauna Impact Assessment provided as **Appendix 7**.

1.2 Project Overview

Northern Coal Services seeks a single new development consent for the Project to regulate the coal handling, processing and transport operations at the Newstan Colliery Surface Site, Cooranbong Entry Site and along the private haul roads, and utilise existing and proposed new surface infrastructure. The Project will provide the flexibility, not possible under the existing development consents for Newstan Colliery and Mandalong Mine, to supply varying quantities of coal to domestic and export markets. The

Project does not cover the mining operations of the existing source mines or any future sources, which are subject to separate applications as required.

The Project Application Area for the Project comprises:

- The existing Newstan Colliery Surface Site, encompassing the coal preparation and handling infrastructure, coal rejects emplacement areas, water management infrastructure and rail loading infrastructure, near Fassifern. The exceptions to this are the mine ventilation shafts and ventilation fans, which form part of the Newstan Extension of Mining Project;

- The proposed extension to the Newstan Colliery Surface Site to accommodate new coal handling and processing infrastructure;

- The existing surface infrastructure at the Cooranbong Entry Site near Dora Creek, comprising the coal handling plant (CHP), coal stockpiles, workshop building and water management infrastructure. The exceptions to this are the mine ventilation shaft, ventilation fan and the Borehole Dam, which form part of the Mandalong Southern Extension Project;

- The existing Hawkmount Quarry, which comprises a disused quarry located immediately to the east of the Cooranbong Private Haul Road between Newstan Colliery Surface Site and Cooranbong Entry Site, for coal rejects emplacement; and

- The existing Cooranbong Private Haul Road, Awaba Private Haul Road and Newstan-Eraring Private Haul Road, which link the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and Eraring Power Station.

The primary components of the Project are:

- Upgrade the existing coal preparation and handling infrastructure at the Newstan Colliery Surface Site to enable continued utilisation for the receipt, handling and processing of up to 8 Mtpa run of mine (ROM) coal from the Newstan Colliery (up to 4.5 Mtpa), the Awaba Colliery (up to 0.88 Mtpa) and Mandalong Mine (up to 6 Mtpa);

- Continue to utilise the existing coal handling infrastructure at the Cooranbong Entry Site to enable the receipt and handling of up to 6 Mtpa of ROM coal from Mandalong Mine;

- Increase the tonnage of coal transported from the Cooranbong Entry Site to Newstan Colliery Surface Site, via truck using existing private haul roads, from 4 Mtpa to up to 6 Mtpa;

- Increase the tonnage of coal transported from the Cooranbong Entry Site to Eraring Power Station, using the existing dedicated overland conveyor, from 4 Mtpa to up to 6 Mtpa;

- Increase the tonnage of coal transported from the Newstan Colliery Surface Site to Eraring Power Station, via truck using existing private haul roads, from 2 Mtpa to up to 4.5 Mtpa;

- Increase the tonnage of coal transported from the Newstan Colliery Surface Site rail loading facilities by train to the Port of Newcastle and/or Port Kembla (for export) and/or Vales Point Power Station from 3 Mtpa to up to 8 Mtpa;

- Continue to transport up to 0.5 Mtpa of middlings (middle quality coal product) by truck via private haul roads from Newstan Colliery Surface Site to Cooranbong Entry Site for subsequent supply to the Eraring Power Station via a dedicated overland conveyor.

- Continue to transport up to 0.88 Mtpa of material (including coal and stone from construction activities undertaken as part of the Newstan Colliery Extension of Mining Project) by truck via private haul roads from the Awaba Colliery Surface Site to the Newstan Colliery Surface Site;

- Transport coal rejects from the Newstan Colliery Surface Site to the Newstan Colliery Northern Rejects Emplacement Area (NREA), the Newstan Colliery Southern Rejects Emplacement Area (SREA) and/or Hawkmount Quarry via existing private haul roads;

- Increase the volume of water discharged via Licenced Discharge Points (LDPs) at the Newstan Colliery Surface Site and Cooranbong Entry Site;

- Provide employment for up to 120 full-time personnel;

- Provide a life of operation of 30 years from the granting of development consent; and

- Operate 24 hours per day, seven days per week.

2 Summary of Submissions

228 submissions were received during the public exhibition period of the EIS. 187 submissions were received from community individuals. Of these:

- six submissions were in objection to the Project;
- one submission provided comment on the Project; and
- 180 submissions were in support of the Project

31 submissions were received from special interest groups and non-government organisations. Of these:

- three submission were in objection to the Project;
- four submissions provided comment on the Project; and
- 24 submissions were in support of the Project.

Ten submissions were received from government agencies during the public exhibition period being:

- Ausgrid;
- Department of Primary Industries – Crown Lands Division (Crown Lands);
- Department of Trade Investment Regional Infrastructure and Services – Division of Resources and Energy (DRE);
- Environmental Protection Authority (EPA);
- Hunter New England Local Health District;
- Lake Macquarie City Council (LMCC);
- NSW Office of Water (NOW);
- Office of Environment and Heritage (OEH);
- Roads and Maritime Service (RMS); and
- Transport for NSW.

This RTS also considers issues raised in a submission by the Environmental Protection Authority (EPA) received regarding the adequacy of the EIS prior to public exhibition. The EIS had been determined by DP&E to be adequate for public exhibition prior to the submission from the EPA being received.

2.1 Summary of Issues Raised

A summary of the issues raised by the government agencies is provided in **Table** 1, a summary of the issues raised by special interest groups is provided in **Table 2** and a summary of the submissions made by individual community members is provided in **Table 3**. Detailed responses to each of the issues raised are provided in **Section 3.0**.

Table 1 - Summary of Government Agency Submissions

Area of Concern	Raised By	Summary of Issue
Air Quality	Environmental Protection Authority	The Project will result in an increase in train movements along the western side of Lake Macquarie. The coal trains (rolling stock operators) will be moving along rail systems, whilst the EIS has identified increased noise impacts from train movements at sensitive receivers as a result of the project, any impacts on air quality from dust have not been addressed.
		The Air Quality Impact Assessment does not identify rail transport as potentially impacting the environment and EPA recommends that the Air Quality Impact Assessment be amended to identify this source and to detail the site specific best management practice approaches to minimise emissions from coal loading and transport through all stages of the project.
		Audits by the EPA of Newstan coal train loading have identified parasitic coal on wagons, a potential air quality impact. Through adequate coal handling, loading and management issues on the premises, this parasitic coal can be limited.
		The assessment identifies that PM_{10} impact assessment criterion is likely to be exceeded at the Newstan Colliery Surface Site once operations reach 6 Mtpa. Measures to reduce emissions from coal handling were assessed and a combination that reduces PM_{10} impact below the criterion was identified for both 6 and 8 Mtpa coal handling limits. EPA recommends that these measures be implemented once handling of more than 5 Mtpa of ROM coal is exceeded at the premises as these measures are considered best practice.
		As a result the measures discussed within the EIS and in particular automation of coal transfers between the coal preparation plant and rail loop stockpile and train loading operations should be implemented when extraction and/or handling and/or storage of more than 5 Mtpa of ROM coal occurs at Newstan colliery. This should be incorporated as a condition of approval as they are considered best practice to minimise dust.
		The Air Quality Impact Assessment has not made any assessment of dust $PM_{2\cdot5}$ as an annual average which is important in order to measure potential impacts against national advisory reporting standards and goals.
		EPA advise DP&E that a condition of approval of the project and handling of greater volumes of ROM coal at Newstan Colliery should include automation of train loading at Newstan Colliery and automation of covered transfers between the coal preparation plant and rail loop stockpile and train loading operations once ROM coal handling, storage, transfer, loading exceeds 5 Mtpa at

Area of Concern	Raised By	Summary of Issue
		Newstan Colliery to bring the colliery in line with best practice for control of coal dust and to minimise dust and to ensure that air impact criteria for PM_{10} is met at the sensitive receivers.
		The Air Quality Impact Assessment summarises results from simulating meteorology over five years 2006-2010. Analysis notes a greater frequency of F-class stability in the years 2006-2008, but chooses the most recent year of 2010, for analysis. The Air Quality Impact Assessment states that "this is not considered to have a significant impact on the results" but provides no justification of explanation of this. The year 2010 has significantly lower concentrations than other years and less frequent incidence of very stable conditions (F-class). Analysis must be undertaken to justify that choosing 2010 does not significantly impact results.
		EPA advises DP&E that a condition of approval of the project should include establishment of an ambient continuous particulate monitoring site monitoring $PM_{2.5}$ and PM_{10} at or near Fassifern Public School as a close sensitive receiver.
	Hunter New England Local Health District	Hunter New England Local Health District noted the potential air quality impacts on the NC6 and NC2 receptor sites, it will be important to ensure that the proposed mitigations for these impacts are in place.
Biodiversity	Office of Environment and Heritage	The final EIS does not provide an assessment of the mitigation actions proposed in relation to the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014) and the six offsetting principles.
		The mitigation and offset strategy for this project is inadequate.
		OEH acknowledges that the proponent has modified the development footprint to reduce its impact on threatened biodiversity. Proposed translocation of Tetratheca juncea, and associated research, and installation of nest boxes may be considered as appropriate supplementary measures only if the proponent has been able to demonstrate that both land-based offsets are not available and that the supplementary measures proposed have the approximately equivalent value that a land-based offset would have cost.
		There is no indication in the EIS that Centennial Coal has considered providing a land-based offset with Tetratheca juncea, or has calculated the value of the impact of the project on threatened biodiversity, or of the proposed supplementary measures as required under the current offset policy.
		OEH requires that this project and its mitigation measures

Area of Concern	Raised By	Summary of Issue
		are assessed as required under the current biodiversity offset policy.
		OEH requires that Centennial Coal commits to an appropriate level of modelling of health and persistence of threatened biodiversity downstream the project area and commits to offsetting any harm to this biodiversity in accordance with the NSW Biodiversity Offsets Policy for Major Projects.
		The EIS did not include a survey or a description of the one hectare or so of wetlands at the Hawkmount Quarry site. Based on the time that has elapsed since the last quarrying activities and, based on available satellite imagery, and the longevity of these water bodies OEH has adopted a precautionary approach and considers that that these wetlands may provide habitat for threatened species, such as Maundia trigochinoides - which is considered likely to occur downstream of the quarry, but the quarry site was not surveyed. Thus OEH considers that in the absence of a survey for this species at the quarry site then it is likely to occur and must be offset for this project.
		Biodiversity survey effort for the project area is described in Section 3.0 of Appendix K of the EIS and indicates that they all occurred outside the flowering season of Corybas dowlingii (NSW Scientific Committee, 2007) and Corunastylis sp. Charmhaven (NSW Scientific Committee, 2012).
		Scientific Licences issues under section 132C of the National Parks and Wildlife Act 1974 come with reporting requirements that require a full report of the survey, research or other biodiversity assessment works carried out under the licence to be submitted to OEH at the expiry of the licence. Where a licence is valid for more than one year, records must be submitted annually. Section 3.0 of Appendix K of the EIS documents that biodiversity survey work for this project commenced in April 2012. Given that RPS's scientific licence (No. S 1 00536) was issued on 1 January 2013 then this suggests that RPS is in breach of their scientific licence conditions by not yet having provided threatened species records for this project collected in 2012 and 2013.
		It is noted that a recent provision of records to OEH, as administrators of the Wildlife Atlas, includes several Grevillea parviflora subsp. parviflora and many Tetratheca juncea records; but none that are shown in the maps included in the EIS for this project.
Consents	Lake Macquarie City Council	The application proposes to surrender a number of consents that currently provide approval for mining and the subsequent environmental controls. Council is concerned that the surrender of these consents may

Area of Concern	Raised By	Summary of Issue
		affect the ability to mine and remove substantive environmental controls that have been developed for these sites over many years. In this regard, Council requires greater assurance from the proponent that the environmental controls and approvals to mine under the various consents will be successfully transferred to a new single consent as proposed.
Electrical Infrastructure	Ausgrid	If the clearances to the private road crossings are changed by changing road RLs or vehicle heights, Ausgrid will need to be involved in assessing safety clearances.
		Toronto zone substation will require two new 132kV feeder crossings of the Newstan-Eraring private haul road. Ausgrid will consult with Centennial regarding traffic closures required to complete the installation of the new feeder crossing. Availability of traffic closures may be impacted by increased truck movements forecast in the EIS.
		Ausgrid has a project in development to replace aged equipment in the Cooranbong 33/11kV zone substation. Ausgrid will require access to the substation site to be maintained under the existing arrangements.
Land Use	Crown Lands	The EIS has identified a large amount of Crown land within the Project Application Area. Crown Lands have a number of concerns related to the impact of this development on the land including: • Access management and unauthorised use, • Illegal dumping, including asbestos, • Acquisition process for significantly affected Crown land, • Aboriginal Land Claims and Native Title, • The need to rationalise existing Crown Land tenures. Crown Lands request that the Proponent consult directly with Crown Lands, Maitland Office to discuss the above matters.
		Crown Lands request that the Proponent provide Crown Lands, Maitland Office with a table of Crown Land impacted by this development. Details required for each parcel include: • Cadastral identifier (Lot and DP), • Current and proposed use of the parcel by Proponent,

<table>
<tr><th>Area of Concern</th><th>Raised By</th><th>Summary of Issue</th></tr>
<tr><td rowspan="2"></td><td></td><td>• Crown Lands authorisation - Crown Lands tenure(s) held by the Proponent,
• Mining activity authorisation - Approval under the Mining Act 1992 for the activity.</td></tr>
<tr><td>Lake Macquarie City Council</td><td>Hawkmount Quarry (Lot 7306 DP 1164232) is affected by Permissive Occupancy (PO) No: 146079 from Crown Lands. This is a dual PO with Centennial Coal. Should the Department countenance approval of the project then the development should contain a condition requiring relinquishment of the PO with Crown Lands as it can no longer gain access to the site and has finished quarrying activities on the site.</td></tr>
<tr><td>Licencing Requirements</td><td>Environmental Protection Authority</td><td>There is insufficient information in the EIS for the EPA to determine the proponent's intention with respect to current EPLs specifically in relation to the generation of coal tailings, fines, rock and waste and their emplacement (disposal). EPA recommends that the proponent provide adequate information about the project in relation to whether the whole project will be covered by an EPL or whether individual premises based EPLs will remain and require variation. This may have implications for the proponent in relation to Protection of the Environment Operations (Waste Regulation) 2014.</td></tr>
<tr><td rowspan="3">Noise</td><td rowspan="3">Environmental Protection Authority</td><td>The EPA advise that because of the relatively small sample size of background noise measurements during the shoulder period, it is inappropriate to calculate a shoulder Rating Background Level (RBL) directly from those measurements. Following the approach in the INP, the EPA nominates alternate Project Specific Noise Levels for the morning shoulder.
<table>
<tr><th>Receiver Location</th><th>Nominated in Noise and Vibration Impact Assessment</th><th>Nominated by EPA</th></tr>
<tr><td>NC1 and NC2 ($L_{Aeq(15min)}$)</td><td>46</td><td>39</td></tr>
<tr><td>NC3 to NC5 ($L_{Aeq(15min)}$)</td><td>45</td><td>40</td></tr>
</table></td></tr>
<tr><td>The "Morning Shoulder" Project Specific Noise Levels adopted in the Noise and Vibration Impact Assessment were LAeq(15min) 46 dBA and 45 dBA, for receivers NC1 and NC2, and NC3 to NC5, respectively. These levels are higher than the daytime Project Specific Noise Levels.</td></tr>
<tr><td>The New South Wales Industrial Noise Policy (INP, EPA 2000) suggests that due to the smaller sample size of the Shoulder Period compared to other times of day, the RBL should not be directly calculated from measurements</td></tr>
</table>

Area of Concern	Raised By	Summary of Issue
		during the shoulder period. The Industrial Noise Policy suggests that an acceptable shoulder period RBL may be the mid-point (arithmetic average) of the day time and night time RBLs.
		Model results for comparison against Project Specific Noise Levels for the nearest residential sensitive receiver in the vicinity of receiver NC6 (a primary school). From the information in the Noise and Vibration Impact Assessment, the EPA expects that the Project Specific Noise Levels for receiver locations NC3 and NC5 may also be suitable for the residential receiver locations near NC6.
		Modelled noise levels as a result of the project at residential sensitive receivers near NC6 (a school) were not presented in the Noise and Vibration Impact Assessment. Daytime Leq(1hour) predictions in the Noise and Vibration Impact Assessment for receiver NC6 were typically 2 dBA above the corresponding Leq(15min) predictions for receiver NC3, which is located in a similar location relative to the project. This indicates that residential receivers near receiver NC6 may be impacted by the project by between 3 and 7 dBA above Project Specific Noise Levels.
		Cladding of the proposed new Coal Preparation Plant in noise-attenuating material (Noise and Vibration Impact Assessment scenarios 5 and 6) resulted in predicted noise levels at sensitive receivers NC1 to NC6 up to 3 dBA lower than with standard steel cladding, indicating that the Project Specific Noise Levels at receiver location NC4 could be complied with, and Project Specific Noise Level exceedance at receiver location NC3 reduced to 2 dBA during the night time only. This indicates, using the relationship described above, that residential receiver locations near NC6 may still be impacted by the project during scenarios 5 and 6 by up to 4 dBA above the night time Project Specific Noise Level.
		Predicted Project Specific Noise Level exceedences appear to be due to operations at the Newstan Colliery surface site, particularly the existing and proposed Coal Preparation Plants. The Noise and Vibration Impact Assessment listed mitigation measures which had already been committed to in previous development applications for the existing Coal Preparation Plant, but did not identify whether all further feasible and reasonable mitigation measures had been considered for the project, particularly the Coal Preparation Plants.
		No new mitigation measures were identified in the Noise and Vibration Impact Assessment for the existing Coal Preparation Plant. The implementation of a real-time monitoring system is also not a new mitigation measure, as it was proposed for the Newstan Colliery Main West

Area of Concern	Raised By	Summary of Issue
		Mining Project.
		The Noise and Vibration Impact Assessment did not demonstrate that impacts predicted above the Project Specific Noise Levels were acceptable in accordance with Chapters 8 and 9 of the INP, or that all feasible and reasonable mitigation measures had been committed to for the project.
Rehabilitation	Division of Resources and Energy	DRE requires that proponent submit a revised Mine Operations Plan to include this modification if approved.
		The Proponent must rehabilitate the site to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.
		The proponent shall carry out all surface disturbing activities (e.g. pre-stripping in advance of mining operations including for example monitoring lines and access for rehabilitation purposes) in a manner that, as far is reasonably practicable, minimises potential for dust emissions and shall carry out rehabilitation of disturbed areas progressively, as soon as reasonably practicable, to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.
		The Proponent must prepare and implement a Rehabilitation Plan to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.
Rejects Emplacement	Division of Resources and Energy	The Coal Mine Health and Safety Act 2002 Section 100-101 requires secondary approval from the Minister of Resources and Energy for any tailing and emplacement facility proposed.
		DRE advises that under the Coal Mine Health and Safety Act 2002 Section 100 and 101 the proposed capping strategy will need approval of the Minister of Resources and Energy.
Road Traffic	Roads and Maritime Service	One of two scenarios being considered by Northern Coal Services is having all the construction employee traffic (170 vph) assemble at the Cooranbong Entry Site and travel to the Newstan Colliery Surface Site via private haul roads. This option is intended to reduce the impact of the construction traffic on the Fassifern local road network. The Traffic Impact Assessment has adopted 80% of the traffic generated during both the operational and construction phases of the development travelling from/to the east and states that Newport Road and Gradwells Road can satisfactorily cater for this additional traffic. However, no assessment of the Wangi Road/Dora Street intersection, which this additional traffic will use to access Newport Road has been undertaken.

Area of Concern	Raised By	Summary of Issue
		Access for heavy vehicles to the Cooranbong Entry Site during the construction phase of the development via the Wangi Road/Dora Street intersection is not viable as there is a low clearance restriction on Newport Road under the Dora Creek bridge.
		No assessment has been undertaken of the Main Road/Macquarie Road traffic signal controlled intersection which will be used by the majority (80% to/from the east) of the traffic generated during the operational phase of the project. Additionally, if the second scenario is adopted for construction traffic access to the Newstan Colliery Surface Site, 80% of this traffic generated will use the Main Road/Macquarie Road traffic control signal intersection.
		The Traffic Impact Assessment should consider the additional impact on the road network of traffic generated by the transportation of excess spoil material from the construction of the Mandalong South Surface Site and a new ventilation shaft site (site yet to be determined). The Traffic Impact Assessment has indicated that these projects will utilise the public road network to access the Cooranbong Entry Site and the Awaba Surface Facilities Site.
Surface Water	Environmental Protection Authority	The EPA disagrees with the EIS's assertion that there has been little environmental impact from the increase in discharge of wastewater from Newstan at LT Creek from 7ML/d to 11ML/d, as the data collected so far is insufficient to make such determinations. The EPA also advises the DPE that the Clean Water Plant commissioning report that Newstan had completed is not adequate for the EPA to ascertain whether the Clean Water Plant is capable of reducing total metals, dissolved metals or to treat water to an acceptable level at a range of throughputs. Newstan has not been able to demonstrate to the EPA that Newstan Clean Water Plant discharge is not toxic to a range of aquatic animals. The EPA is in the process of writing to Newstan to request a more detailed Water Commissioning Plant Study, a further water quality monitoring and ecotoxicological assessment of the discharge water to freshwater prawns and eastern rainbow fish and macroinvertebrate monitoring downstream of the Centennial Newstan's discharges, compared to control. Until this monitoring has been undertaken, data analysed and reported to the EPA, the EPA is not in a position to comment on or approve an increase in the discharge from 11ML/d to 14.5ML/d into LT Creek from Newstan.
		According to the EIS, 40% of all catchment input into northern Lake Macquarie is attributed by Centennial operations.
		The EIS has not modelled nor discussed the increased

Area of Concern	Raised By	Summary of Issue
		loading of metals into the western tributaries of Lake Macquarie or Lake Macquarie generally, nor established potential impacts on sediments and aquatic biota and how these will be mitigated.
		EPA recommends that the EIS consider and evaluate further how increased discharges from Stony Creek will be avoided. The EIS predicts that during the Centennial Newstan Extension Project, groundwater inflow into the Fassifern seam will exceed transfers into the Fassifern Underground storage and lead to increased discharges from the seam into Stony Creek post 2036, peaking at 60 ML/d. EPA consider that this is untenable given that Newstan have exceeded EPL water quality limits on numerous occasions in Stony Creek. The EIS must consider what practical means of management and/or treatment of Stony Creek discharges is practicable to ensure that discharge meets appropriate water quality limits such that the increased occurrence of uncontrolled discharges will not impact the environment.
		The northern section of Lake Macquarie where LT Creek and Stony Creek discharge has been identified as sensitive in relation to flushing times and pollutant loading in a recent Office of Environment and Heritage Draft Report titled "Lake Macquarie Management Summary. Water Wetlands and Coasts Science Branch, NSW Government" (OEH, 2014), as such any ability to assimilate toxicants is diminished when compared to other areas of Lake Macquarie.
		Water discharges must be further treated after the CWP with a reverse osmosis plant in order to remove salt and dissolved metals.
		The EPA emphasises to DPE that variation of the EPLs or issue of an EPL to increase pollutants discharged in waste water would only be approved by the EPA if the proponent constructs and implements a reverse osmosis treatment plant (RO Plant) or an equivalent level of treatment that treats water such that it removes salinity (salts), total and dissolved metals to achieve the ANZECC guidelines for fresh and marine waters, to treat waste water discharged water from Cooranbong entry site and Newstan Colliery to prevent further metals and other pollutant loading and the consequent degradation to receiving waters LT Creek, Stony Creek and Muddy Lake and therefore Lake Macquarie. The EPA advises DP&E that a condition of approval of this project should include new water treatment facilities that are capable of treating wastewater to RO plant standards prior to discharge to the environment.
		The EPA advise DP&E that at this stage, given the lack of appropriate mixing models and pollutant modelling and assessment of the impact of metal loads to receiving

Area of Concern	Raised By	Summary of Issue
		waters the EPA would be able to undertake a licence variation or a combination of surrendering licences and providing a new EPL for the project only if a reverse osmosis treatment plant (RO Plant) or an equivalent plant that treats water such that it removes salts, total and dissolved metals to achieve the ANZECC guidelines for fresh and marine waters was constructed and installed to treat pollutants in waste water discharged water from Cooranbong entry site and Newstan Colliery to prevent further metal and other pollutant loading in receiving waters of L T Creek, Stony Creek, Muddy Lake and therefore Lake Macquarie. This option would also provide for rehabilitation of the waterways and environments towards a more natural freshwater system which would have naturally prevailed. Given that mining will cease in the future in these areas, and the saline groundwater discharges are likely to also cease at that time as dewatering will no longer be required, this option provides for a gradual rehabilitation of the receiving environments during the lifetime of the mine, rather than legacy issues post closure with cessation dewatering.
		Section 2.7.2 of the EIS states that an ecotoxicology study was undertaken by GHD in 2014 to assess the potential impacts of existing discharge to aquatic organisms downstream of Cooranbong Entry site. However evidence of this assessment was not provided in the EIS.
		The water quality data for Cooranbong entry site discharges appear to indicate that bicarbonate anion concentrations of 973 mg/L and or dissolved metals such as nickel at the licensed discharge point are likely to be the significant driver in observed toxicity effects on organisms. Given that target dilution factors are not met under annual average rainfall conditions at current discharge limits, the mixing zone, and associated toxicity is likely to extend downstream of the discharge site to Lake Macquarie meaning that muddy lake is not protected from any increase in discharge at the current likely concentrations. Bicarbonate SSTV appear to have been exceeded on numerous occasions at Cooranbong and Newstan licensed discharge points.
		The impact of combined increase in discharges into the two arms of L T Creek and Stony Creek and loads of pollutants going into Fennell Bay and Muddy Lake have not been considered, nor has the assimilative capacity and accumulation/potential toxic effects in the receiving environments (creeks, Fennell Bay, Muddy Lake and greater Lake Macquarie.
		It was unclear as to the capacity of the clean water diversions and dirty water diversions around the Newstan emplacement areas (NREA and SREA) before there is potential mixing of the two water streams downstream.

Area of Concern	Raised By	Summary of Issue
		Heavy rainfall results in overflows directly into receiving waters from a number of water treatment devices at Newstan and Cooranbong. These overflows have not been characterised and the impacts of these pollutant loads assessed in relation to acute or chronic effects on downstream environments. The receiving environments are poorly mixed and it is likely that contaminants may accumulate within these environments (Muddy Lake and Fennell Bay).
		It is noted that a water access licence (WAL) exists for take from Newstan's by-wash dam at a rate of 9.5 ML/d with an annual limit of 750ML for use in the coal preparation plant. The bywash dam is also used as a mixing zone for waste water discharges from the licensed discharge point, yet no discussion of the impact of this extraction from the 40ML dam on the mixing zone was undertaken.
		The discussion of the options for water treatment and any options for mitigating discharge impacts from the discharge of waste water were poor. The objects of the POEO Act as discussed above and matters to be considered in licensing under section 45 of the POEO Act require the EPA to assess 'practical measures that could be taken to prevent, control, abate or mitigate pollution'. To that extent the EPA believe that the EIS has not demonstrated that the project will adequately mitigate and manage increased pollutant loads of metals and other pollutants. The current reports that the EPA has received from the Centennial Newstan Ply Limited in relation to the Clean Water Treatment Plant (CWTP) do not demonstrate that the CWTP has any capacity to reduce the pollutants present in the waste water as dissolved metals or salinity (salts).
		The derivation of SSTVs was undertaken by assessment reports referred to in this EIS, but documentation of assumptions and methods were not provided in the EIS. A full account of the reasoning and background to derivation of these values should be provided in the EIS for the community and other agencies to assess. On many occasions the derived SSTVs are very high compared to ANZECC default guidelines. It is also unclear if these derived SSTVs have taken into account the increased loads and concentration of pollutants that would occur as a result of the increase daily volumetric discharges at Cooranbong and Newstan sites or whether derivation of these SSTVs were in response to EPA requirements for current discharges and licensing conditions.
		In table 10-4 which refers to Newstan water quality data, the value for TSS median is higher than the maximum; the documented maximum electrical conductivity was very high and exceeded the 100%ile current EPL limit, as

Area of Concern	Raised By	Summary of Issue
		did to the nitrogen, phosphorus, sulfate and bicarbonate concentrations.
		The size of the mixing zone for Cooranbong identified on page 172 extends for 2km. This is inconsistent with ANZECC/ARMCANZ 2000 guidelines for mixing zones and is not appropriate to manage impacts. The Cooranbong ecotoxicological study recommended a dilution factor of 1:6.25 is required to provide ecosystem protection at 95% species protection of 1.6 ML/day and mixing zone estimate calculations provided have used this dilution factor. The project has requested an increase to 8 ML/day discharge and as a result the mixing zone model must be updated to incorporate this maximum flow in order to assess impact. It is recommended that mixing calculations be done using mixing zone calculation software such as Cormix rather that the approach adopted within the EIS.
	Lake Macquarie City Council	Centennial Coal had previously discussed including contributions to the remediation of LT Creek as part of future applications relevant to the site, but noted that this issue is not addressed in the current application. It is considered that clarification from Centennial Coal be provided as to their intentions with regards to contributions to dredging as part of this current application.
		The application does not propose any improvements to LPD002. Whilst this discharge point has not experienced regular exceedances of licence conditions, where this has occurred the exceedance has been significant.
		Centennial Coal's environmental audit report for 2014, reports a total suspended solids (TSS) reading of 688mg/L in March 2013. This is 13 times above the licensed 50mg/L limit. In this regard, it is requested that the proponent provide mitigation measures to prevent further incidences in the future.
	Office of Environment and Heritage	The proponent should prepare a flood emergency response plan that takes into consideration the residential development downstream of the Newstan Colliery Surface Site and Cooranbong Entry Site.
		The proponent should prepare an assessment of the likely impact of the probably maximum flood (PMF) flows on the site, including onsite storage dams and the open cut areas, and the impact of PMF flood flows out of the site are not known.
		The proponent should prepare a flood emergency response plan that has been developed in the case of failure in any of the water management structures on the site during flood and non-flood times, and details of safeguards in place for the management of the

Area of Concern	Raised By	Summary of Issue
		downstream residents in the flood prone areas. It should be ensured that the flood behaviour in the watercourses downstream are not altered by the works on the site, or the potential failure of these works.
		The proponent details of how piping of watercourses on site has catered for blockages whilst ensuring that a clear overland flow path is maintained.
Train Movements	Lake Macquarie City Council	The EIS does not include a rail study. It is recommended that a rail study be undertaken that assesses the likely cumulative impacts of the proposed development under the scenario where both the Wallarah 2 and Cobbora Coal projects are additionally using the existing rail network as proposed. The study should consider whether any additional network improvements are required to support the proposed development.
	Transport for NSW	Transport for NSW requests that the likely train movements, frequencies required to service the project's transportation requirements between Newstan Colliery Surface Site and the Port of Newcastle, Port Kembla, and/or Vales Point Power Station and associated impact on rail network be provided, noting the different tonnages of coal to be received at each destination.
		It should be noted that the proponents only have approval in their development consent for eight train movements a day from Newstan, it does not have eight return train paths. Based on the above, Transport for NSW requests that the proponent provides actual train path requirements for the Project from Newstan.
		The proponent should discuss and work with the network owner(s) on the issues associated with access to the rail network, such as pathing, timing and any necessary infrastructure required to support the proposed use of the network.
		The proponent should provide further information on whether current infrastructure at the Port of Newcastle, Port Kembla and Vales Point Power Station is capable of handling additional tonnages of coal in the proposed train configurations.
		The proponent needs to note the train paths to Eraring power station that use Newstan rail infrastructure. Eraring balloon loop only has a north facing connection to the Main North Rail Line, so trains coming from the south use Newstan balloon loop to turn around. These additional trains on the Newstan balloon loop are a capacity constraint on the loop.
		It should be noted that the project has the potential to generate additional traffic using existing level crossings

Area of Concern	Raised By	Summary of Issue
		which needs to be assessed. Additional rail traffic at level crossings may change the risk profile of the crossing as well as increase road traffic delays and waiting times at level crossings in particular at the Glebe Road, Adamstown and Clyde Street, Hamilton North railway crossings.
		Movement of coal by rail to Vales Point Power Station has not been included in the Director General's Requirements which only list movements by rail to the port of Newcastle and/or Port Kembla.
		The project train numbers from Wallarah are lower than those stated in the Wallarah EIS. The Wallarah EIS quotes up to 5 coal trains per day while the Northern Coal EIS estimates 2-3 trains per day.
		Rail access fees for coal on the RailCorp network are not "take or pay" as suggested by the EIS.
		On page 365 of the EIS, it states that Clyde St in Hamilton North is crossed the Main Northern Railway Line, operated by RailCorp. This railway is leased to Australian Rail Track Corporation and is not operated by RailCorp.
Water Licencing	NSW Office of Water	The capture and use of clean surface water runoff is limited to intermittent extraction from the Main By-Wash Dam at the Newstan Colliery Surface Site. This extraction is licensed under a water access licence (WAL18735) with a share component (licensed entitlement) of 750 units. Extraction under this licence is to be conducted in accordance with any conditions on the licence or nominated approval and the requirements of the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources.
		It is recommended that the proponents continue to liaise with the Office of Water to ensure all extraction and use of water is appropriately authorised.

Table 2 - Summary of Community Individual Submissions

Area of Concern	Raised By	Summary of Issue
Air Quality	CLP148	There is concern is the increase of air pollution and thus the decrease in air quality. Regardless of national standards and emission guidelines, it is important for the NSW Government and Centennial Coal acknowledge and act on the concerns of the residents of West Lake Macquarie and the government representatives that represent the area regarding air pollution.
		The increase of 28 truck movements to 32 per hour will accumulate to an extra 96 truck movements in a 24 hour period. In regards to greenhouse gas and air quality there will still be a cumulative increase in the effects of air pollution.
		Centennial should implement additional sensitive receptors to the modelling and projections of air quality and greenhouse gas monitoring at Awaba, Blackalls Park, Fassifern, Fennell Bay, Toronto and Woodrising, with the findings reported to the Community Consultative Committee and LMCC.
		Centennial should dedicate to research into $PM_{2.5}$, its distribution and fall out, as well as the health effects of this particulate matter on the population.
		Centennial should assess air quality impacts associated with emission products of combustion from vehicle engines. This was not carried out by the consultants.
		All coal wagons should be covered.
	CLP159 and CLP160	Centennial should put in place a comprehensive air monitoring program that extended further afield than the 1-2 km from the sites as my concern is that the small particulate has a greater area of 'field of effect' due to its small size and ability to be carried further on the wind.
		Centennial should put in place an extensive and effective dust (small particulate) monitoring program and report the findings to the community on a regular basis to ensure accountability, transparency and corporate responsibility.
		If small particulate pollution has been widely accepted as detrimental to the health of individuals of all ages, then there should be regular and comprehensive monitoring and reporting to the community for areas such as Fennell Bay, Toronto, Bolton Point and Woodrising as these are growing population areas with large numbers of children (schools and sporting grounds) and elderly (age care facilities and villages).
		A comprehensive air monitoring program should include appropriate and accurate air quality testing units.

Area of Concern	Raised By	Summary of Issue
		All coal wagons should be covered.
	CLP185	Diesel carcinogens will also increase via this proposal.
Biodiversity	CLP148	Approximately 20% of the local population of Tetratheca juncea will be removed, which is a significant impact and therefore must be offset. Offset ratios should be in accordance with the NSW Biobanking Guidelines.
		The offsets proposed in the assessment are not actual offsets but mitigations which are not consistent the EPBC Act offset guidelines or NSW offsetting guidelines for significant impacts.
		Centennial Coal should commence negotiations with the Land and Property Management Authority to secure land to facilitate the beginning of long waited Awaba Conservation Area. I believe land that should begin the Awaba Conservation Area include properties DP755218, lots 88-93.
		Jigadee Estate, 1174 Freemans Drive Cooranbong, should be a point of operation for the research projects as it is owned by Centennial Coal and is known to have significant biodiversity and a number of threatened species including Tetratheca juncea on site.
	CLP154	There is an Inadequate survey of the bat alley. While surveys have occurred in 1998 that showed that pregnant Bent-wings were using the Bat Alley, the current survey did not complete adequate surveys to determine if the site is a maternity roost.
		The number of bats using the bat alley roost is not known. This roost may be very important for threatened cave dependent bat species, however this is not known from the current inadequate surveys.
		There is no rationale for providing a 30 metre buffer from the bat alley to the impact area. Why was this distance chosen? Will any monitoring occur to determine if bat numbers decline post construction? To do this, the number of bats within the bat alley needs to be determined first.
		The proposed 'offsets' listed under the offsets heading are predominantly mitigation.
		No formal offsets are proposed, which is inconsistent with the EPBC Act Offset policy. In particular offsets for Tetratheca juncea must occur.
	CLP159 and CLP160	Part of the Tetratheca juncea study should include maintenance and monitoring of Jigadee Estate which has significant biodiversity and a number of threatened

Area of Concern	Raised By	Summary of Issue
		species including Tetratheca juncea.
		Centennial should implement Offsets to meet the guidelines of the EPBC Act and NSW Offsetting guidelines.
		Parcels of crown land should be offset into the Awaba Conservation Area for the conservation and protection of biological diversity and ecological integrity, in particular DP 755218 – Lots 88-91.
	CLP185	Ongoing fragmentation of remaining bush land places the fragile flora and fauna under unsustainable stress causing cruelty, illness, harm, death and increasing toll of lost legally protected and threatened species. This includes downstream aquatic and marine species e.g. Seagrass, wetlands, soaks, fish nurseries and migratory life.
Climate Change	CLP185	The climatic conditions, already evident with increased weather extremes and the fact that coal is scientifically proven to be linked to climate change surely must be considered as a greater priority.
Consultation	CLP148	Centennial should closely monitor and communicate their progress and findings to the Community Consultative Committee, LT Creek Sustainable Neighbourhood Group, LMCC and OEH in regards to: 1. the nesting box program 2. the Tetratheca juncea translocation research project 3. the development and implementation of the research project investigating genetic patterns among and within the populations of Tetratheca juncea.
	CLP159 and CLP160	Centennial should put in place and actively engage/maintain/report on to the local community: the nesting box program and the relocation/study for Tetratheca juncea.
		Question whether or not communities such as Fennell Bay, Toronto, Bolton Point and Woodrising have been adequately consulted with and considered.
	CLP185	Accurate community complaints and procedures along with proper publicly available record keeping have been an issue.
		Failed community consultation, historically has been a serious issue with Centennial and the subject of many complaints.
		Centennial is unwilling to address wider community concerns and has undertaken an effort to distort true

Area of Concern	Raised By	Summary of Issue
		community opposition and complaints.
		Many locals were surprised to actually learn of this proposed projects existence and the submission deadline of November 17.
Economic	CLP185	We currently have a coal glut. Therefore can there really be any economic justification or indeed any sensible rational gain obtained by approving this project in its current form.
General	CLP185	Centennial Coal has failed to adhere to regulations guidelines and conditions of consent on numerous occasions. Many past incidents and breaches have been documented in community correspondences media articles and through prosecutions via the EPA.
		Question Centennials genuine capability to contain pollutants and discharges, be they via air water or land.
Hazardous Materials	CLP 185	Concerned over extreme bushfire risks and the fact that this industry has created a ready stockpile of fuel, chemicals and volatile materials near a large population.
Infrastructure	CLP148	Under the existing approval for Newstan, the train loading system is to be automated when export exceeds 3 Mtpa. This condition should remain the same.
	CLP159 and CLP160	Under the existing approval for Newstan, the train loading system is to be automated when export exceeds 3 Mtpa. This condition should remain the same.
	CLP185	The pollution control dam's integrity, its ability and capacity to contain the toxic black contents from the washery, is worrying to say the least. The approval of these pollution control dams really should have had any potentially increased capacity considered during their initial planning approval and construction phase.
Noise	CLP185	The noise and sounds of trains braking and the coal carriages rumbling during the night, has disturbed sleep patterns of many residents already.
Rehabilitation	CLP185	The ongoing inability to have remediated so much of the western side of Lake Macquarie which Centennial having occupied for such an extended part of our European history, draws one to conclude that they are not serious or they are incapable of undertaking genuinely remediation.
Social	CLP148	The Social Impact Assessment fails to take into consideration the suburb of Fennell Bay in its assessment and statistical analysis, thus not giving an accurate representation of the community. Toronto, the nearest population centre and a growing town, only receives a fleeting mention but is not considered in any statistical

Area of Concern	Raised By	Summary of Issue
		analysis. Yet it is less than four kilometres away from Newstan.
		The Social Impact Assessment has not acknowledged the percentage of residents that are on pensions or self-funded retirees.
		The Social Impact Assessment fails to acknowledge in its summary of air quality modelling and projections that NC6, Fassifern Public School may have exceedences of PM_{10}, depending on the scenario.
	CLP185	Proposed 24 -7 operations for all this increased activity are unreasonable for residents and will affect property values negatively.
Train Movements	CLP148	Centennial claims that the amount of train movements will remain the same, eight per day, there would need to be variance in the number of locomotives and wagons to haul the additional 5 Mtpa.
		Centennial Coal has at least a fleet of seven C44ACi Standard Gauge Heavy Haul Locomotives and in trials three of these locomotives could haul 50 wagons of coal from Fassifern to the Port of Newcastle. On page 205, under 8.1 Project Optimisation, projections of coal haulage could be up to 60 wagons with a maximum loading rate of 4500 tonnes per hour. This would mean another locomotive would be needed. If this is the optimum haulage to move 8 Mtpa of coal, this will have a significant impact on air quality and greenhouse gas on the residents of west Lake Macquarie.
	CLP185	Making coal carriages longer and yet still uncovered, is unreasonable.
Visual	CLP185	The nocturnal lighting of the mines operations are also impacting negatively.
Water Management	CLP185	LT Creek and Stony Creeks both can no longer be used as indefinite discharge points.

Table 3 – Summary of Special interest Group Submissions

Area of Concern	Raised By	Summary of Issue
Air Quality	LT Creek Sustainable Neighbourhood Group	Concerns of the residents generally and of the LT Creek Sustainable Neighbourhood Group include the increase of coal dust including Total suspended particles, PM_{10} and $PM_{2.5}$.
		The increase of 28 truck movements to 32 per hour will accumulate to an extra 96 truck movements in a 24 hour period. In regards to greenhouse gas and air quality there will still be a cumulative increase in the effects of air pollution.
		Centennial should implement additional sensitive receptors to the modelling and projections of air quality and greenhouse gas monitoring at Awaba, Blackalls Park, Fassifern, Fennell Bay, Toronto and Woodrising, with the findings reported to the Community Consultative Committee and LMCC.
		All coal wagons should be covered.
		Centennial should dedicate to research into $PM_{2.5,}$ its distribution and fall out, as well as the health effects of this particulate matter on the population.
		Centennial should assess air quality impacts associated with emission products of combustion from vehicle engines. This was not carried out by the consultants.
	Community Environment Network	The use of the private haul road to Newstan colliery and rail haulage contribute to increased fine particulate matter in the atmosphere of the Lower Hunter. These fine particles are so injurious to human health and especially the health of children. Fine particles of dust from coal haulage by road and rail and smoke stack emissions from coal burning power stations are a major contributing factor to high levels of asthma in the population of Lake Macquarie and the Hunter Valley. Royalties to the NSW government from coal mining will be rapidly offset by increased public health care costs
	Rathmines Progress Association	It is noted in this EIS that the only EPA independent monitored sites are at Newcastle, Wallsend and Beresfield a distance of approximately 17.5 km, 12.5 km and 22 km respectively from Newstan Mine. Our Association believes such distances from independent monitored EPA sites are too great to properly reflect our local areas.
		It states on page 307 of this EIS “limited research has been undertaken to assess the fraction of PM_{10} from a wide range of sources which would be emitted as $PM_{2.5}$ and as such, publicly available emission rates for $PM_{2.5}$ are not available”. Given the lack of reliable evidence they adopted an eight year old document, namely

Area of Concern	Raised By	Summary of Issue
		"Fugitive Dust Emission Factors MRI dated 2006" to calculate the emission rates for $PM_{2.5.}$
		Nothing is mentioned regarding fugitive emissions from uncovered coal wagons from the Wallarah 2 Coal Project transporting five million tons of coal per annum for 28 years or Centennial Coal transporting eight million tons of coal per annum for the next thirty years in uncovered wagons. The return trip of these empty uncovered wagons also emits fine coal particles of coal (venturi effect) to the atmosphere in our surrounding areas.
		It is mentioned in this EIS that RailCorp, Australian Rail Track Corporation and Hunter Valley Coal Chain are in control of timetabling coal transport. Indeed it is possible that other collieries may transfer their coal via Port Kembla if delay time to Port Newcastle became unacceptable. This would result in more uncovered coal wagons travelling through our area.
		This project applies for a combined total increase (from 4 million tonnes to 8 million tonnes per annum) for shipping from Newcastle or Port Kembla. All the rail trips will originate from the Newstan train loading loop, these additional movements double the risk of coal dust to the suburban communities of Lake Macquarie, Newcastle, Sydney Metropolitan Area and communities to the south to Port Kembla.
		Covered wagons should be made a mandatory requirement for all Mining Projects.
		The Director General's Requirements for Air Quality in this EIS requires "reasonable and feasible mitigation measures to minimise dust emissions, including evidence there is no such measures, available other than those proposed". We believe the Directors General's Requirement have not been met.
		Due to the large increase in coal operations and transportation of coal by the Project we submit the social implications for the planned increases of transportation of coal in uncovered wagons venting fines into the atmosphere in Lake Macquarie coupled with the double whammy of increased coal ash fallout by Eraring Power station in our areas is completely unacceptable.
Biodiversity	LT Creek Sustainable Neighbourhood Group	Parcels of land should be offset into the Awaba Conservation Area for the conservation and protection of biological diversity and ecological integrity.
		The RPS ecological assessment undertook ultrasonic bat detection adjacent to the shaft; however this occurred in May, with night temperatures going down as low as eight Degrees Celsius. Ultrasonic surveys under these conditions are not adequate for any bat species, in

Area of Concern	Raised By	Summary of Issue
		particular adjacent to a potentially important bat roost. Eight harp traps nights are also inconsistent with the federal guidelines for bat surveys, which specify a minimum survey effort of 20 harp trap nights.
		Potential inadequacy of the 30 metre buffer around Bat Alley.
		Jigadee Estate, 1174 Freemans Drive Cooranbong, should be a point of operation for the research projects as it is owned by Centennial Coal and is known to have significant biodiversity and a number of threatened species including Tetratheca juncea on site.
Climate Change	Community Environment Network	Climate change science predicts accelerated global warming if global dependency on fossil fuels such as coal continues.
		The expansion planned for Cooranbong and Newstan Collieries will only contribute further to climate change and global warming.
		Expansion of rail loading facilities will increase the tonnage of coal exported and further increase the consumption of fossil fuels overseas. The increased emissions of CO2 will result in further global atmospheric warming.
Consultation	LT Creek Sustainable Neighbourhood Group	"Centennial should closely monitor and communicate their progress and findings to the Community Consultative Committee, LT Creek Sustainable Neighbourhood Group, LMCC and OEH in regards to: 1. the nesting box program 2. the Tetratheca juncea translocation research project 3. the development and implementation of the research project investigating genetic patterns among and within the populations of Tetratheca juncea."
Economic	Community Environment Network	NSW is experiencing a reduced demand for electricity sourced from coal fired power stations such as Earing. As a member of Eraring Power Station Community Forum Community Environment Network was made aware of this downward trend - which is likely to continue in the foreseeable future – thus reducing its overall demands for coal from the Mandalong and Newstan mine.
		Further uptake of renewable forms of energy in Australia and globally will continue to reduce the total demand for coal thus reducing the need to continue and expand coal production at the proposed sites.
		Home owners and businesses are responding to climate change with increased uptake of renewable sources of

Area of Concern	Raised By	Summary of Issue
		energy. Global demand for coal is weakening. The local and global community increasingly supports the move to renewable energy both privately and publicly. Community Environment Network strongly urges the NSW government to withhold consent to the upgrades of surface sites at the Newstan and Mandalong coal mines and to focus strongly on facilitating the switch from dirty fossil fuels to clean renewable sources of energy such as solar and wind.
General	Community Environment Network	The State government should move away from giving consent to projects that are environmentally and/or socially damaging. The NSW government should be supporting the development of renewable energy sources such as solar and wind. The proposed development seeks to expedite further mining of coal which is one of the most polluting sources of energy and proven to be injurious to public health especially that of children.
Infrastructure	LT Creek Sustainable Neighbourhood Group	Under the existing approval for Newstan, the train loading system is to be automated when export exceeds 3 Mtpa. This condition should remain the same.
	Rathmines Progress Association	The high readings at Fassifern Public School are of concern. Centennial Coal proposes to automate coal transfers at 6 million tonnes per annum. Considering the current high readings we suggest they should advance their automation schedule.
Noise	Origin Energy	EIS Appendix N - Noise - Section 3.6.4 Private Haul Roads - the study refers to road traffic noise assessments at the Newstan Surface Site and Cooranbong Entry Site however does not adequately consider the Newstan-Eraring Haul Roads other than to indicate it is a sealed road with drainage. There is no cumulative assessment of noise due to the increased number of vehicle movements and co-incidental movements which may impact on local receptors.
Social	LT Creek Sustainable Neighbourhood Group	The Social Impact Assessment fails to take into consideration the suburb of Fennell Bay in its assessment and statistical analysis, thus not giving an accurate representation of the community.
		The Social Impact Assessment fails to acknowledge in its summary of air quality modelling and projections that NC6, Fassifern Public School may have exceedences of PM_{10}, depending on the scenario.
Traffic	Origin Energy	EIS Appendix 0 - Traffic- Section 7.3 Internal Coal Transport- the study does not adequately address the impacts both directly in relation to the users of the Private Haul Road or in fact any potential external effects such as additional noise, additional luminous pollution during hours of darkness and the additional interaction with local subsidence areas.

Area of Concern	Raised By	Summary of Issue
Train Movements	LT Creek Sustainable Neighbourhood Group	Centennial claims that the amount of train movements will remain the same, eight per day, there would need to be variance in the number of locomotives and wagons to haul the additional 5 Mtpa.
		Centennial Coal has at least a fleet of seven C44ACi Standard Gauge Heavy Haul Locomotives and in trials three of these locomotives could haul 50 wagons of coal from Fassifern to the Port of Newcastle. On page 205, under 8.1 Project Optimisation, projections of coal haulage could be up to 60 wagons with a maximum loading rate of 4500 tonnes per hour. This would mean another locomotive would be needed. If this is the optimum haulage to move 8 Mtpa of coal, this will have a significant impact on air quality and greenhouse gas on the residents of west Lake Macquarie.
	Rathmines Progress Association	There are discrepancies in the Projects EIS and the Wallarah No. 2 Project EIS regarding the number of trains from the Wallarah No. 2 Project.
Visual	Origin Energy	EIS Appendix P - Visual - Sections 5.4 - Private Haul Roads and Section 7. 9 - Night Time Lighting does not address the additional or cumulative impacts of additional haul truck movement lighting.

3 Response to Submissions

3.1 Response to Government Agency Submissions

3.1.1 Air Quality

The Project will result in an increase in train movements along the western side of Lake Macquarie. The coal trains (rolling stock operators) will be moving along rail systems, whilst the EIS has identified increased noise impacts from train movements at sensitive receivers as a result of the project, any impacts on air quality from dust have not been addressed. (EPA)

The Air Quality Impact Assessment does not identify rail transport as potentially impacting the environment and EPA recommends that the Air Quality Impact Assessment be amended to identify this source and to detail the site specific best management practice approaches to minimise emissions from coal loading and transport through all stages of the project. (EPA)

As detailed in Section 3.8.1 of the EIS, up to eight trains per day are approved to transport coal from the Newstan Colliery Surface Site. As is detailed in Section 4.8.1, the Project does not propose to increase the number of trains transporting coal from the Newstan Colliery Surface Site above the currently approved maximum of eight trains per day. An Air Quality Impact Assessment was prepared by SLR Consulting Pty Limited (SLR) to support the Project and was provided as Appendix L to the EIS. The modelling included all dust generating activities associated with the coal handling and train loading operations carried out at the Newstan Colliery Surface Site which are detailed in Table 16 of the Air Quality Impact Assessment. Although air quality impacts from train movements along the Main Northern Rail Line were not considered in the EIS, there are a number of contributing factors leading to particulate emissions from the transport of coal along the rail network being:

- Coal properties. The fines content and moisture content are the two coal properties likely to have the greatest influence on PM emissions. The relative dustiness of coal has been measured in terms of dust extinction moisture content (DEM) for coal. The DEM is the point at which there is sufficient moisture to prevent dust being raised from the surface.

- Train speed. Train travel speed influences the speed at which air travels across the coal surface. When this exceeds the threshold friction velocity for a particulate coal type, PM emissions will occur. Ambient wind speeds can add to this effect.

- Load profile. When wagons are loaded in an uneven manner, the surface area is increased and emission potential is greater. Load profiling creates a reduced surface area that is exposed to air flow.

- Travel distance. The emission factors used to estimate dust emissions from wagons adopted in Canada are dependent on the distance the train travels. In other words, longer distances result in higher emission estimates. The further a coal train has to travel, the greater the potential for the coal surface to dry out.

- Ambient conditions. Ambient conditions can increase the rate at which the coal surface dries, particularly in summer. Local winds can increase the speed at which air travels across the coal surface.

- Leakage through wagon doors. Leakage can occur through gaps in the wagon doors or when doors are not closed properly following unloading.

- Residual coal / carry back in unloaded wagons. Coal remaining in wagons after unloading can be lead to fugitive emissions or leakage as the train travels back to the mine. Residual coal is generally caused when coal properties (high moisture, 'sticky' coal) make unloading difficult.

- Spilled coal. Poor loading practices can result in coal spill on sills, shear plates and bogies of the wagons. Similarly, when unloading, ploughing can result in coal being collected on the bogie as the train moves through the unloading station.

- Spilled coal on wagons (referred to as parasitic coal) can be entrained by the wind as the train moves or can drop onto the track and become re-entrained during high winds or train pass-bys.

Northern Coal Services implements controls to minimise or prevent coal spills and dust emissions from the top of wagons during transport by maintaining the moisture content of the coal above the DEM levels. Northern Coal Services has established the DEM through the standard testing procedure as outlined in Australian Standard AS-4156.6-2000. Train coal samples indicate that the moisture content of the coal is above the DEM. In the unlikely event that additional dust suppression is required for the transport of coal via rail, then a water cart is also available to add additional moisture.

The average train speed of coal trains transporting coal along the rail networks is between 30-40 km/hour. Train speeds are already considered to be low and reducing this further is seen as exacerbating congestion issues.

The 'garden bed' load profile is not possible to be established through the current process of loading of trains at the Newstan Colliery Surface Site using a front end loader however Northern Coal Services manages the prevention of spills by under loading the wagons (i.e. not fill them to capacity) to ensure the top of the coal profile is below the wagon gunwhale (sill).

The average travel distance for coal trains from the Newstan Colliery Surface Site is a relatively short travel distance to the port when compared to the distance trains transporting coal from other mines have to travel.

On site management measures have been implemented by Northern Coal Services to reduce the risks associated with parasitic coal from train wagons leaving the Newstan Colliery Surface Site. To do this, wagons are cleaned using a water cart to remove any parasitic coal prior to the train leaving site. Training on the risks and the correct train loading procedures are provided to all staff involved in the train loading operations through regular tool box talks.

Dust from coal trains wagons is a contentious issue in the community. Ongoing research and monitoring, by both industry and government agencies has been undertaken and is providing a better understanding air quality along the coal transport corridor, particularly in the Hunter region of NSW.

Scientific studies to date have generally found that fugitive dust from coal trains is a relatively small source of ambient particulate matter (Connell Hatch, 2008; Environ, 2012; Katestone, 2013, Ryan et al 2014). While many of the scientific studies to date have found that fugitive dust from coal trains is not a significant source of ambient particulate matter, ongoing work in regards to this issue is continuing to provide a better understanding of the composition and source of particulate matter. Nevertheless, fugitive dust from coal trains remains a significant community concern and the industry is committed to identifying areas of improvement in management practices.

Audits by the EPA of Newstan coal train loading have identified parasitic coal on wagons, a potential air quality impact. Through adequate coal handling, loading and management issues on the premises, this parasitic coal can be limited. (EPA)

Northern Coal Services responded to the EPA's draft audit report on 15 September 2014. From the evidence provided at the time of the audit, and included within the letter dated 15 September 2014, Northern Coal Services was able to demonstrate that train loading activities are carried out in a manner which minimises or prevents coal spills and dust emissions from wagons during rail transport, and that train loading equipment is maintained in a proper and efficient manner.

Northern Coal Services manages the prevention of spills by under loading the wagons (i.e. not fill them to capacity) to ensure the top of the coal profile is below the wagon gunwhale (sill). As advised to the EPA during the audit, train wagons have a capacity of 79t, however operators are instructed to load wagons to 75t. The instruction "Do no overload or overfill any wagons" and "Maximum target weight = 75 tons" is included in the Train Loading instruction sheet which is issued for every train that is loaded at the Newstan Colliery Surface Site.

Northern Coal Services implements controls to minimise or prevent coal spills and dust emissions from the top of wagons during transport by maintaining the moisture content of the coal above the Dust Extinction Moisture (DEM) levels. Northern Coal Services has established the DEM through the standard testing procedure as outlined in Australian Standard AS-4156.6-2000. Train coal samples indicate that the moisture content of the coal is above the DEM. In the unlikely event that additional dust suppression is required for the transport of coal via rail, then a water cart is also available to add additional moisture.

Spilled coal on wagons (referred to as parasitic coal) has been identified as a potential source of particulate matter emissions from coal trains impacting on the local air quality can be entrained by the wind as the train moves or can drop onto the track and become re-entrained during high winds or train pass-bys. On site management measures have been implemented by Northern Coal Services to reduce the risks associated with parasitic coal from train wagons leaving the Newstan Colliery Surface Site. To do this, wagons are cleaned using a water cart to remove any parasitic coal prior to the train leaving site. Training on the risks and the correct train loading procedures are provided to all staff involved in the train loading operations through regular tool box talks. Evidence of this training has been provided previously to the EPA.

The assessment identifies that PM_{10} impact assessment criterion is likely to be exceeded at the Newstan Colliery Surface Site once operations reach 6 Mtpa. Measures to reduce emissions from coal handling were assessed and a combination that reduces PM_{10} impact below the criterion was identified for both 6 and 8 Mtpa coal handling limits. EPA recommends that these measures be implemented once handling of more than 5 Mtpa of ROM coal is exceeded at the premises as these measures are considered best practice. (EPA)

As a result the measures discussed within the EIS and in particular automation of coal transfers between the coal preparation plant and rail loop stockpile and train loading operations should be implemented when extraction and/or handling and/or storage of more than 5 Mtpa of ROM coal occurs at Newstan colliery. This should be incorporated as a condition of approval as they are considered best practice to minimise dust. (EPA)

EPA advise DP&E that a condition of approval of the project and handling of greater volumes of ROM coal at Newstan Colliery should include automation of train loading at Newstan Colliery and automation of covered transfers between the coal preparation plant and rail loop stockpile and

train loading operations once ROM coal handling, storage, transfer, loading exceeds 5 Mtpa at Newstan Colliery to bring the colliery in line with best practice for control of coal dust and to minimise dust and to ensure that air impact criteria for PM_{10} is met at the sensitive receivers. (EPA)

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment for Project (provided as Appendix L to the EIS). In order to assess the worst case impacts from the Project, SLR modelled a total of 10 different operational scenarios:

Eight scenarios associated with the operations at the Newstan Colliery Surface Site; and

Two scenarios associated with the operations at the Cooranbong Entry Site.

A description of the scenarios assessed for the Cooranbong Entry Site and Newstan Colliery Surface Site is provided in Tables 71 and 72 of the EIS respectively. SLR's Air Quality Impact Assessment for the Project concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended Particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.
- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.
- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

An automatic train loading facility will be installed to meet operational efficiencies which will subsequently result in the air quality criteria being achieved for the life of the Project. Consent conditions on handling, processing or export volumes on when an automatic train loading facility is to be installed is not required to ensure compliance with the air quality criteria.

Northern Coal Services will continue to implement the dust management practices to minimise the impacts on air quality as a result of the Projects operations. Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved. Additionally, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site.

The AQIA has not made any assessment of dust $PM_{2.5}$ as an annual average which is important in order to measure potential impacts against national advisory reporting standards and goals. (EPA)

An Air Quality Impact Assessment was prepared by SLR Consulting Pty Limited (SLR) to support the Project and was provided as Appendix L to the EIS. In order to assess the worst case impacts from the Project, a total of ten modelling scenarios were carried out. Eight of those scenarios were associated with the operations at the Newstan Colliery Surface Site. A description of the eight scenarios assessed for the Newstan Colliery Surface Site is provided in Table 17 of the Air Quality Impact Assessment.

The modelling included all dust generating activities associated with the coal handling and train loading operations carried out at the Newstan Colliery Surface Site which are detailed in Table 16 of the Air Quality Impact Assessment.

Section 8.4 and Table 49 of the Air Quality Impact Assessment details the results of the Project on annual average $PM_{2.5}$ concentrations at each of the identified receptors. The results of the modelling indicated that the annual average $PM_{2.5}$ concentrations are predicted to be well below the criterion of 10 $\mu g/m^3$ set by the World Health Organisation and 8 $\mu g/m^3$ set by the National Environment Protection Measure (NEPM) all identified sensitive receptor locations.

There appears to be an error in text and tables with text discussing results tabulated in tables 53 and 54 incorrectly referring to tables 51 and 52. Table 54 is titled "Predicted annual average TSP Concentrations-Cooranbong Entry Site" yet the header line reads "Maximum 24-hr average PM_{10}" and the note providing the project criterion is for annual average $PM_{2.5}$. The text (erroneously referring to table 52) discussed 24 hr average $PM_{2.5}$ concentrations. This table needs replacing with one showing results for maximum 24 hour $PM_{2.5}$.

The Air Quality Impact Assessment has been revised to correct all references and table titles and has been provided as **Appendix 5** to this RTS.

The Air Quality Impact Assessment summarises results from simulating meteorology over five years 2006-2010. Analysis notes a greater frequency of F-class stability in the years 2006-2008, but chooses the most recent year of 2010, for analysis. The Air Quality Impact Assessment states that "this is not considered to have a significant impact on the results" but provides no justification of explanation of this. The year 2010 has significantly lower concentrations than other years and less frequent incidence of very stable conditions (F-class). Analysis must be undertaken to justify that choosing 2010 does not significantly impact results. (EPA)

The MM5 data generated by the Pennsylvania State University/National Centre for Atmospheric Research was used for input into CALMET. The CALMET model was run for 2006, 2007, 2008, 2009 and 2010.

During the investigation of the data, it was found that there was no apparent trend in the modelled wind speeds, wind directions or mixing heights. However for the modelled stability classes, it was found that a higher percentage of F class is predicted for the years 2006 to 2008. Stability Class F is indicative of very

stable night time conditions, which is less conducive to pollutant dispersion due to reduced atmospheric mixing.

Investigations into this issue have revealed that the supplier of the MM5 data used in meteorological modelling altered the planetary boundary layer process parameterisation scheme from the Eta Turbulent Kinetic Energy scheme to the MRF scheme between model years 2008 and 2009 as part of ongoing refinement and improvement in model outputs. The MRF scheme is a newer parameterisation scheme which better evaluates the interactions of a number of variables within the boundary layer. A study by Fernandez et al (2007) found that the Eta scheme yielded a colder bias at the surface than the MRF scheme which may result in the prevalence of more stable conditions. The changes in the stability class distribution should be viewed as an improvement in previous (2006-2008) predictions and ongoing improvements and changes in parameterisation schemes will be incorporated into modelling techniques as they become available.

The use of the 2010 meteorological year is consistent with all Centennial Coal Air Quality Impact Assessment studies performed and submitted for agency review since 2012. This approach has been adopted to allow the relevant agencies to review each assessment in the knowledge that a consistent meteorological dataset underpins each assessment and that no 'cherry-picking' of meteorological data has been performed.

Hunter New England Local Health District noted the potential air quality impacts on the NC6 and NC2 receptor sites, it will be important to ensure that the proposed mitigations for these impacts are in place. (Hunter New England Local Health District)

An Air Quality Impact Assessment was prepared by SLR Consulting Pty Limited (SLR) to support the Project and was provided as Appendix L to the EIS. SLR's Air Quality Impact Assessment for the Project concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended Particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.
- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.

- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

Northern Coal Services will continue to implement the dust management practices to minimise the impacts on air quality as a result of the Projects operations. Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved. Additionally, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site.

The Environmental Management System to be developed for the Project will include an Air Quality Management Plan, which will take into consideration the findings, conclusions and recommendations of the Air Quality Impact Assessment, the commitments made in this EIS and all relevant consent conditions.

EPA advises DP&E that a condition of approval of the project should include establishment of an ambient continuous particulate monitoring site monitoring $PM_{2.5}$ and PM_{10} at or near Fassifern Public School as a close sensitive receiver. (EPA)

As detailed in Section 2.9 of the EIS, ambient air quality monitoring has been undertaken at the Newstan Colliery Surface Site for the following parameters:

- Monitoring of dust deposition (insoluble solids) has been undertaken since 1995 using deposited dust gauges.

- Monitoring of TSP (total suspended particulate - particulate matter less than 50 microns in diameter) and PM_{10} (particulate matter with an aerodynamic diameter of 10 microns (µm) or less) has been undertaken since November 2006 using a High Volume Air Sampler (HVAS). The ambient air quality monitoring program has been incorporated into a wider environmental monitoring campaign, and includes TSP and PM_{10} measurements using a co-located HVAS.

- Continuous PM_{10} monitoring has been undertaken since March 2012 using co-located tapered element oscillating microbalance (TEOM).

- $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5 µm or less) monitoring has been performed since September 2011 using a co-located HVAS, with TSP and PM_{10}.

The HVASs are operated to the applicable Australian Standard; DECCW (EPA) approved method or guideline. All laboratory analysis was conducted by a National Association of Testing Authorities (NATA) accredited laboratory.

The following Australian Standards are used:

- AS3580.9.3 —Methods for Sampling and Analysis of Ambient Air. Determination of Suspended Particulates—Total suspended particulate matter (TSP) High Volume sampler Gravimetric method

- AS3580.9.6. —Methods for Sampling and Analysis of Ambient Air. Determination of Suspended Particulates—PM_{10} High Volume sampler with size selective inlet - Gravimetric method.

Sampling is undertaken for 24 hours every 6 days to the DECCW (EPA) protocol. The results are reported as µg/m^3.The location of the High Volume Air Samplers was determined based on the Australian Standard AS 2922 - Ambient Air - Guide for the Siting of Sampling Units.

The HVAS at the Water Tank site is located approximately 250 metres from the Fassifern Primary School.

As detailed in Section 7.1.2 of the Air Quality Impact Assessment provided as Appendix L to the EIS, continuous monitoring of the PM_{10} using the TEOM has recorded a total of five exceedances of the 24-hour average guideline (50 µg/m^3). The maximum concentration recorded was 65.3 µg/m^{3}on 16 August 2012. The average over the nine months of monitoring has been 21.8 µg/m^3.

The current monitoring and location of monitoring for air quality at the Newstan Colliery Surface Site is considered appropriate and no additional air quality monitoring beyond that which is already undertaken is considered necessary in determining impacts form the Project on air quality criteria.

3.1.2 Biodiversity

The final EIS does not provide an assessment of the mitigation actions proposed in relation to the NSW Biodiversity Offsets Policy for Major Projects (OEH, 2014) and the six offsetting principles. (OEH)

OEH acknowledges that the proponent has modified the development footprint to reduce its impact on threatened biodiversity. Proposed translocation of Tetratheca juncea, and associated research, and installation of nest boxes may be considered as appropriate supplementary measures only if the proponent has been able to demonstrate that both land-based offsets are not available and that the supplementary measures proposed have the approximately equivalent value that a land-based offset would have cost. (OEH)

There is no indication in the EIS that Centennial Coal has considered providing a land-based offset with Tetratheca juncea, or has calculated the value of the impact of the project on threatened biodiversity, or of the proposed supplementary measures as required under the current offset policy. (OEH)

The mitigation and offset strategy for this project is inadequate. (OEH)

OEH requires that this project and its mitigation measures are assessed as required under the current biodiversity offset policy. (OEH)

The Project will result in approximately 21.4 hectares of surface disturbance, of which 12.63 hectares is already cleared/disturbed and the remaining 8.75 hectares comprising remnant native vegetation in varying condition.

The clearing of vegetation involves the removal of two hollow-bearing trees from Study Area 1 and three hollow-bearing trees from Study Area 2. A total of 10 hollows, including seven small hollows (2 to 10 centimetres) and three medium hollows (11 to 25 centimetres) were identified within the five hollow bearing trees. No large hollows (i.e. greater than 25 centimetres) were identified.

Two threatened flora species, namely Grevillea parviflora subsp. parviflora and Tetratheca juncea, where identified within the 8.75 hectares of native vegetation proposed to be removed. One individual stem of

Grevillea parviflora subsp. parviflora will be removed as part of the Project from within Study Area 2 and 376 clumps of Tetratheca juncea will be removed as part of the Project from within Study Area 1.

Through the Project design phase, the two disturbance areas were modified to reduce impacts to identified threatened species. As a result of the redesign of these areas, the Project was able to avoid impacts to 131 stems of Grevillea parviflora subsp. parviflora from within Study Area 2, 425 clumps of Tetratheca juncea from within Study Area 1 and 219 clumps of Tetratheca juncea at Study Area 2.

A number of additional mitigation and management measures are identified in Section 10.4.9 of the EIS that will further minimise potential impacts to threatened flora and fauna.

A variety of indirect offset measures are proposed to compensate for the residual impacts of the Project. It is proposed as part of the compensation measures to:

- Develop and implement a Tetratheca juncea translocation research program to build on the current knowledge regarding translocation of this species. The 376 clumps of Tetratheca juncea from within Study Area 1 will be translocated and monitored in accordance with the proposed research program.

- Nest boxes will be installed at a ratio of 1:1 (i.e. one nest box for every habitat hollow removed). The design and installation of nest boxes will draw on the information obtained from the five year research program undertaken by Centennial Mandalong into the utilisation of different nest box designs and aspects.

- Northern Coal Services will fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of Tetratheca juncea from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of Tetratheca juncea.

The proposed research programme has been developed with a focus on addressing the priority actions identified by the OEH and the DotE for Tetratheca juncea as part of this species Recovery Plan.

The NSW biodiversity offsets policy for major projects (OEH 2014) commenced a 12-18 month transitional implementation period on 1 October 2014. During this period, proponents and the consent authority will apply the policy to new major projects and certain existing projects in consultation with stakeholders. The Project was issued Director General's Requirements on 20 March 2012 which outlined the general requirements and key issues to be addressed within the EIS. The Director General's Requirements were subsequently re-issued by the DP&E on 7 August 2013. The Flora and Fauna Impact Assessment was finalised in April 2014 prior to the release of the NSW biodiversity offset policy for major projects. As such, the NSW biodiversity offset policy for major projects does not apply to the Project and subsequently, no assessment against the NSW biodiversity offset policy for major projects has been undertaken or is required to be undertaken.

Northern Coal Services consider the indirect compensatory measures proposed adequately compensate for the residual impacts to threatened flora species impacted as a result of the Project and that the compensatory measures proposed provide an overall net benefit to the ongoing understanding of Tetratheca juncea. The knowledge gained as a result of the proposed compensatory measures will lead to improved management of this species. No direct offsets or additional biodiversity mitigation measures are proposed.

OEH requires that Centennial Coal commits to an appropriate level of modelling of health and persistence of threatened biodiversity downstream the project area and commits to offsetting any harm to this biodiversity in accordance with the NSW Biodiversity Offsets Policy for Major Projects. (OEH)

As committed to in Section 10.3.11 of the EIS:

- The aquatic ecology monitoring of LT Creek will be continued biannually for an additional two years. This will assist in improving the management of water quality by providing an indication of ecological response to the quality of the discharge water (with the Clean Water Plant operational) and also the additional section of piping along LT Creek. To assess the impact of the proposed creek piping, this monitoring program will also include establishing replicate sites for sampling aquatic flora and fauna in “impact” and “control” locations.

- The macroinvertebrate and sediment monitoring program will be continued at the Cooranbong Entry Site to identify any future impacts or changes to water and sediment quality that may occur as a result of this increased discharge via Cooranbong LDP001. The aquatic macroinvertebrate monitoring and sediment sampling will be undertaken every six months (in spring and autumn) (due to the increase in discharge being a gradual increase over the life of the Project).

- The stability of LT Creek through the Fassifern Archery Club will be increased with the construction of small rock bed control structures within the flow area. It is expected that no more than three bed control structures will be required for this length of creek. The installation of these in stream works will be done in consultation with NOW and the Fassifern Archery Club.

- Quarterly and event based waterway visual inspections of LT Creek will be undertaken during the initial period of increased discharge via Newstan LDP001 until the stability of the creek under the new flow regime has been confirmed.

- In the event that in stream instabilities occur, remediation works, which will include the construction of bed control structures, will be undertaken. In locations where potential instabilities are a result of vegetation induced headcuts, in stream works may include localised bed stabilisation works including the placement of appropriately sized riprap not deeper than 500 millimetres underlaid by a geotextile fabric.

Surface water and ecological monitoring will be detailed in the respective management plans to be developed following development consent and as committed to in the Statement of Commitments contained in Section 11 of the EIS.

Should impacts above those identified in the EIS be identified, appropriate management actions included in a TARP will be implemented in consultation with landowners and relevant government agencies.

The EIS did not include a survey or a description of the one hectare or so of wetlands at the Hawkmount Quarry site. Based on the time that has elapsed since the last quarrying activities and, based on available satellite imagery, and the longevity of these water bodies OEH has adopted a precautionary approach and considers that that these wetlands may provide habitat for threatened species, such as Maundia trigochinoides - which is considered likely to occur downstream of the quarry, but the quarry site was not surveyed. Thus OEH considers that in the absence of a survey for this species at the quarry site then it is likely to occur and must be offset for this project. (OEH)

Table 10 in the FF report states that this site was comprehensively surveyed (all tracks for random meanders are not shown on our figures) and that there was potential for this species to occur. Accordingly, further assessments under the TSC Act 7-part test were undertaken in Appendix 2, which ruled out a significant impact. Additionally, GHD (2014) conclude that the water quality and intensity of the receiving water are not substantial enough to cause modification to the ecosystems and morphology of the downstream water course. It was concluded that no significant impact is expected to occur as a result of the project for Maundia trigochinoides.

Biodiversity survey effort for the project area is described in Section 3.0 of Appendix K of the EIS and indicates that they all occurred outside the flowering season of Corybas dowlingii (NSW Scientific Committee, 2007) and Corunastylis sp. Charmhaven (NSW Scientific Committee, 2012). (OEH)

Whilst late in the flowering period, surveys were undertaken within the recommended flowering period for Corybas dowlingii, as recommended on the OEH website. The flowers of Corybas dowlingii are needed to differentiate this species from the non-listed Corybas aconitiflorus (Spurred Helmet Orchid), due to the leaves of both species being identical. The August surveys undertaken are likely to have detected the leaf of Corybas dowlingii if present. However, no leaves of any Corybas species were detected and therefore the need for earlier surveys to differentiate flowers is not warranted in this instance.

On behalf of Northern Coal Services, RPS Australia East Pty Limited (RPS) also undertook targeted surveys at other locations within the Newstan lease area over the same August period. These surveys recorded old flowers, fruit and leaf of Corybas hispidus (Bristly Helmet Orchid). Therefore, the timing of surveys was appropriate in detecting locally occurring Corybas species. However, no individuals of Corybas were recorded within the Project Area. Whilst small, Corybas species are predominately located in areas with a sparse understorey and moderate leaf litter, making them readily detectable. Targeted survey effort was appropriate for the detection of Corybas species as demonstrated by the detection of Corybas hispidus at the time of these surveys.

Due to the little available literature on the flowering habits of Corunastylis sp. Charmhaven, predicting the appropriate time to undertake surveys is problematic. An assessment of the potential for this species to occur is discussed in Table 10 of the Flora and Fauna Assessment. It concludes the following:

Whilst little other information has been released, the available information suggests that this species could occur in Map Unit (MU) 23: Narrabeen Impeded Wet Heath or MU 31: Narrabeen Doyalson Coastal Woodland as mapped by The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales (Bell, 2002). The literature, therefore, indicates that this species is restricted to a low woodland or heathland with a more coastal influence than what exists within the disturbance footprints. This species is unlikely to occur.

Scientific Licences issues under section 132C of the National Parks and Wildlife Act 1974 come with reporting requirements that require a full report of the survey, research or other biodiversity assessment works carried out under the licence to be submitted to OEH at the expiry of the licence. Where a licence is valid for more than one year, records must be submitted annually. Section 3.0 of Appendix K of the EIS documents that biodiversity survey work for this project commenced in April 2012. Given that RPS's scientific licence (No. S100536) was issued on 1

January 2013 then this suggests that RPS is in breach of their scientific licence conditions by not yet having provided threatened species records for this project collected in 2012 and 2013. (OEH)

RPS Australia East Pty Limited (RPS) is in the process of providing all threatened species records for this Project to OEH.

It is noted that a recent provision of records to OEH, as administrators of the Wildlife Atlas, includes several Grevillea parviflora subsp. parviflora and many Tetratheca juncea records; but none that are shown in the maps included in the EIS for this project. (OEH)

As per the terms of the data licencing agreement held by RPS, they are not permitted to show threatened species records from the Atlas at a scale fine enough to provide delineation for the site. Certainly these species and records in the vicinity have been duly considered in the EIS and biodiversity assessment processes undertaken.

3.1.3 Consents

The application proposes to surrender a number of consents that currently provide approval for mining and the subsequent environmental controls. Council is concerned that the surrender of these consents may affect the ability to mine and remove substantive environmental controls that have been developed for these sites over many years. In this regard, Council requires greater assurance from the proponent that the environmental controls and approvals to mine under the various consents will be successfully transferred to a new single consent as proposed. (LMCC)

Northern Coal Services seeks a single new development consent for the Project to regulate the coal handling, processing and transport operations at the Newstan Colliery Surface Site, Cooranbong Entry Site and along the private haul roads, and utilise existing and proposed new surface infrastructure. The Project will provide the flexibility, not possible under the existing development consents for Newstan Colliery and Mandalong Mine, to supply varying quantities of coal to domestic and export markets. The Project does not cover the mining operations of the existing source mines or any future sources, which are subject to separate applications as required.

As detailed in Section 1.8 of the EIS, it is intended that the development consent granted in respect of the Project will authorise and regulate, among other things, the operational management of coal handling, processing and transport from the Mandalong Mine, Newstan Colliery and Awaba Colliery currently approved pursuant to Development Consent 73-11-98, Development Consent DA 97/800, and Project Approval 10_0038, respectively.

As such, it is anticipated that the development consent granted in respect of the Project would contain a condition which has the effect of requiring the surrender of Development Consent DA 73-11-98, Development Consent DA 97/800, and Project Approval PA 10_0038, but with such surrender only to occur after the grant of development consent in respect of the Newstan Extension of Mining Project and Mandalong Southern Extension Project.

3.1.4 Electrical Infrastructure

If the clearances to the private road crossings are changed by changing road RLs or vehicle heights, Ausgrid will need to be involved in assessing safety clearances. (Ausgrid)

Northern Coal Services will consult with Ausgrid regarding the assessment of safety clearances should road RLs or vehicle heights change throughout the life of the Project.

Toronto zone substation will require two new 132kV feeder crossings of the Newstan-Eraring private haul road. Ausgrid will consult with Centennial regarding traffic closures required to complete the installation of the new feeder crossing. Availability of traffic closures may be impacted by increased truck movements forecast in the EIS. (Ausgrid)

Ausgrid has a project in development to replace aged equipment in the Cooranbong 33/11kV zone substation. Ausgrid will require access to the substation site to be maintained under the existing arrangements. (Ausgrid)

Northern Coal Services will continue to consult with Ausgrid in regards to access to, and any impacts arising from, infrastructure upgrades required throughout the life of the Project.

3.1.5 Land Use

The EIS has identified a large amount of Crown land within the Project Application Area. Crown Lands have a number of concerns related to the impact of this development on the land including:

- **Access management and unauthorised use,**
- **Illegal dumping, including asbestos,**
- **Acquisition process for significantly affected Crown land,**
- **Aboriginal Land Claims and Native Title,**
- **The need to rationalise existing Crown Land tenures.**

Crown Lands request that the Proponent consult directly with Crown Lands, Maitland Office to discuss the above matters. (Crown Lands)

Crown Lands request that the Proponent provide Crown Lands, Maitland Office with a table of Crown Land impacted by this development. Details required for each parcel include:

- **Cadastral identifier (Lot and DP),**
- **Current and proposed use of the parcel by Proponent,**
- **Crown Lands authorisation - Crown Lands tenure(s) held by the Proponent,**

- **Mining activity authorisation - Approval under the Mining Act 1992 for the activity. (Crown Lands)**

Land ownership within the Project Application Area is detailed in Section 2.2.4 and shown in Figure 7 of the EIS. The Project Application Area comprises both privately-owned freehold land and land owned by the NSW State Government, as listed below:

- Newstan Colliery Surface Site occupies mainly freehold land owned by Fassifern Colliery Pty Ltd. There are two portions of Crown land, a small portion of land owned by LMCC and a small portion of privately-owned freehold land.
- Cooranbong Entry Site occupies freehold land owned by Centennial Fassifern Pty Limited (subsidiary company of Centennial Coal) and Crown land.
- Hawkmount Quarry occupies Crown land under Permissive Occupancy No. 146079 held by LMCC.
- Newstan-Eraring Private Haul Road is located on Crown land used under Permissive Occupancy No. 16313 held by Origin Energy.
- Cooranbong Private Haul Road is constructed on Crown land used by Centennial Mandalong Pty Limited under Crown Land Licence No. L1432152.
- Awaba Private Haul Road is constructed on Crown land leased by Centennial Newstan Pty Limited.

All surface infrastructure for the Project is within existing mining leases held by Centennial Newstan Pty Limited or Centennial Mandalong Pty Limited. Mining Leases relevant to the Project are detailed in Section 3.4 of the EIS.

All current and proposed activities are undertaken in accordance with the conditions of the relevant mining leases. No new mining leases are required to support the Project.

Table 4 below provides details on the Crown Lands impacted by the Project and the relevant authorisations held in respect to that land.

Table 4 – Crown Land Status within the Project Application Area

Owner	Lot//DP	Associated Use Within project Application Area	Mineral Authority	Licence/PO
CROWN	7343//1186699	Newstan Eraring haul road	CCL727	PO16313
CROWN	171//755218	Cooranbong Entry Site	CCL746, MPL191	
CROWN	7322//1166295	Newstan Eraring haul road	CCL746	
CROWN	184//755218	Cooranbong haul road	CCL746	L1432152
CROWN	7336//1170023	Newstan Eraring haul road	CCL746	PO16313
CROWN	7309//1164559	Newstan Eraring haul road	CCL746	PO16313
CROWN	7304//1149082	Newstan Eraring haul road	CCL746	PO16313
CROWN	102//755218	Newstan Eraring haul road	CCL746	PO16313

CROWN	101//755218	Newstan Eraring haul road	CCL746	PO16313
CROWN	9//239629	Newstan Eraring haul road	CCL746	PO16313
CROWN	5//239629	Newstan Eraring haul road	CCL746	PO16313
CROWN	213//755207	Newstan Eraring haul road	CCL746	PO16313
CROWN	7338//1170024	Newstan Eraring haul road	CCL746, ML1452	PO16313
CROWN	7341//1169843	Newstan Eraring haul road	CCL746	PO16313
CROWN	7305//1149082	Newstan Eraring haul road	CCL746	PO16313
CROWN	225//755207	Newstan Eraring haul road	CCL746, ML1452	PO16313
CROWN	1//582126	Newstan Eraring haul road	CCL746	PO16313
CROWN	223//755207	Newstan Eraring haul road	CCL746, ML1452	PO16313
CROWN	214//755207	Awaba Haul Road	CCL746	
CROWN	212//755207	Awaba Haul Road	CCL746	
CROWN	6//239629	Awaba Haul Road	MPL327	
CROWN	8//239629	Newstan Eraring haul road	MPL328, CCL746	PO16313
CROWN	211//755207	Newstan Eraring haul road	CCL727, ML1452	PO16313
CROWN	7337//1170022	Newstan Eraring haul road	CCL727, ML1452	PO16313
CROWN	616//817275	Newstan Eraring haul road	CCL727	PO16313
CROWN	230//755207	Newstan Eraring haul road	ML1452	PO16313
CROWN	207//755207	Newstan Eraring haul road	CCL727, ML1452	PO16313
CROWN	318//39722	Newstan Eraring haul road	CCL727	PO16313
CROWN	210//755207	Newstan Eraring haul road	ML1452	PO16313
CROWN	206//755207	Newstan Eraring haul road	CCL727	PO16313
CROWN	208//755207	Newstan Eraring haul road	CCL727, ML1452	PO16313
CROWN	4//46737	Newstan Eraring haul road	CCL764	PO16313
CROWN	6//46737	Newstan Colliery Surface Site	CCL764	
CROWN	234//755207	Newstan Colliery Surface Site	CCL764	
CROWN	104//1149241	Newstan Eraring haul road	CCL764	PO16313

CROWN	102//1149241	Newstan Eraring haul road	CCL764	PO16313
CROWN	7335//1170004	Newstan Colliery Surface Site	CCL764	
CROWN	149//728974	Newstan Colliery Surface Site	CCL764	
CROWN	5//46737	Newstan Colliery Surface Site	CCL764	
CROWN	14//1031778	Newstan Colliery Surface Site	CCL764	
CROWN	11//1031859	Newstan Eraring haul road	CCL727	PO16313
CROWN	1//1031859	Newstan Eraring haul road	ML1380, CCL727	PO16313
CROWN	4//1031859	Newstan Eraring haul road	ML380	PO16313
CROWN	216//755207	Newstan Eraring haul road	CCL746	PO16313
CROWN	215//755207	Newstan Eraring haul road	CCL746	PO16313
CROWN	97//755218	Cooranbong Entry Site	CCL746	
CROWN	7306//1164232	Cooranbong Entry Site and Cooranbong Private Haul Road	CCL746	L1432152
NSW GOVERNMENT	1//1191489	Newstan Colliery Surface Site	CCL764	
NSW GOVERNMENT	1//1191308	Newstan Eraring haul road	CCL746	PO16313

Hawkmount Quarry (Lot 7306 DP 1164232) is affected by Permissive Occupancy No: 146079 from Crown Lands. This is a dual permissive occupancy with Centennial Coal. Should the Department countenance approval of the project then the development should contain a condition requiring relinquishment of the PO with Crown Lands as it can no longer gain access to the site and has finished quarrying activities on the site. (LMCC)

Northern Coal Services will continue to consult with Crown lands and Lake Macquarie City Council regarding ongoing matters in relation to Hawkmount Quarry.

3.1.6 Licensing Requirements

There is insufficient information in the EIS for the EPA to determine the proponent's intention with respect to current EPLs specifically in relation to the generation of coal tailings, fines, rock and waste and their emplacement (disposal). EPA recommends that the proponent provide adequate information about the project in relation to whether the whole project will be covered by an EPL or whether individual premises based EPLs will remain and require variation. This may have implications for the proponent in relation to Protection of the Environment Operations (Waste Regulation) 2014.

As detailed in Section 5.0, Table 1 of the EIS, Newstan Colliery and Mandalong Mine are premises-based "scheduled activities" under Schedule 1 of the POEO Act and currently operate under the provisions of EPL 395 and 365, respectively. The Northern Coal Logistics Project will also be a premises-based scheduled activity ("coal works") under Schedule 1 of the POEO Act and will be required to operate under a new EPL that includes:

- Three existing LDPs and one proposed new LDP at the Newstan Colliery Surface Site;
- Two existing LDPs at the Cooranbong Entry Site; and
- One proposed new LDP at Hawkmount Quarry.

If the material proposed to be transported in to the Project Application Area from the Awaba Colliery Surface Site, Mandalong Mine Access Site, Mandalong South Surface Site and proposed Newstan Extension of Mining Project Ventilation Shaft Sites (see Section 4.10.1 of the EIS) is not classed as Virgin Excavated Natural Material (VENM) of Excavated Natural Material (ENM), the Project's EPL will need to include acceptance of this material or specific exemptions will need to be applied for.

3.1.7 Noise

The EPA advise that because of the relatively small sample size of background noise measurements during the shoulder period, it is inappropriate to calculate a shoulder Rating Background Level (RBL) directly from those measurements. Following the approach in the Industrial Noise Policy, the EPA nominates alternate Project Specific Noise Levels for the morning shoulder. (EPA)

Receiver Location	Nominated in Noise and Vibration Impact Assessment	Nominated by EPA
NC1 and NC2 ($L_{Aeq(15min)}$)	46 dBA	39 dBA
NC3 to NC5 ($L_{Aeq(15min)}$)	45 dBA	40 dBA

The "Morning Shoulder" Project Specific Noise Levels adopted in the Noise and Vibration Impact Assessment were LAeq(15min) 46 dBA and 45 dBA, for receivers NC1 and NC2, and NC3 to NC5, respectively. These levels are higher than the daytime Project Specific Noise Levels. (EPA)

The New South Wales Industrial Noise Policy (INP, EPA 2000) suggests that due to the smaller sample size of the Shoulder Period compared to other times of day, the RBL should not be directly calculated from measurements during the shoulder period. The Industrial Noise Policy suggests that an acceptable shoulder period RBL may be the mid-point (arithmetic average) of the day time and night time RBLs. (EPA)

The Industrial Noise Policy has acknowledged that "where early morning (5 am - 7 am) operations are proposed, it may be unduly stringent to expect such operations to be assessed against the night-time criteria - especially if existing background noise levels are steadily rising in these early morning hours". For this reason, the morning shoulder period (6:00 am to 7.00 am) has been considered separately as part of this assessment. The Morning Shoulder periods were determined based on actual noise monitoring undertaken and this approach to the morning shoulder period was previously accepted by the EPA for the previous Noise and Vibration Impact Assessment for Newstan Colliery (SLR 2011). Either way, the amended morning shoulder period criteria as proposed by the EPA has no impact on the

outcome of the predicted noise modelling results and no exceedances of the proposed morning shoulder period are predicted.

A revised table of predicted results against for all scenarios against the revised morning shoulder period criteria as proposed by the EPA is provided as **Table 5**.

Table 5 – Noise Predictions against revised Morning Shoulder Periods including NC6 Residential Receivers

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)												Project Specific Noise criteria
		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6		
		Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	
NC1	Morning Shoulder	<35	35	<35	35	<35	<35	<35	<35	<35	<35	<35	<35	39 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	41 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	41 dBA
	Night	<35	<35	<35	35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
NC2	Morning Shoulder	<35	36	<35	36	<35	35	<35	37	<35	35	<35	35	39 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	41 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	41 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	35	<35	<35	<35	<35	36 dBA
NC3	Morning Shoulder	<35	40	36	40	<35	38	37	40	<35	38	<35	37	40 dBA
	Day	36	N/A	36	N/A	<35	N/A	37	N/A	<35	N/A	<35	N/A	44 dBA
	Evening	36	N/A	36	N/A	<35	N/A	37	N/A	<35	N/A	<35	N/A	44 dBA
	Night	**36**	**39**	**36**	**39**	<35	**37**	**37**	**40**	<35	**37**	<35	**36**	35 dBA
NC4	Morning Shoulder	<35	36	<35	36	<35	<35	<35	36	<35	<35	<35	<35	40 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	44 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	44 dBA
	Night	<35	35	<35	**36**	<35	<35	<35	35	<35	<35	<35	<35	35 dBA
NC5	Morning Shoulder	<35	35	<35	35	<35	<35	<35	36	<35	35	<35	<35	40 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	44 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	44 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	35	<35	<35	<35	<35	35 dBA
NC6 (school)	Morning Shoulder	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)												Project Specific Noise criteria
		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6		
		Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	
	Day	38	N/A	38	N/A	37	N/A	39	N/A	37	N/A	37	N/A	55 dBA (School Playground)
		<35		<35		<35		35	N/A	<35		<35		35 dBA (internal)
	Evening	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Night	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
NC6 (Residential)	Morning Shoulder	36	**41**	37	**41**	35	39	38	**41**	35	39	35	38	40 dBA
	Day	37	N/A	37	N/A	35	N/A	38	N/A	35	N/A	35	N/A	44 dBA
	Evening	37	N/A	37	N/A	35	N/A	38	N/A	35	N/A	35	N/A	44 dBA
	Night	**37**	**40**	**37**	**40**	35	**38**	**38**	**41**	35	**38**	35	**37**	35 dBA
NC7	Morning Shoulder	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	40 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	44 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	44 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	35 dBA
NC8	Morning Shoulder	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
NC9	Morning Shoulder	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
NC10	Morning Shoulder	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA

Location	Period	Predicted Noise Level LAeq(15minute) (dBA)												Project Specific Noise criteria
		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5		Scenario 6		
		Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	Calm	Temp Inv	
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
NC11	Morning Shoulder	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA
	Day	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Evening	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	<35	N/A	38 dBA
	Night	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	<35	36 dBA

Model results for comparison against Project Specific Noise Levels for the nearest residential sensitive receiver in the vicinity of receiver NC6 (a primary school). From the information in the Noise and Vibration Impact Assessment, the EPA expects that the Project Specific Noise Levels for receiver locations NC3 and NC5 may also be suitable for the residential receiver locations near NC6. (EPA)

Modelled noise levels as a result of the project at residential sensitive receivers near NC6 (a school) were not presented in the Noise and Vibration Impact Assessment. Daytime Leq(1hour) predictions in the Noise and Vibration Impact Assessment for receiver NC6 were typically 2 dBA above the corresponding Leq(15min) predictions for receiver NC3, which is located in a similar location relative to the project. This indicates that residential receivers near receiver NC6 may be impacted by the project by between 3 and 7 dBA above Project Specific Noise Levels. (EPA)

Cladding of the proposed new Coal Preparation Plant in noise-attenuating material (Noise and Vibration Impact Assessment scenarios 5 and 6) resulted in predicted noise levels at sensitive receivers NC1 to NC6 up to 3 dBA lower than with standard steel cladding, indicating that the Project Specific Noise Levels at receiver location NC4 could be complied with, and Project Specific Noise Level exceedance at receiver location NC3 reduced to 2 dBA during the night time only. This indicates, using the relationship described above, that residential receiver locations near NC6 may still be impacted by the project during scenarios 5 and 6 by up to 4 dBA above the night time Project Specific Noise Level. (EPA)

The main contributor at NC6 (school) are the locomotives on the rail loop. The predicted noise levels at residential locations near NC6 are lower than NC6 (school) because they are located over double the distance from the rail loop. **Table 5** includes noise predictions for the residential locations surrounding NC6 (School). As demonstrated in **Table 5**, depending on the scenario, noise may impact on the residential receivers at NC6 by up to 6 dBA.

Scenario 3 predicts a 3 dBA exceedance at the NC6 residential locations at night during temperature inversions once all current noise mitigation measures have been implemented. If a second CPP is constructed, the Coal Preparation Plant will be clad in noise attenuating panels, as committed to in the Statement of Commitments provided in Section 11 of the EIS. This will maintain predicted noise exceedances to only 3 dBA above the Project Specific Noise Levels at night during temperature inversions.

In practice, noise levels will depend on the number of plant items and equipment operating at any one time and their precise location relative to the receiver of interest. Noise levels will vary due to the movement of plant and equipment about the worksites and the concurrent operation of plant. In some cases, reductions in noise levels will occur when plant are located in cuttings or behind embankments, buildings or other items of equipment. The noise predictions are representative of the worst-case scenario with all equipment operating simultaneously. The actual noise levels during operation are likely to be lower than predicted in this assessment.

Furthermore, the predicted noise levels in Scenario 5 and Scenario 6 show that with the proposed mitigation measures in place, the noise levels are lower than the existing levels experienced at the nearest potentially affected receiver locations and below the current approved development consent noise conditions.

The exceedances of the project specific noise criteria for Scenario 5 and Scenario 6 are only confined during night-time temperature inversion. The assessment of temperature inversion is to determine whether disturbance to sleep is possible “Assessment of impacts is confined to the night noise assessment period (10pm to 7 am), as this is the time likely to have the greatest impact—that is, when temperature inversions usually occur and disturbance to sleep is possible”, Industrial Noise Policy. The

sleep disturbance noise predictions under worst case temperature inversion conditions showed that all is assessment receiver locations were less than the minimum sleep disturbance criteria of 45 dBA and hence sleep disturbance is unlikely.

Northern Coal Services will continue to employ the mitigation measures and management strategies currently adopted at the Newstan Colliery and Mandalong Mine, as relevant to the Project, to minimise noise emissions. These are standard work procedures to minimise noise emissions, maintaining plant and equipment to ensure optimal operating conditions, and assessing the sound power levels when purchasing new plant and equipment.

Northern Coal Services will complete the implementation of the following noise mitigation measures at the Newstan Colliery Surface Site:

- Existing Coal Preparation Plant
    - Sealing of all unnecessary openings in all the walls around the preparation plant (now complete);
    - Continuance of the existing plant external walls down to the ground level as required;
    - Fully enclosing exposed conveyors with the same Colorbond steel being used for the building and conveyors as required; and
    - Replacement of the alsynite panels on eastern wall with Colorbond steel as required.
- Reclaim Conveyor Transfer House
    - Sealing of all unnecessary openings in all the walls around the conveyor transfer house by December 2014;
    - Continuance of the existing plant external walls down to the ground level;
    - Fully enclosing exposed conveyors with the same Colorbond steel being used for the building and conveyors as required; and
    - Replacement of the alsynite panels on eastern wall with Colorbond steel as required.

Northern Coal Services will complete the installation of a real-time noise monitor at the Newstan Colliery Surface Site as committed to in Section 10.9.6 of the EIS. When noise levels from the site are identified as approaching the project-specific noise criteria, a review of operations will be undertaken and adaptive management measures implemented to ensure noise levels are maintained below the below the relevant criteria.

Predicted Project Specific Noise Level exceedences appear to be due to operations at the Newstan Colliery surface site, particularly the existing and proposed Coal Preparation Plants. The Noise and Vibration Impact Assessment listed mitigation measures which had already been committed to in previous development applications for the existing Coal Preparation Plant, but did not identify whether all further feasible and reasonable mitigation measures had been considered for the project, particularly the Coal Preparation Plants. (EPA)

No new mitigation measures were identified in the Noise and Vibration Impact Assessment for the existing Coal Preparation Plant. The implementation of a real-time monitoring system is also not a

new mitigation measure, as it was proposed for the Newstan Colliery Main West Mining Project. (EPA)

The Noise and Vibration Impact Assessment did not demonstrate that impacts predicted above the Project Specific Noise Levels were acceptable in accordance with Chapters 8 and 9 of the INP, or that all feasible and reasonable mitigation measures had been committed to for the project. (EPA)

A review of noise issues undertaken by Northern Coal Services as part of the Main West modification identified a number of noise mitigation strategies that could be implemented to reduce the potential for noise exceedances from the Newstan Colliery Surface Site operations. These mitigation measures have been implemented progressively with monitoring undertaken to determine their effectiveness. To date, the noise mitigation measures that have been implemented have resulted in noise reductions greater than previously predicted. The noise mitigation measures identified as part of the Main West modification and included in the EIS will continue to be implemented as required with monitoring undertaken to determine their effectiveness. The mitigation measures identified to be implemented as part of the Main West modification were a result of extensive modelling and consultation with site in order to identify all reasonable and feasible measures that could be adopted. As a result of this work, the Noise and Vibration Impact Assessment has identified that once these measures are implemented, they will be effective at managing noise from the Newstan Colliery Surface Site for the life of the Project. Additionally, if a second Coal Preparation Plant is constructed, the Coal Preparation Plant will be clad in noise attenuating panels, as committed to in the Statement of Commitments provided in Section 11 of the EIS. As identified in the EIS, exceedances are still predicted with all identified mitigation measures adopted at night during temperature inversions. As such, Northern Coal Services has committed to complete the installation of a real-time noise monitor at the Newstan Colliery Surface Site. . When noise levels from the site are identified as approaching the project-specific noise criteria, a review of operations will be undertaken and adaptive management measures implemented to ensure noise levels are maintained below the below the relevant criteria. This adaptive management approach will assist Northern Coal Services comply with the Project Specific Noise Levels identified in the Noise and Vibration Impact Assessment.

3.1.8 Rehabilitation

DRE requires that proponent submit a revised Mine Operations Plan to include this modification if approved. (DRE)

Northern Coal Services will prepare and submit a revised Mine Operations Plan to DRE for the Project Application Area should the Project be approved.

The Proponent must rehabilitate the site to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services. (DRE)

Northern Coal Services will undertake all rehabilitation at the site to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.

The proponent shall carry out all surface disturbing activities (e.g. pre-stripping in advance of mining operations including for example monitoring lines and access for rehabilitation purposes) in a manner that, as far is reasonably practicable, minimises potential for dust emissions and shall carry out rehabilitation of disturbed areas progressively, as soon as reasonably practicable, to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services. (DRE)

Northern Coal Services will undertake all surface disturbing activities in a manner that, as far is reasonably practicable, minimises potential for dust emissions and shall carry out rehabilitation of disturbed areas progressively, as soon as reasonably practicable and to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.

The Proponent must prepare and implement a Rehabilitation Plan to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services. (DRE)

All rehabilitation and associated monitoring and management actions will be incorporated into the Mine Operations Plan for the Project taking into consideration the commitments made in the EIS and relevant consent conditions. Rehabilitation will be undertaken to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.

3.1.9 Rejects Emplacement

The Coal Mine Health and Safety Act 2002 Section 100-101 requires secondary approval from the Minister of Resources and Energy for any tailing and emplacement facility proposed. (DRE)

Approval under Section 100 of the Coal Mine Health and Safety Act 2002 was granted on 9 January 2007 by the then Department of Primary Industries for the emplacement of reject at the Southern Reject Emplacement Area.

Approval will be sought from DRE for the proposed emplacement of reject at the Hawkmount Quarry prior to the utilisation of this site as a reject emplacement facility.

DRE advises that under the Coal Mine Health and Safety Act 2002 Section 100 and 101 the proposed capping strategy will need approval of the Minister of Resources and Energy. (DRE)

Northern Coal Services will seek approval from DRE in accordance with the requirements of the Coal Mine Health and Safety for the proposed capping strategy for the Southern Reject Emplacement Area and the Hawkmount Quarry Reject Emplacement Area prior to commencement of the capping of these areas.

3.1.10 Road Traffic

One of two scenarios being considered by Northern Coal Services is having all the construction employee traffic (170 vph) assemble at the Cooranbong Entry Site and travel to the Newstan Colliery Surface Site via private haul roads. This option is intended to reduce the impact of the construction traffic on the Fassifern local road network. The Traffic Impact Assessment has adopted 80% of the traffic generated during both the operational and construction phases of the development travelling from/to the east and states that Newport Road and Gradwells Road can satisfactorily cater for this additional traffic. However, no assessment of the Wangi Road/Dora Street intersection, which this additional traffic will use to access Newport Road has been undertaken.

The Wangi Road / Dora Street intersection is only to be impacted on by construction traffic. Therefore it is a short term peak which will occur outside the normal road network peak periods. It would be unreasonable to require upgrading of this intersection for a construction traffic impact. Any impacts from construction traffic will be managed through the construction traffic management plan. If issues were identified, construction employee access to the Newstan Colliery Surface Site could be via alternate routes and split between access via the Cooranbong Entry Site and the Newstan Colliery Surface Site.

Access for heavy vehicles to the Cooranbong Entry Site during the construction phase of the development via the Wangi Road/Dora Street intersection is not viable as there is a low clearance restriction on Newport Road under the Dora Creek bridge.

As detailed in Section 10.10.8 of the EIS, while construction traffic is likely to utilise the local public road network to access the Newstan Colliery Surface Site off Miller Road, construction workers may be assembled at the Cooranbong Entry Site and bussed along the private haul roads to the Newstan Colliery Surface Site to reduce the impact of this traffic on the local road network around Fassifern.

Heavy vehicle access to and from the construction areas at the Newstan Colliery Surface Site will continue to be via the access off Miller Road only.

No assessment has been undertaken of the Main Road/Macquarie Road traffic signal controlled intersection which will be used by the majority (80% to/from the east) of the traffic generated during the operational phase of the project. Additionally, if the second scenario is adopted for construction traffic access to the Newstan Colliery Surface Site, 80% of this traffic generated will use the Main Road/Macquarie Road traffic control signal intersection.

The Main Road/Macquarie Street intersection has a high level of control (traffic signals) and the Project is only directing 31 to 33 vehicles per day in two directions through the intersection. By experience, even if the signals were operating at near capacity this amount of traffic would not be such that they would generate a nexus to provide additional turning lanes particularly as the peak traffic generating periods for the Project will not coincide with the peak road network flows.

RMS state that 80 % of traffic would be directed to this intersection. This is incorrect as some traffic will head back to Toronto at Fassifern Road and in reality only 35 – 40 % of traffic will go through this intersection.

The Traffic Impact Assessment should consider the additional impact on the road network of traffic generated by the transportation of excess spoil material from the construction of the Mandalong South Surface Site and a new ventilation shaft site (site yet to be determined). The Traffic Impact Assessment has indicated that these projects will utilise the public road network to access the Cooranbong Entry Site and the Awaba Surface Facilities Site.

The impact on the local road network from traffic generated by the Transport of material from construction sites associated with other Projects has been and will be considered as part of the Environmental Assessment for those Projects.

As outlined in Section 4.10.1 of the EIS, it is anticipated that there could be up to 7,500 cubic metres of excess cut material from the construction of the proposed Mandalong South Surface Site (part of the Mandalong Southern Extension Project), which will require up to 500 truckloads between the Mandalong South Surface Site and Newstan Colliery Surface Site. Trucks carrying the excess material will leave the

Mandalong South Surface Site and travel north along Mandalong Road and subsequently north along the M1 Pacific Motorway taking the Palmers Road exit to Toronto. Once on Palmers Road the trucks would travel to the Newstan Colliery Surface Site via Wakefield in order to avoid travelling through highly populated areas and past schools.

As also outlined in Section 4.10.1, the Newstan Extension of Mining Project proposes to install a new ventilation shaft and borehole within the Newstan Extension of Mining Project Application Area. The bulk of the excavated material will be deposited directly into the mine workings and will be removed from underground using the mine coal clearance system to the Newstan Colliery Surface Site. However any excavated material left on the surface is proposed to be transported by truck to the Newstan Colliery Surface Site via the public road network and/or private haul roads. It is estimated that there will be up to 3,500 cubic metres of material, which will require up to 235 truckloads between the ventilation shaft site and Newstan Colliery Surface Site.

As detailed in Section 10.10.8 of the EIS, Intersect Traffic has undertaken traffic assessments for both the Mandalong Southern Extension Project and the Newstan Extension of Mining Project, which determined that the construction traffic generated by these projects will not adversely impact on the local road network as there is sufficient spare capacity within the local road network. The Traffic Impact Assessment prepared by Intersect Traffic and provided as Appendix O to the EIS advises that the traffic generated by these short term activities will not adversely impact on the local road network and can be readily managed through the preparation and implementation of Construction Management Plans.

3.1.11 Surface Water

The EPA disagrees with the EIS's assertion that there has been little environmental impact from the increase in discharge of wastewater from Newstan at LT Creek from 7ML/d to 11ML/d, as the data collected so far is insufficient to make such determinations. The EPA also advises the DPE that the Clean Water Plant commissioning report that Newstan had completed is not adequate for the EPA to ascertain whether the Clean Water Plant is capable of reducing total metals, dissolved metals or to treat water to an acceptable level at a range of throughputs. Newstan has not been able to demonstrate to the EPA that Newstan Clean Water Plant discharge is not toxic to a range of aquatic animals. The EPA is in the process of writing to Newstan to request a more detailed Water Commissioning Plant Study, a further water quality monitoring and ecotoxicological assessment of the discharge water to freshwater prawns and eastern rainbow fish and macroinvertebrate monitoring downstream of the Centennial Newstan's discharges, compared to

control. Until this monitoring has been undertaken, data analysed and reported to the EPA, the EPA is not in a position to comment on or approve an increase in the discharge from 11ML/d to 14.5ML/d into LT Creek from Newstan. (EPA)

GHD has undertaken an ecotoxicology assessment of discharges through licensed discharge point 1 (LDP001) at Newstan Colliery. Direct toxicity assessment of water sampled from LDP001 has been conducted using the methodology outlined by the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) using the test species required by condition U3.2 of the Environment Protection Licence (EPL) 395 held by Newstan Colliery.

The following toxicity tests were undertaken:

- Eight day reproduction impairment test using the freshwater cladoceran Ceriodaphnia dubia.
- 10 day embryonic development and post-hatch survival test using the freshwater eastern rainbow fish Melanotaenia splendida splendida.
- 10 day survival test using the freshwater shrimp Paratya australiensis.

The clean water plant (CWP) commissioning report has been updated to include the results of the ecotoxicology assessment, as well as recent macroinvertebrate monitoring results. Further discussion on the environmental impact of increased discharges at LDP001 from 7 ML/day to 11 ML/day since 2012 is provided in the Clean Water Treatment Plant: Ecotoxicology Assessment provided as **Appendix 3** to this RTS.

In addition, a technical report has been developed by GHD to summarise the results of ecotoxicology and macroinvertebrate assessments conducted for LT Creek, Stony Creek and the unnamed tributary of Muddy Lake at Cooranbong Services Site over the period from 2012 to 2014. This report details the methodology and results of the assessments, including water and sediment quality testing, as well as discussion on the mitigation and management measures currently in place and proposed as part of the Project and the proposed ongoing monitoring for toxicity and macroinvertebrates. Further information is provided in the Northern Coal Logistics Project: Aquatic Monitoring and Ecotoxicology Assessment Summary Report provided as **Appendix 4** to this RTS.

According to the EIS, 40% of all catchment input into northern Lake Macquarie is attributed by Centennial operations. (EPA)

As demonstrated by the results of the *Northern Operations Water and Salt Balance* (provided as Appendix J to the EIS), discharges from the Project were modelled to currently make up approximately 40% of the total licensed discharges into each of the Dora Creek and North Lake Macquarie water sources. However, this value does not consider catchment runoff or the contribution of Eraring Power Station to Lake Macquarie. Considering the contribution from these sources, discharges from the Project are expected to be less than 4% of the total discharge to each water source and less than 3% of the total inflow into Lake Macquarie. Thus, the Project is predicted to input considerably less than 40% of the total volume discharging to the lake overall, compared to surface runoff and other industrial sites with licensed discharges into the catchment.

The EIS has not modelled nor discussed the increased loading of metals into the western tributaries of Lake Macquarie or Lake Macquarie generally, nor established potential impacts on sediments and aquatic biota and how these will be mitigated. (EPA)

Based on the predicted average daily discharge results from the water balance model developed and the 50th percentile water quality statistics at LDP001 of both Newstan Colliery Surface Site and Cooranbong Services Site provided as part of EIS, forecast metal loads that are likely to be discharged can be predicted. Selected filterable/dissolved metals were assessed for total load considering the 50th percentile water quality result for each analyte. Filterable/dissolved metals have been considered as these are the bioavailable fraction of the total metal concentrations. **Table 6** and **Table 7** below provides the results for LDP001 at Cooranbong Services Site and LDP001 at Newstan Colliery Surface Site respectively.

Table 6 – Predicted Metal Loads as a Result of the Project (Cooranbong Entry Site)

Parameter	50th percentile concentration (mg/L)	Predicted flow volume 2014–2051 (GL)	Load (tonnes)
Filterable/dissolved metals			
Aluminium	0.01	53.2	0.5
Antimony	0.01	53.2	0.1
Arsenic	0.001	53.2	0.1
Barium	0.001	53.2	22.5
Boron	0.423	53.2	11.7
Cadmium	0.22	53.2	0.01
Cobalt	0.0001	53.2	0.3
Copper	0.006	53.2	0.1
Iron	0.001	53.2	9.0
Lead	0.17	53.2	0.1
Manganese	0.001	53.2	3.7
Molybdenum	0.07	53.2	1.2
Nickel	0.022	53.2	3.0
Tin	0.056	53.2	0.1
Zinc	0.001	53.2	0.3

Table 7 – Predicted Metal Loads as a Result of the Project (Newstan Colliery Surface Site)

Parameter	50th percentile concentration (mg/L)	Predicted flow volume 2014–2051 (GL)	Load (tonnes)
Cations			
Calcium	30	134.8	4,043.0
Magnesium	12	134.8	1,617.0
Potassium	5	134.8	674.0
Sodium	660	134.8	88,945.0
Filterable/dissolved metals			
Aluminium	0.01	134.8	1.4
Antimony	0.001	134.8	0.1
Arsenic	0.001	134.8	0.1
Barium	0.067	134.8	9.0
Beryllium	0.001	134.8	0.1
Boron	0.19	134.8	25.6
Cadmium	0.0001	134.8	0.01
Chromium	0.001	134.8	0.1
Cobalt	0.001	134.8	0.1
Copper	0.001	134.8	0.1
Iron	0.05	134.8	6.7
Lead	0.003	134.8	0.4
Lithium	0.1	134.8	14.0
Manganese	0.131	134.8	18.0
Molybdenum	0.02	134.8	2.7
Nickel	0.024	134.8	3.2
Zinc	0.005	134.8	0.7

LDP001 at both Cooranbong Services Site and Newstan Colliery Surface Site are the only proposed constant discharge points for the Project. Other LDPs that exist at the sites are proposed to have discharges occur, however these will be rare or infrequent based on rainfall patterns and system demands.

EPA recommends that the EIS consider and evaluate further how increased discharges from Stony Creek will be avoided. The EIS predicts that during the Centennial Newstan Extension Project, groundwater inflow into the Fassifern seam will exceed transfers into the Fassifern Underground storage and lead to increased discharges from the seam into Stony Creek post 2036, peaking at 60 ML/d. EPA consider that this is untenable given that Newstan have exceeded EPL water quality limits on numerous occasions in Stony Creek. The EIS must consider what practical means of management and/or treatment of Stony Creek discharges is practicable to ensure that discharge meets appropriate water quality limits such that the increased occurrence of uncontrolled discharges will not impact the environment. (EPA)

Discharges at LDP017 occur from the Fassifern Underground Storage into Stony Creek when water levels in the storage exceed 16.6 m below ground level through two 600 mm pipes. An assessment of the frequency and quantity of discharges through LDP017 was undertaken as part of the water balance assessment for the Project and provided as Appendix J to the EIS.

Under existing conditions, the average annual discharge through LDP017 was modelled to be approximately 10.4 ML/year. The 10th percentile and 90th percentile values for LDP017 were predicted to be 0 ML/year, indicating that the average value is significantly skewed by high rainfall events and prolonged wet periods.

Under proposed conditions in 2036, the average inflows into the Fassifern Underground Storage are predicted to be greater than the outflows, causing a predicted increase in storage and increased discharges through LDP017 into Stony Creek. The average annual discharge through LDP017 under proposed conditions was modelled to increase to 65.8 ML/year. This value was predicted to vary between 0 ML/year (10th percentile) and 260 ML/year (90th percentile).

Figure 1 below presents the predicted daily flow percentiles through LDP017 into Stony Creek. Daily time steps were used for the water balance modelling as daily rainfall data was the shortest period of data available.

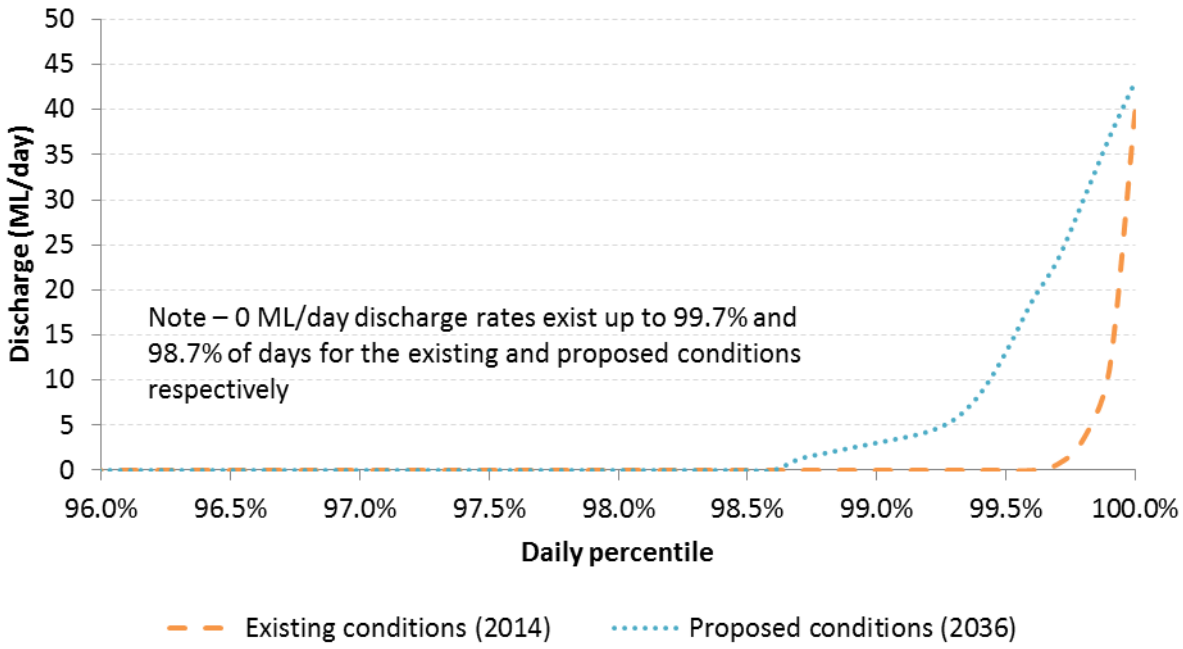


Figure 1 - Predicted LDP017 Daily Flow Percentiles

Considering the daily flow predicted through LDP017, discharges under existing conditions in 2014 were estimated to occur for approximately 0.3% of days in the year, or one day per year. No discharge through LDP017 was predicted to occur for up to 99.7% of days modelled, as shown in **Figure 1**. The maximum predicted daily discharge under existing conditions was approximately 40 ML/day.

For proposed conditions presented in 2036, the frequency of discharges through LDP017 was predicted to increase to approximately 1.3% of days in the year, or five days per year. No discharge through LDP017 was predicted to occur for up to 98.7% of days modelled, as shown in **Figure 1**. The maximum predicted daily discharge was not modelled to vary considerably from existing conditions, with a value of approximately 43 ML/day.

The maximum discharge under both existing and proposed conditions was modelled to occur only once over the 113 annual realisations, or 41,358 days, modelled. This equates to a frequency of less than 0.01% of days modelled.

The purpose of discharges through LDP017 is not for daily discharge but to allow for emergency discharges in a controlled manner in order to ensure the safety of personnel in the underground workings at Newstan Colliery. As a result of occasions where discharges to Stony Creek that have exceeded EPL water quality limits, Centennial installed a water management and monitoring station at LDP017 in 2013. This station allows for the control of water via the pipeline from the Fassifern Underground Storage into a concrete sump.

Continuous live monitoring of water quality within the station is undertaken for physicochemical parameters including electrical conductivity, pH, turbidity, total suspended solids and temperature. Grab samples are taken for laboratory analysis of other parameters such as metals, anions, cations and nutrients. The avoidance of uncontrolled discharges with water quality exceeding the limits specified by the EPL was not considered by the water balance model as water quality parameters were not represented by the model.

Although the frequency and annual quantity of discharge through LDP017 were predicted by water balance modelling to increase under proposed conditions, the control of discharges by the water management and monitoring station is expected to avoid uncontrolled discharges with water quality exceeding limits specified by EPL 395. The station allows for the increased future reliance on the use of LDP017 as a legitimate point of discharge in the future that is not expected to impact the receiving environment with respect to water quality.

The northern section of Lake Macquarie where LT Creek and Stony Creek discharge has been identified as sensitive in relation to flushing times and pollutant loading in a recent Office of Environment and Heritage Draft Report titled "Lake Macquarie Management Summary. Water Wetlands and Coasts Science Branch, NSW Government" (OEH, 2014), as such any ability to assimilate toxicants is diminished when compared to other areas of Lake Macquarie. (EPA)

The report referred to by the EPA is a draft report that is not publicly available. As such, an assessment of the impacts of the Project taking into consideration the results and outcomes of this report can not be undertaken by Northern Coal Services.

Water discharges must be further treated after the CWP with a Reverse Osmosis (RO) plant in order to remove salt and dissolved metals. (EPA)

The EPA emphasises to DPE that variation of the EPLs or issue of an EPL to increase pollutants discharged in waste water would only be approved by the EPA if the proponent constructs and implements a reverse osmosis treatment plant or an equivalent level of treatment that treats water such that it removes salinity (salts), total and dissolved metals to achieve the ANZECC guidelines for fresh and marine waters, to treat waste water discharged water from Cooranbong entry site and Newstan Colliery to prevent further metals and other pollutant loading and the consequent degradation to receiving waters LT Creek, Stony Creek and Muddy Lake and therefore Lake Macquarie. The EPA advises DP&E that a condition of approval of this project should include new water treatment facilities that are capable of treating wastewater to reverse osmosis plant standards prior to discharge to the environment. (EPA)

The EPA advise DP&E that at this stage, given the lack of appropriate mixing models and pollutant modelling and assessment of the impact of metal loads to receiving waters the EPA would be able to undertake a licence variation or a combination of surrendering licences and providing a new EPL for the project only if a reverse osmosis treatment plant or an equivalent plant that treats water such that it removes salts, total and dissolved metals to achieve the ANZECC guidelines for fresh and marine waters was constructed and installed to treat pollutants in waste water discharged water from Cooranbong entry site and Newstan Colliery to prevent further metal and other pollutant loading in receiving waters of LT Creek, Stony Creek, Muddy Lake and therefore Lake Macquarie. This option would also provide for rehabilitation of the waterways and environments towards a more natural freshwater system which would have naturally prevailed. Given that mining will cease in the future in these areas, and the saline groundwater discharges are likely to also cease at that time as dewatering will no longer be required, this option provides for a gradual rehabilitation of the receiving environments during the lifetime of the mine, rather than legacy issues post closure with cessation dewatering. (EPA)

As detailed in Section 8.5 of the EIS, water quality treatment options were investigated to determine the feasibility and functionality. This primarily focused on the use of reverse osmosis (RO) filtration technology to provide a treatment of TSS, including concentrations of the dissolved fraction of metals, at both Newstan Colliery Surface Site (14.5 ML/day) and Cooranbong Entry Site (8 ML/day). The RO plant considered for the Newstan Colliery Surface Site was a standard unit adjoining the existing conventional Clean Treatment Plant, while RO plant considered at Cooranbong Entry Site was a smaller unit with limited primary treatment requirements.

The use of RO was identified as a high cost, low benefit solution for water quality where consideration was given to the following factors:

- Likely hardness of intake water has been known to cause scaling and hence fouling of RO treatment systems requiring significant management requirements.

- The existing water hardness (i.e. the presence of calcium and magnesium) has the potential to ameliorate metal toxicity in downstream environments. The removal of water hardness via RO treatment will remove this potential benefit.

- The receiving aquatic environments downstream of both the Newstan Colliery Surface Site and Cooranbong Entry Site have adapted over the years of operation to the typical water quality discharged from these surface sites. The implementation of RO treatment will significantly alter the chemistry of water being discharged, in particular the ionic balance. This is likely to result in discharges not being compatible with the existing ionic balance and ionic ratios present in the receiving environment.

- A waste product in the form of high conductivity sludge is produced in RO treatment systems. The management of this sludge would require continual management via a third party or waste disposal agreement, which is not feasible given the anticipated sludge volume. The potential discharge of

this waste product to Lake Macquarie would be problematic given the recreational usages of the lake and the potential environmental impact.

Hunter Water Australia (HWA) were engaged by Centennial in 2011 to undertake a high level review of the use an RO treatment system at Newstan Colliery Surface Site for the mine water treatment. HWA identified brine management as a key reason for considering alternate treatment options (to RO), especially when a low cost and environmentally sound disposal option is not available.

HWA concluded that the installation of an RO plant requires a strong understanding of the technical complexity and challenges and capital and operating costs. Water treatment is not the core business of Centennial and, therefore, HWA (2011) advised that any treatment facility needs to be low complexity, robust, easily operated and easily maintained without heavy reliance on a third party.

HWA noted that discharging RO permeate directly into the environment is not advisable as the water is very unstable with no alkalinity (pH buffering capacity) or mineral content. This was supported by Dr Graeme Batley of the Commonwealth Scientific and Industrial Research Organisation, who advised that the discharge of low ionic strength RO water to the low salinity creek water (i.e. LT Creek) would most likely affect the salt-adapted species that inhabit this system. In consideration of the advice provided by HWA and CSIRO, the use of RO as a treatment system has been determined by Centennial to have a lower benefit as a means of treating water destined to be discharged to the environment. On this basis, the use of RO was not considered further for the management of water quality being discharged as a result of the Project.

As detailed in Section 3.11.1 of the EIS, in October 2012 the EPA varied Newstan Colliery's EPL 395 to include a PRP for the construction of a water treatment plant capable of treating at least 11 ML/day of water to be discharged via Newstan LDP001. A Clean Water Plant, with a capacity of 14.5 ML/day, was commissioned at the Newstan Colliery Surface Site in March 2014 to treat all water from the Newstan Colliery underground workings, water from dirty water management storages and surface water runoff (except during prolonged and/or significant rainfall events) prior to discharge to LT Creek via Newstan LDP001. The water is treated to reduce the pollutant concentrations within water discharges to LT Creek. It employs coagulation, flocculation, sedimentation, filtration and ultra-violet treatment to reduce the concentrations of TSS and total (unfiltered) metals.

The increase in discharges through LDP001 at Cooranbong will be a gradual increase over the life of the Mandalong Southern Extension Project, peaking in the year 2035. To manage water quality, Centennial Mandalong will utilise the Cooranbong Colliery goaf storage area to increase the retention time of water prior to discharge to the surface and promote settlement of any suspended material. This will also assist in reducing total metal concentrations. If the quality of water collected in the Borehole Dam is not suitable for discharge the water will be pumped back underground for recirculation (additional filtration and sediment settlement) through the Cooranbong Colliery goaf storage area before returning to the Borehole Dam.

As part of the Mandalong Southern Extension Project, the storage volume of the Borehole Dam at the Cooranbong Entry Site will be increased to increase the settling capacity. In additional baffles will be retrofitted in the Borehole Dam to provide increased residence time and a flocculent will be introduced. These proposed measures will reduce total metal concentrations and indirectly mitigate dissolved metal concentrations.

The macroinvertebrate and sediment monitoring program will be continued at the Cooranbong Entry Site to identify any impacts or changes to water and sediment quality that may occur as a result of this increased discharge at LDP001. The aquatic macroinvertebrate monitoring will be undertaken every 6 months (in spring and autumn) and sediment sampling will be undertaken quarterly (due to the increase in discharge being a gradual increase over the life of the Project). The first follow up round of macroinvertebrate sampling was completed in October 2013.

Due to only slight chronic toxicity being identified and with the proposed water management, mitigation and monitoring measures described above being implemented, Centennial Mandalong does not consider further treatment of mine water discharge is required.

Section 2.7.2 of the EIS states that an ecotoxicology study was undertaken by GHD in 2014 to assess the potential impacts of existing discharge to aquatic organisms downstream of Cooranbong Entry site. However evidence of this assessment was not provided in the EIS. (EPA)

The Water Impact Assessment provided as Appendix J to the EIS referenced a March 2013 ecotoxicological assessment undertaken for the Mandalong Southern Extension Project. The results of the assessment are discussed in the Northern Coal Logistics Project: Aquatic Monitoring and Ecotoxicology Assessment Summary Report provided as **Appendix 4** to this RTS, along with a summary of aquatic ecology monitoring at both Cooranbong Entry Services Site and Newstan Colliery Services Site.

The water quality data for Cooranbong entry site discharges appear to indicate that bicarbonate anion concentrations of 973 mg/L and or dissolved metals such as nickel at the licensed discharge point are likely to be the significant driver in observed toxicity effects on organisms. Given that target dilution factors are not met under annual average rainfall conditions at current discharge limits, the mixing zone, and associated toxicity is likely to extend downstream of the discharge site to Lake Macquarie meaning that muddy lake is not protected from any increase in discharge at the current likely concentrations. Bicarbonate SSTV appear to have been exceeded on numerous occasions at Cooranbong and Newstan licensed discharge points. (EPA)

The potential toxic effects of bicarbonate alkalinity were investigated as part of the Mandalong Southern Extension Project. Note that Cooranbong Services Site and Newstan Colliery Surface Site have different SSTVs for bicarbonate alkalinity and different median concentrations recorded at discharge points. The geology present within the underground workings at Mandalong Mine and Newstan Colliery differ with regards to sources of bicarbonate alkalinity.

As detailed in Section 10.3 of the Water Impact Assessment, the OEH (2012) has calculated a trigger value of 225 mg/L for bicarbonate based on ‘no observed effect concentration’ data generated from North American species described by Farag and Harper (2012). This trigger value has been exceeded at Newstan LDP001 for the majority of sampling undertaken, with a minimum result of 377 mg/L and maximum result of 725 mg/L. Isolated sampling of bicarbonate downstream of the Main By-Wash Dam has indicated that concentrations remain above the trigger of 225 mg/L for most of LT Creek to Lake Macquarie with SP003 and WMP3 indicating concentrations of 416 mg/L and 490 mg/L respectively.

OEH (2012) reports that bicarbonate is one of the more potentially toxic of the major ions to aquatic organisms. Bicarbonate has been found to be about two to 2.5 times more acutely toxic to cladoceran than chloride. There remains uncertainty regarding the most appropriate trigger value for bicarbonate in freshwater, and for this reason it is recommended that the existing Newstan EPL concentration limit for bicarbonate alkalinity of 711 mg/L at LDP001 remain unchanged.

The trigger value was shown to be exceeded at Cooranbong LDP001 on all sampling occasions with a minimum of 873 mg/L and maximum of 1220 mg/L. However, the trigger value is met at the downstream

site SW16 a large percentage of the time with a median concentration of 182 mg/L, with the trigger value being exceed on 20% of sampling occasions. The bicarbonate trigger value is exceeded at SW17 on the majority of sampling occasions with a median concentration of 390 mg/L.

For the Cooranbong LDP001 discharge water, chronic toxicity was observed in the cladoceran reproduction and the rainbowfish post hatch survival bioassays. However, the sensitive cladoceran showed no mortalities in 100% Cooranbong LDP001 discharge over an eight day exposure even with a conductivity of 4,130 µS/cm and bicarbonate concentration of 973 mg/L, which is slightly below the concentration of 1,186 mg/L bicarbonate (as CaCO3) reported Harper et al. (2014) as causing 50% mortalities in the cladoceran, Ceriodaphnia dubia, in a 48 hour exposure.

The impact of combined increase in discharges into the two arms of LT Creek and Stony Creek and loads of pollutants going into Fennell Bay and Muddy Lake have not been considered, nor has the assimilative capacity and accumulation/potential toxic effects in the receiving environments (creeks, Fennell Bay, Muddy Lake and greater Lake Macquarie. (EPA)

Ecotoxicological assessments have been undertaken on the LDP001 discharges at both Cooranbong Entry Site and Newstan Colliery Surface Site. The results of these assessments have been discussed within the EIS and are also summarised within the Ecotoxicology Assessment Summary Report provided as Appendix 4 to this RTS. The water quality statistics that these assessments have been based on is unlikely to vary significantly over the life of the Project without the effect of other environmental variables. This is supported by the time series data of the water quality monitoring undertaken to date.

The ability for discharges to be diluted by catchment runoff is greater at Muddy Lake compared with downstream of Newstan Colliery Surface Site based on catchment size alone. Also the need for discharge water is greater at Newstan Colliery Surface Site than that at Cooranbong Entry Site given that in recent times Cooranbong Entry Site has been able to manage discharges within the Cooranbong Underground Storage. However, management of excess water in his way is limited due to the finite volume of storage.

A bioregional assessment of the water transfers to and from Lake Macquarie was undertaken as part of the Northern Operations Water and Salt Balance provided as an Appendix to the Water Impact Assessment prepared to support the EIS. The results of the assessment indicated that discharges from Cooranbong Entry Site and Newstan Colliery Surface Site make up a small proportion of the total discharges from industry and commercial operations within the catchment. In addition, it was shown that discharges from industry and commercial operations are a small fraction of the natural catchment runoff to Lake Macquarie. The quantification of metal loads into Lake Macquarie for the Project has been provided as part of this RTS. The assessment of these loads has not considered the outflow of the lake to the ocean.

It should be noted that this statement on Stony Creek discharges does not consider the function of the water quality monitoring station located at discharge point LDP017. This station allows for continuous live monitoring of water quality and the control of discharges to Stony Creek. This station allows for the control of water via the pipeline from the Fassifern Underground Storage into a concrete sump.

Continuous live monitoring of water quality within the station is undertaken for physicochemical parameters including electrical conductivity, pH, turbidity, total suspended solids and temperature. Grab samples are taken for laboratory analysis of other parameters such as metals, anions, cations and nutrients.

Although the frequency and quantity of discharges through LDP017 into Stony Creek were predicted by the water balance modelling to increase as a result of the Project, these results should be considered as indicative of the increased water management requirements for underground mining activities at Newstan Colliery generally. As LDP017 is the overflow point for the Fassifern Underground Storage, the consideration of this discharge point as being uncontrolled is incorrect. The management of the Fassifern Underground Storage is managed by a Trigger Action Response Plan and independent management plan. Figure 7-6 in the Water Impact Assessment (provided as Appendix J to the EIS) indicates that discharges are only likely to occur in the most extreme of events.

It was unclear as to the capacity of the clean water diversions and dirty water diversions around the Newstan emplacement areas (NREA and SREA) before there is potential mixing of the two water streams downstream. (EPA)

The design criteria adopted for the clean and dirty water diversions for the Newstan Colliery Surface Site reject emplacement areas are based on the guidelines provided by Managing Urban Stormwater Soils and Construction Volume 2E Mines and Quarries (DECC, 2008). The design criteria for the diversions has also considered observed rainfall events and risk assessments undertaken internally by Centennial.

A summary of the diversion design criteria has been provided in **Table 8** below.

Table 8 –Design Criteria for Water Diversions at Newstan Colliery Surface Site

Water management feature	Criteria
Clean water diversions	20 year average recurrence interval (ARI), three hour event (DECC, 2008) – provided in Section 5.2.1 of Water Impact Assessment (GHD, 2014a)
Dirty water open channels	20 year ARI event, time of concentration flow (DECC, 2008)

The nature of the surface facilities area at Newstan Colliery Surface Site is such that the defined watersheds around the site are managed with water quality control devices such as the Final Pollution Control Dam. In the event that one water management feature was to have its capacity exceeded, the overflow would then be managed by either the Final Pollution Control Dam, Graunch's Dam Cell 1 and 2 (northern arm of LT Creek) or the Clean Water Dam (southern arm of LT Creek).

Heavy rainfall results in overflows directly into receiving waters from a number of water treatment devices at Newstan and Cooranbong. These overflows have not been characterised and the impacts of these pollutant loads assessed in relation to acute or chronic effects on downstream environments. The receiving environments are poorly mixed and it is likely that contaminants may accumulate within these environments (Muddy Lake and Fennell Bay). (EPA)

Overflow volume and frequency percentiles were provided as part of the Water Impact Assessment (provided as Appendix J to the EIS). These percentiles indicate the likely frequency of discharges from both Cooranbong Services Site and Newstan Colliery Surface Site as a result of rainfall. These results were assessed for all licensed discharge locations and storage overflows for both Cooranbong Services Site and Newstan Colliery Surface Site considering a daily rainfall total.

The following discharge locations are either currently or are proposed to directly discharge to the receiving environment:

- Sediment Dams 1 and 2 overflows through LDP001 (Cooranbong Services Site);
- Borehole Dam pumped outflows through LDP001 (Cooranbong Services Site);
- 5 ML Dam overflows through LDP002 (Cooranbong Services Site);
- Construction Dam overflows to Muddy Lake tributary (Cooranbong Services Site);
- CWP pumped outflows through LDP001 (Newstan Colliery Surface Site);
- Graunch's Dam Cell 1 and 2 overflows through LDP001 (Newstan Colliery Surface Site);
- Final Pollution Control Dam overflows through LDP002 (Newstan Colliery Surface Site);
- Clean Water Dam overflows through proposed LDP003 (Newstan Colliery Surface Site);
- Fassifern Underground Storage overflows through LDP017 (Newstan Colliery Surface Site); and
- Sediment Dam pumped outflows through proposed LDP (Hawkmount Quarry).

The characterisation of the operation of each of these points is discussed below.

Pumped Outflows

The Project will maintain two points at which pumped outflows occur. These points are LDP001 at Cooranbong Services Site and LDP001 at Newstan Colliery Surface Site. These pumped outflow volumes can be increased or decreased as required, however have been assessed at a maximum rate to consider the worst case within the Water Impact Assessment.

The proposed pump out operation for the Hawkmount Quarry site is based on a typical sediment basin capture and treatment system that will manage TSS through flocculation. The operation of this pump out system will be as a result of rainfall only.

Overflows

A number of storages at both Cooranbong Services Site and Newstan Colliery Surface Site have been identified as having an overflow occur from the water balance assessment undertaken. These overflows have been assessed for volume and frequency. The following discussion provides a background to the key contributing factors to the overflow discharges that are predicted to occur and the likely water quality implications.

Sediment Dams 1 and 2 at Cooranbong Services Site manage dirty water runoff from catchments around the coal stockpile at the Cooranbong Services Site. These dams are managed with overflows into the Cooranbong Underground Storage or LDP001 depending on water quality. Stored water is treated using conventional dosing technology. The dams offer a final capture point for all other storages within the Cooranbong Services Site prior to runoff and overflows entering the receiving environment, with the exception of 5 ML Dam and the Construction Dam.

The Borehole Dam is managed as a turkeys nest dam with storage overflows unlikely. In the event that the dam does overflow, due to its position, discharges will be captured by the Sediment Dams 1 and 2.

The 5 ML Dam at Cooranbong Services Site manages water from the hardstand area and catchments where coal handling is undertaken. This dam does not receive or manage underground mine water for discharge. The dam volume is drawn down through dewatering activities which transfers captured water into the Cooranbong Underground Storage. In the event that the storage capacity of the 5 ML Dam is exceeded, discharges will occur via LDP002. These flows would progress down to unnamed tributary of Muddy Lake. The quality of discharges have historically had some increased concentrations of TSS and oil and grease, however site management practices have been focused on addressing these sources of poor water quality and water discharged through LDP002 should be representative of the catchment.

The Construction Dam overflows to Muddy Lake tributary are unlikely to impact the downstream receiving environment. The Construction Dam is a disused dam which captures water from both vegetated and hardstand catchments. There is no draw down pump or low flow device on the dam, hence it overflows to the unnamed tributary contributing to Muddy Lake. The water present within the dam is representative of the existing catchment water quality.

Graunch's Dam Cell 1 and 2 overflows through LDP001 at Newstan Colliery Surface Site and its main inflows are driven by seepage rates from the Northern Reject Emplacement Area (NREA) and the storages catchment. While the seepage rate from the NREA can vary due to rainfall, the modelling undertaken for the Project has considered observed data and has been calibrated to represent the existing conditions. The water quality of these overflows would represent the water quality of the seepage from the NREA. The catchment contributing to the dams consist of rehabilitated areas of the completed NREA. Overflows occur as a result of the storage capacity being exceeded.

The Final Pollution Control Dam can overflow through LDP002 at Newstan Colliery Surface Site when required. The Final Pollution Control Dam is a final capture point for overflows of the majority of storages within the Newstan Colliery Surface Site. The catchment of the dam consists of a mixture of infrastructure and coal handling areas. No underground water is managed directly through the dam, however due to the complicated inter-site transfers from various storages, it is reasonable to assume that underground water would make up of some portion of water within the dam. As discussed, the Final Pollution Control Dam consists of water from a number of sources hence in the event of a discharge the monitoring of water quality at LDP002 best characterises the potential water quality of discharges when they occur. Historical discharges at this location have been isolated. Typically water quality statistics at LDP002 has shown elevated in concentrations of TSS and EC.

The Clean Water Dam overflows through the proposed LDP003 at Newstan Colliery Surface Site occur when the storage capacity is exceeded. The Clean Water Dam is located at the end of the water management structures associated with the Southern Reject Emplacement Area (SREA) and southern arm of LT Creek catchment. Pumps are present on all the water storages through this arm of the creek to redirect captured water to the CWP to be discharged through LDP001.

The water within the Clean Water Dam is representative of runoff and seepage from the SREA. The water quality is typically elevated with TSS and of poor turbidity compared with the trigger, with isolated exceedances of dissolved metals such as zinc and copper. EC levels are slightly elevated compared to background levels, however not as high as the levels observed in underground water. The likelihood of discharges via this location would be infrequent and as the water balance results indicated, occurring in greater than 90th percentile of results of 113 years.

As discussed within Section 5.2 of the Water Impact Assessment (provided as Appendix J to the EIS), in the event Fassifern Underground Storage maximum level is triggered, overflows through LDP017 will occur as a safety measure to protect assets and people underground. SSTVs exist for water that is to be discharged through LDP017 in addition to a water quality monitoring station. Risks to the receiving environment from water quality of LDP017 are increased EC, metals and in some cases turbidity.

The Sediment Dam at Hawkmount Quarry will be managed as a result of rainfall. This dam will capture sediment-laden water, allow for water detention and treatment via flocculation and discharge via a pump out configuration. In the event that the Sediment Dam capacity is exceeded and overflows of the dam were to occur, then a discharge with elevated TSS would likely occur to the downstream environment. TSS would be the likely water quality issues as the catchment use is proposed as a coarse rejects storage area.

It is noted that a water access licence (WAL) exists for take from Newstans by-wash dam at a rate of 9.5ML/d with an annual limit of 750ML for use in the coal preparation plant. The bywash dam is also used as a mixing zone for waste water discharges from the licensed discharge point, yet no discussion of the impact of this extraction from the 40ML dam on the mixing zone was undertaken. (EPA)

Water for operational requirements (mostly at the Coal Processing Plant) is sourced from both potable water and water stored on-site. The limit of extraction from the Main By-Wash Dam specified by water access licence 18735 is a maximum value. Newstan Colliery Surface Site currently extracts water from Connollys Dam at an average of 1.9 ML/day for use in Coal Processing Plant and not from the Main By-Wash Dam.

The Main By-Wash Dam has developed into a wetland habitat and the security of this water is high. Historically the dam has not become dry in the recent past.

The discussion of the options for water treatment and any options for mitigating discharge impacts from the discharge of waste water were poor. The objects of the POEO Act as discussed above and matters to be considered in licensing under section 45 of the POEO Act require the EPA to assess 'practical measures that could be taken to prevent, control, abate or mitigate pollution'. To that extent the EPA believe that the EIS has not demonstrated that the project will adequately mitigate and manage increased pollutant loads of metals and other pollutants. The current reports that the EPA has received from the Centennial Newstan Ply Limited in relation to the Clean Water Treatment Plant do not demonstrate that the CWTP has any capacity to reduce the pollutants present in the waste water as dissolved metals or salinity (salts). (EPA)

As part of the Project a number of workshops and a phase of options assessment was undertaken to assess practical measures that could be taken to avoid the need to increase discharges at both Cooranbong Services Site and Newstan Colliery Surface Site. The outcomes of this assessment have been summarised in Appendix C of the Water Impact Assessment provided as Appendix J to the EIS. The discussion of the options for water treatment that was provided in the EIS was in addition to this discussion of options specifically assessed as part of the Project's Water Impact Assessment.

With respect to the comments made around the operation of the Clean Water Treatment Plant at Newstan Colliery Surface Site, the Clean Water Treatment Plant: Ecotoxicology Assessment has been recently revised to reflect a new round of toxicity and water quality testing and is provided as **Appendix 3** to this RTS. A discussion of the conclusions of this monitoring are provided below.

Direct toxicity assessment testing during the first round of investigations in May 2014 found that the treated discharge from the Clean Water Plant was not acutely toxic to the test species, which was found

to be the same for the untreated and laboratory treated discharge. The treated discharge was also found to be slightly less chronically toxic than the untreated discharge testing in 2011 and similar to the laboratory treated discharge tested in 2012, based on the effect concentration of the discharge where 50% of test organisms exhibited a specified endpoint (EC50) and no observable effect concentration results.

The results of the second round of toxicity testing in November 2014 show that the treated discharge from the Clean Water Plant is not acutely or chronically toxic to the test species, based on the EC50 and no observable effect concentration results.

The results of toxicity testing indicate that the Clean Water Plant discharge through LDP001 meets the requirements of Section U3.2 of EPL 395, where the EC50 was found to not exceed a discharge concentration limit of 50% for the following bioassays:

- Cladoceran reproduction test.
- Eastern rainbowfish embryo development and post-hatch survival test.
- Freshwater shrimp survival test.

Water quality monitoring of the discharge through LDP001 show that the chemistry of the treated discharge from the Clean Water Plant is similar to that of the laboratory treated discharge, with a reduction in turbidity, EC, TSS and metals compared to monitoring of untreated discharge. For round one of testing, none of the parameters analysed for the water treated by the Clean Water Plant were found to exceed SSTVs or the limits specified by EPL 395. The SSTV for EC was exceeded for samples collected during the second round of testing in November 2014, however levels remained below the EPL limit of 3,250 µS/cm and the exceedence did not affect the toxicity of the samples.

Additional toxicity testing is not recommended at this point in time. Impacts of discharge from LDP001 will be managed by the ongoing water, sediment and macroinvertebrate monitoring program in place at Newstan Colliery.

The derivation of SSTVs was undertaken by assessment reports referred to in this EIS, but documentation of assumptions and methods were not provided in the EIS. A full account of the reasoning and background to derivation of these values should be provided in the EIS for the community and other agencies to assess. On many occasions the derived SSTVs are very high compared to ANZECC default guidelines. It is also unclear if these derived SSTVs have taken into account the increased loads and concentration of pollutants that would occur as a result of the increase daily volumetric discharges at Cooranbong and Newstan sites or whether derivation of these SSTVs were in response to EPA requirements for current discharges and licensing conditions. (EPA)

Appendix E of the Water Impact Assessment (provided as Appendix J to the EIS) has been devoted to the complete background and reasoning for the derivation of SSTVs. The derived SSTVs have been developed based on at least two years of background data which support, where appropriate, elevated concentrations of some analytes above the recommended ANZECC (2000) default trigger values.

The predicted loads over the life of the Project have been determined as part of this response to submissions documentation.

In table 10-4 which refers to Newstan water quality data, the value for TSS median is higher than the maximum; the documented maximum electrical conductivity was very high and exceeded the 100%ile current EPL limit, as did to the nitrogen, phosphorus, sulfate and bicarbonate concentrations. (EPA)

With respect to the TSS statistics for Newstan LDP001 in Table 10-4, please see the updated results in **Table 9** below.

Table 9 – Update to Table 10-4 in Water Impact Assessment

Parameter	Unit	Count	Minimum	Median	Maximum
Physicochemical parameters					
TSS	mg/L	644	1	5	94

A review of the time series data provided in the impact assessment for EC, nitrogen, phosphorous, sulfate and bicarbonate alkalinity illustrated the period of time at which the maximum results occurred to determine if there was a correlation with the timing of the maximum to indicate an environmental variable that may have contributed to the outcome. A spike in the time series was evident in a few isolated monitoring rounds. This included:

- June and July 2012: Sulfate, nitrogen, and phosphorus.
- March and April 2013: TSS, turbidity, potassium, silica, sodium, calcium and magnesium.

The rainfall events of these months were determined to be between 170 mm to 300 mm, however similar results were not shown to occur regularly with this size of rainfall event. Due to the site operations the causes of such maximum values cannot be confirmed.

Bicarbonate alkalinity statistics indicate a small variability in the results recorded ranging from 500 mg/L to 700 mg/L. This is as expected given the source of this parameter is the geology of the underground workings and is not affected by the mine's operation. The maximum value provided in Table 10-4 of the Water Impact Assessment was recorded September 2012 and was not found to correspond to any environmental or operational variable.

The maximum value for EC recorded April 2012 suggests an anomaly in the monitoring undertaken as it was a one off reading where the majority of results are within the range of 2,000 µS/cm to 4,000 µS/cm.

The size of the mixing zone for Cooranbong identified on page 172 extends for 2km. This is inconsistent with ANZECC/ARMCANZ 2000 guidelines for mixing zones and is not appropriate to manage impacts. The Cooranbong ecotoxicological study recommended a dilution factor of 1:6.25 is required to provide ecosystem protection at 95% species protection of 1.6 ML/day and mixing zone estimate calculations provided have used this dilution factor. The project has requested an increase to 8 ML/day discharge and as a result the mixing zone model must be updated to incorporate this maximum flow in order to assess impact. It is recommended that mixing calculations be done using mixing zone calculation software such as Cormix rather that the approach adopted within the EIS. (EPA)

Appendix 1 *Mixing zones adjacent to effluent outfalls* of Volume 2 of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) provides recommendations for the management of nominated mixing zones which includes:

"Mixing zone size: the mixing zone must be as small as practical in accordance with the waste management hierarchy, and … should not occupy a significant proportion of the receiving waters. The overall integrity of the ecosystem should not be compromised..."

The last comment in this point is a significant one regarding the potential impact to the integrity of an ecosystem. The classification of the ecosystem health at Muddy Lake has been monitored as part of the operations at Mandalong Mine seasonally for three years. The site's operational discharges have occurred for such a significant period that the integrity of the ecosystem is based upon these discharges. The increase in discharges is not predicted to change the structure of this ecosystem. The terrestrial habitat surrounding Muddy Lake consists of swamp oaks, swamp mahogany, paperbark, swamp melaleuca and river she oak, which are all salt tolerant species (Industry & Investment NSW, 2009) which are found in areas close to standing water on soils that are water-logged or subject to periodic flooding (DECC, 2007) possibly due to the proximity to Lake Macquarie. This type of habitat is likely to adapt to the gradual increase in volume discharged from the Cooranbong Services Site. Minimal impacts to aquatic vegetation along the unnamed creek have been observed and toxicity testing of algae and duckweed species bioassays show minimal impact.

The results of the water balance assessment for the Cooranbong Services Site indicate an average daily discharge through LDP001 of less than 8 ML/day hence why the maximum limit of 8 ML/day was not used in the assessment of the mixing zone extent. The proposed 8 ML/day volumetric limit for LDP001 is based on an administrative position and provides a small amount of buffer for the site. It must be noted that the difference between the water balance results and this proposed administrative maximum licence value does not affect the impact assessment outcomes. These results are consistent with the outcomes of the Mandalong Southern Extension Project, of which this information is also discussed within.

There is no precedence for the use of a three dimensional computation fluid dynamics program such as Cormix for assessment of the mixing zones for industry discharges to Lake Macquarie. It is expected that the use of this type of program would no doubt present a better result for proposed discharge impacts than what has been determined to date. The three dimensional hydrodynamic aspects that would be considered in this style of modelling would include:

- Diffusion;
- Turbulence;
- Buoyancy; and
- Velocity effects.

To effectively model the proposed discharges using a three dimensional model would create significant data requirements which are not practicable for the assessment. These data requirement include detailed bathometry survey of Muddy Lake, gauging level and flow of Muddy Lake.

The methodology adopted has simply considered a slug flow with a constant velocity and a well-mixed environment. It could be viewed that three dimensional modelling may actually show a poorly mixed environment, in which case the potential impact determined would increase.

It must be noted that the maximum discharge will not occur on a daily occurrence as was shown in flow percentile plots of predicted LDP001 and LDP002 discharges. The 8 ML/day discharge case that has been assessed for potential impact has been determined as a regulatory maximum requirement such that

the Project will not be constrained in its effective management of safety to underground miners. The basis for the discharge predictions have been determined on long-term modelling for the water requirements for the mine considering groundwater make (from the Mandalong Southern Extension Project) that increases with the mine's progression.

At the time of the development of the water balance model, the Cooranbong Underground Storage was managed at a very high level. Since this time the void is managed such that a significant buffer capacity is available such that emergency situations require it to be used. These emergency situations include intense prolonged storm events, power or mechanical failure of transfer pumps and significant changes in underground water quality or inflow volume.

Centennial Coal had previously discussed including contributions to the remediation of LT Creek as part of future applications relevant to the site, but noted that this issue is not addressed in the current application. It is considered that clarification from Centennial Coal be provided as to their intentions with regards to contributions to dredging as part of this current application. (LMCC)

Northern Coal Services have implemented a number of projects across the Newstan Colliery Surface Site to improve the management of water and quality of water discharged from the site. These water management improvements include:

- The installation of a clean water diversion drain around the Southern Reject Emplacement Area;
- The installation of a Clean Water Plant to treat water prior to discharge from the Newstan Colliery Surface Site; and
- The enlargement of the Final Pollution Control Dam from 18 ML to 50 ML.

These water management improvements have significantly reduced the sediment load being transported into the north arm of LT Creek.

Additionally, in 2009, Lake Macquarie City Council released the LT Creek Catchment Water Quality Management Plan (Umwelt 2009). The LT Creek Catchment Water Quality Management Plan identified a number of actions to be undertaken for various stakeholders, including Northern Coal Services, to improve stream health within LT Creek. Northern Coal Services have implemented all management actions identified in their area of responsibility and reported progress against these management actions to the Newstan Community Consultative Committee previously.

With the significant improvements to water management across the Newstan Colliery Surface Site and the management actions proposed to be implemented as part of the Project, no additional management actions are proposed to be implemented by Northern Coal Services to the improvement of stream health along LT Creek.

As part of Development Consent DA 73-11-98, Centennial Newstan has approval to pipe two sections of the north arm of LT Creek through the Newstan Colliery Surface Site to mitigate the risk of coal entering the creek and impacting downstream water quality. One of these sections has been piped, being approximately 175 metres within the rail loop. The Project proposes to install the second section of approved piping stretching approximately 150 metres between the Main By-Wash Dam and the rail loop, and also pipe an additional 300 metres (two sections) along the north arm of LT Creek between the Main By-Wash Dam and the rail loading facility.

The piping of LT Creek will eliminate the potential for sediment and coal material to be transported off site into LT Creek and thus will likely reduce the deterioration in water quality as it passes through the Newstan Colliery Surface Site. As detailed in the Statement of Commitments provided in Section 11 of the EIS, Northern Coal Services have committed to improve aquatic habitat upstream and downstream of the LT Creek pipeline through bush regeneration and weed control. Actions may include weed removal, replanting with native species and improving bank structure and stability in problem areas.

No commitment has been made for Northern Coal Services to contribute directly towards the dredging of LT Creek.

The application does not propose any improvements to LPD0002. Whilst this discharge point has not experienced regular exceedances of licence conditions, where this has occurred the exceedance has been significant. (LMCC)

Centennial Newstan completed an expansion to the volume of the Final Pollution Control Dam in October 2012 from 16ML to an approved 50ML. The expanded storage volume of 50 ML provides sufficient storage to contain the potential run-off from a 10 year, 24 hour annual recurrence interval design storm event which significantly reduces the frequency of water with high sediment levels from Newstan Colliery. The purpose of the increase in storage of the Final Pollution Control Dam was to operate as a temporary water storage and water quality control dam. The Final Pollution Control Dam serves as a containment dam for surface dirty water runoff which overflows from neighbouring dirty water catchment dams.

Site pumping upgrades have been an ongoing part of the expansion of the Final Pollution Control Dam and at the majority of the dirty water dams at Newstan to automate the pumping and allow for higher efficiency in managing dirty water in rain events to prevent a dirty water exceedance at LDP002. A 263kW pump has replaced a 137kW pump increasing the pumping capacity from 40 l/s to 140 l/s to move water away from LDP002 in a rain event.

A clean water plan was also commissioned in 2013 at Centennial Newstan to further manage and prevent dirty water discharges from site.

Centennial Coal's environmental audit report for 2014, reports a total suspended solids (TSS) reading of 688mg/L in March 2013. This is 13 times above the licensed 50mg/L limit. In this regard, it is requested that the proponent provide mitigation measures to prevent further incidences in the future. (LMCC)

The discharge from LDP002 in March 2013 of 8.132ML has been the only discharge recorded since the expansion of the Final Pollution Control Dam. The exceedence was contributed to by a period of continued rainfall from January 2013 leading up to the exceedance at LDP002. Newstan received a total of 637.9mm of rainfall leading up to the discharge. The Newstan weather station recorded 152mm in the 27 hours prior which led to the discharge of the Final Pollution Control Dam. Due to the high amount of rainfall prior to this particular rain event, the water storage areas at Newstan Colliery were already higher then normal. The Final Pollution Control Dam was maintained at the lowest possible level prior to the rainfall event via pumping, however the Final Pollution Control Dam was not able to maintain its levels building up to the 152mm of rain that contributed to the March 2013 exceedance. The Final Pollution Control Dam was and had been pumping continuously since the rain event on the 23 February and had

been lowered to have approximately 80% storage capacity available at the time of the event. All dirty water dams on the pit top were full at the time of the discharge.

Site pumping upgrades have been a part of the expansion of the Final Pollution Control Dam and at the majority of the dirty water dams at Newstan to automate the pumping and allow for higher efficiency in managing dirty water in rain events to prevent a dirty water exceedance at LDP002. A 263kW pump has replaced a 137kW pump increasing the pumping capacity from 40 l/s to 140 l/s to move water away from LDP002 in a rain event.

A clean water plan was also commissioned in 2013 at Centennial Newstan to further manage and prevent dirty water discharges from site.

The proponent should prepare a flood emergency response plan that takes into consideration the residential development downstream of the Newstan Colliery Surface Site and Cooranbong Entry Site. (OEH)

The proponent should prepare a flood emergency response plan that has been developed in the case of failure in any of the water management structures on the site during flood and non-flood times, and details of safeguards in place for the management of the downstream residents in the flood prone areas. It should be ensured that the flood behavior in the watercourses downstream are not altered by the works on the site, or the potential failure of these works. (OEH)

The target of this submission is assumed to be specifically Newstan Colliery Surface Site as there are minimal residential properties downstream of either Cooranbong Services Site or Hawkmount Quarry that are likely to be influenced by Centennial operations alone.

While the Project has proposed increases in daily discharges, there is are no significant changes in factors that would influence the hydraulic operation of creeks such that properties may be introduced to an increase risk of flood inundation.

As a result of increased discharges from the Project, an estimate on the likely change in flood levels downstream of both Cooranbong Services Site and Newstan Colliery Surface Site was provided as part of the Water Impact Assessment (provided as Appendix J to the EIS). This was determined not to be a significant change in that it was unlikely that no new areas of flooding were to occur from current conditions.

The Project at Newstan Colliery Surface Site has proposed some changes in the operational infrastructure required, however this is unlikely to be the source of increased flooding risks to downstream land owners. There are no proposed changes at Cooranbong Services Site.

Lake Macquarie City Council has undertaken assessments on LT Creek and Lake Macquarie generally which consider the current and future hydrologic and hydraulic conditions of LT Creek. These assessments are:

- BMT WBM (2011) LT Creek Flood Study, Final Report, R.N1355.001.03, April 2011, Lake Macquarie City Council.
- wmawater (2012) Lake Macquarie Waterway Flood Study, Lake Macquarie City Council.

BMT WBM (2011) specifically references the presence and operation of the Newstan Colliery Surface Site as being very dynamic with respect to water management. Despite this BMT WBM (2011) did not foresee the site as a significant influences either positive or negatively on flood event magnitudes, with the exception of the SREA and some specific pieces of infrastructure.

The BMT WBM study (2011) identified a number of key infrastructure features that influence flooding in LT Creek. These are summarised in **Table 10** below.

Table 10 – Key Infrastructure with Respect to Flooding in LT Creek (BMT WBM 2011)

Infrastructure	Location	Asset owner	Flood relief structures	Flood characteristic	Identified risks
Private coal haul road and private access road	Southern arm of LT Creek	Origin Energy (Eraring Power Station)	4 x 1,200 mm pipe culvert 1 x 1,200 mm pipe culvert	Large embankment acting as a dam in flood events.	Culvert blockage and increased water depths leading to embankment failure and flood wave.
SREA tailings dam	Southern arm of LT Creek	Centennial Newstan Pty Limited	Nil	At completion this structure will effectively reduce catchment flow to LT Creek. BMT WBM (2011) has modelled this as being full at time of all storm events.	Dam wall failure causing flood wave.
Main Southern Railway	Northern and southern arm of LT Creek	Transport for NSW	3.7 m x 3.6 m box culvert (northern arm) 3.0 m x 3.0 m box culvert (southern arm)	Large embankment acting as a dam in flood events.	Culvert blockage and increased water depths leading to embankment failure.

Infrastructure	Location	Asset owner	Flood relief structures	Flood characteristic	Identified risks
Fassifern Road	Northern and southern arm of LT Creek	Lake Macquarie City Council	Two cell 2.4 m x 1.8 m box culvert (northern arm) Two cell 2.4 m x 1.2 m box culvert (northern arm) 5.8 m bridge (southern arm) Two cell 2.1 m x 1.8 m box culvert (southern arm)	Medium embankment acting as a dam in flood events.	Culvert blockage and increased water depths leading to embankment failure.

The most significant aspects from **Table 10** were identified as the major embankments associated with the private coal haul road, Main Southern Railway and other roads. The BMT WBM study (2011) considered the greatest risks associated with probable maximum precipitation (PMP) events to be large hydraulic pressure behind embankments leading to a failure of embankments and a flood wave migrating down LT Creek. It was determined that specifically the private coal haul road is at greatest risk of this considering the height of the embankment being in the order of 16 m.

The other infrastructure of significance identified by BMT WBM (2011) was the SREA. The SREA impedes and captures floodwater from the upper LT Creek catchment, however the structure has been designed and approved to undertake this function. The tailings dam (within the SREA) has been designed to include the maintenance of a 2.5 m freeboard and to cater for runoff. The tailings dam is a prescribed dam approved and monitored by the Dam Safety Committee with approved emergency response plans in place.

The actions and responses to the failure of water management structures at Cooranbong Services Site and Newstan Colliery Surface Site will be considered in revisions to water management plans that will be developed as part of the Project's conditions of consent. The development of an emergency flood response required within the LT Creek, as is shown in Table 10, requires the consultation with a number of stakeholders.

The proponent should prepare an assessment of the likely impact of the probably maximum flood (PMF) flood flows on the site, including onsite storage dams and the open cut areas, and the impact of PMF flood flows out of the site are not known. (OEH)

In response to the recommendation for an assessment of probable maximum precipitation (PMP) conditions for the Project, we note some important Lake Macquarie City Council assessments that have been undertaken on LT Creek and Lake Macquarie generally.

From a review of the documents prepared for council, the following is noted:

- Within the developed extent of the LT Creek catchment surrounding Lake Macquarie, widespread inundation is likely to occur at a depth between 1 m to 2 m. The extent of flooding caused by the PMP event is limited by the surrounding topography.

- In a PMP event, the private coal haul road and Main Southern Railway may cause a failure of embankment due to increased water depths.

- BMT WBM (2011) have determined probable maximum flows for the LT Creek northern arm of 179 m3/s, LT Creek southern arm of 62 m3/s and a combined downstream confluence LT Creek flow of 241 m3/s. Critical storm duration for the PMP event was a four hour event.

- wmawater (2012) indicated that a PMP event in the Lake Macquarie catchment would peak at 10,250 m3/s in a six hour event.

As part of the response to submissions GHD have undertaken an estimate of flow as a result of probable maximum precipitation, for the following catchments contributing to:

- LDP001 at Cooranbong Services Site;

- LDP002 at Cooranbong Services Site;

- Total contributing catchment to an unnamed tributary to Muddy Lake (just downstream of LDP002 at Cooranbong Services Site);

- LDP001 at Newstan Colliery Surface Site;

- LDP002 at Newstan Colliery Surface Site;

- Proposed LDP003 at Newstan Colliery Surface Site; and

- Proposed LDP at Hawkmount Quarry.

These PMP flow estimates have been undertaken considering the generalised short-duration method outlined as part of the Bureau of Meteorology (2003) and IE Aust (1987) methodologies for estimating rare rainfall.

The following assumptions were made in the estimation of flows:

- Surface water storages within the Project are at capacity

- PMP rainfall depths were estimated as non-spatially distributed depths due to the size of the relative small size of the catchments

- No mine dewatering will occur in PMP events

- The site would be evacuated and all equipment would be shutdown

Table 11 provides a summary of the results of the PMP assessment undertaken on selected catchments at Cooranbong Services Site and Newstan Colliery Surface Site.

Table 11 – PMP Assessment

Location	Catchment area (km^2)	Sub-catchment storm duration	Flow (m^3/s)	Operational surface water storage capacity
Main By-Wash Dam Weir – Newstan Colliery Surface Site	0.67	15 min	126.7	49 ML
LDP002 – Newstan Colliery Surface Site	0.80	15 min	148.2	145.5 ML (existing) 167.5 ML (proposed)
Proposed LDP003 – Newstan Colliery Surface Site	0.83	15 min	178.9	608 ML
LDP001 – Cooranbong Services Site	0.10	15 min	27.2	13.1 ML
LDP002 – Cooranbong Services Site	0.11	15 min	29.7	5 ML
Unnamed tributary catchment (downstream of LDP002) – Cooranbong Services Site	1.50	15 min	290.3	18.1 ML
Proposed LDP – Hawkmount Quarry	0.22	15 min	56.5	20 ML

As the results from **Table 11** show, the PMP 15 minute storm event produces the greatest peak flow from each of the catchments assessed. This is likely due to the small runoff losses adopted in the assessment of a PMP event and the size of the catchment. It is important to identify that the volumes produced by these events would far exceed the operational surface water storage capacities on site currently and in the future. Comparing the results of **Table 11** to the predictions of BMT WBM (2011), the results of **Table 11** are much greater. A difference between the results are expected to be due to the detail of the model considered by BMT WBM (2011) compared with the simplified equations prepared for this assessment.

The assessment of these PMP events is best to consider flooding hazard potential and primary key sources for runoff. The Newstan Colliery Surface Site has the potential to produce in the order of 454 m^3/s of flow off its catchment in a PMP event. Regardless of the operational conditions of the site and the nature of the site, this flow rate is unlikely to be largely influenced by the presence of the mine itself given the extreme nature of the event. The potential hazard of such an event occurring and causing a failure of the SREA is not relevant for this assessment as the emplacements construction is managed by more stringent national standards for which it has been designed to manage.

At the Cooranbong Services Site it is important to note the difference between the flows estimated to contribute to each Licenced Discharge Pont compared with the flow estimated just downstream of LDP002. This result however is dependent upon the successful operation of clean water diversions around the facilities.

There are no current open cut areas proposed as part of the Project. The operation and management of reject emplacement areas are managed by the Dam Safety Committee and Australian National Committee on Large Dams standards. The Project does not propose to modify these facilities and hence these were not considered as part of the Water Impact Assessment provided as Appendix J to the EIS.

The proponent details of how piping of watercourses on site has catered for blockages whilst ensuring that a clear overland flow path is maintained. (OEH)

As part of Development Consent DA 73-11-98, Centennial Newstan has approval to pipe two sections of the north arm of LT Creek through the Newstan Colliery Surface Site to mitigate the risk of coal entering the creek and impacting downstream water quality. One of these sections has been piped, being approximately 175 metres within the rail loop. The Project proposes to install the second section of approved piping stretching approximately 150 metres between the Main By-Wash Dam and the rail loop, and also pipe an additional 300 metres (two sections) along the north arm of LT Creek between the Main By-Wash Dam and the rail loading facility.

As detailed in Section 4.11.1 of the EIS, the additional piping of LT Creek will be undertaken prior to the expansion of infrastructure occurring on the northern side of LT Creek. The piping will be undertaken using reinforced concrete pipe with a diameter of 1.8 metres. The longitudinal grade of the pipeline will be similar to that of the existing creek with no change in creek flow lengths. The end discharge point of the piped creek will be via an energy dissipater into a stabilised area of the LT Creek.

Blockage of the piping of LT Creek was not quantitatively assessed as part of the Water Impact Assessment (provided as Appendix J to the EIS). If blockage in LT Creek pipeline was to occur, the Final Pollution Control Dam would receive the emergency overflow prior to discharge via LDP002 if the capacity of the dam was exceeded. It is unlikely that a blockage of the piped section of waterway will be a single cause for a discharge at an uncontrolled location other than an LDP due to the position of the watershed being the Final Pollution Control Dam.

As detailed in Section 10.4.9 of the EIS, Northern Coal Services will commit to undertake hydrological modelling for the construction of the pipeline and related structures to ensure that this infrastructure is appropriate for purpose and does not increase flood risk. Northern Coal Services will maintain the pipeline to remove any debris build up over time to ensure blockages do not occur.

3.1.12 Train Movements

The proponent should provide further information on whether current infrastructure at the Port of Newcastle, Port Kembla and Vales Point Power Station is capable of handling additional tonnages of coal in the proposed train configurations. (Transport for NSW)

The current trains utilised by Northern Coal Services meet the infrastructure requirements at the Port of Newcastle, Port Kembla and Vales Point Power Station. Any future changes in coal train configurations would be undertaken to ensure they meet the infrastructure requirements for the facilities in which they are transporting coal to. Any upgrades in infrastructure in the future at the Port of Newcastle, Port Kembla and Vales Point Power Station are the responsibility of those infrastructure owners.

Northern Coal Services consult with a number of stakeholders in regards to the transport and receipt of coal products from the Newstan Colliery Surface Site. The volume of coal transported by train to the Port of Newcastle, Port Kembla and Vales Point Power Station is based on market demand, rail network constraints and coal handling and storage capacity constraints at the receiving entity. The Project is designed to provide flexibility to Northern Coal Services in distributing its coal product to either or all of these entities based on these constraints.

The proponent needs to note the train paths to Eraring power station that use Newstan rail infrastructure. Eraring balloon loop only has a north facing connection to the Main North Rail Line, so trains coming from the south use Newstan balloon loop to turn around. These additional trains on the Newstan balloon loop are a capacity constraint on the loop. (Transport for NSW)

Any trains utilising the Newstan rail loop are considered as part of the maximum 8 trains per day from the Newstan Colliery Surface Site.

The EIS does not include a rail study. It is recommended that a rail study be undertaken that assesses the likely cumulative impacts of the proposed development under the scenario where both the Wallarah 2 and Cobbora Coal projects are additionally using the existing rail network as proposed. The study should consider whether any additional network improvements are required to support the proposed development. (LMCC)

The project train numbers from Wallarah are lower than those stated in the Wallarah EIS. The Wallarah EIS quotes up to 5 coal trains per day while the Northern Coal EIS estimates 2-3 trains per day. (Transport for NSW)

Transport for NSW requests that the likely train movements, frequencies required to service the project's transportation requirements between Newstan Colliery Surface Site and the Port of Newcastle, Port Kembla, and/or Vales Point Power Station and associated impact on rail network be provided, noting the different tonnages of coal to be received at each destination. (Transport for NSW)

The proponent only have approval in their development consent for eight train movements a day from Newstan, it does not have eight return train paths. Based on the above, Transport for NSW requests that the proponent provides actual train path requirements for the Project from Newstan. (Transport for NSW)

The proponent should discuss and work with the network owner(s) on the issues associated with access to the rail network, such as pathing, timing and any necessary infrastructure required to support the proposed use of the network. (Transport for NSW)

It should be noted that the project has the potential to generate additional traffic using existing level crossings which needs to be assessed. Additional rail traffic at level crossings may change the risk profile of the crossing as well as increase road traffic delays and waiting times at level crossings in particular at the Glebe Road, Adamstown and Clyde Street, Hamilton North railway crossings. (Transport for NSW)

The Project is designed to provide flexibility to Northern Coal Services in distributing its coal products from the Newstan Colliery Surface Site and Cooranbong Entry Site into various domestic and export markets in order to meet changing market conditions and contractual requirements into the future. The Project proposes a life of 30 years. Over a 30 year project life, it is impossible to predict actual volumes of coal to be transported from the Project Application Area to the various potential entities who can receive it.

The Project proposes a maximum volume of 8 Mtpa of coal to be transported via rail from the Newstan Colliery Surface Site. This coal can be sent all to the Port of Newcastle, all to Port Kembla, all to the Vales Point Power station, or a combination to all three, but will not exceed a total of the maximum requested limit of 8 Mtpa.

An assessment of the impacts of the Project on the rail network was undertaken by Intersect Traffic as part of the Traffic Impact Assessment provided as Appendix O to the EIS. A maximum of 8 trains per day is proposed to transport coal from the Newstan Colliery Surface Site over the life of the Project. Northern Coal Services do not propose to increase the maximum number of trains from the Newstan Colliery Surface Site above the current approved maximum of 8 trains per day.

It is acknowledged in Section 10.10.7 of the EIS that additional train paths will be required in order for Northern Coal Services to operate with a maximum 8 trains per day. Priorities for accessing and utilising the rail network are to commuter trains, followed by general freight trains, followed by coal trains. The ability to utilise the rail network for coal trains is governed by that priority system. Consultation with various stakeholders to access those additional available paths will be undertaken by Northern Coal Services as required. Should paths not be made available when required, that is a constraint to the ability of Northern Coal Services exporting coal from the Newstan Colliery Surface Site.

Regardless of the number of trains proposed to utilise the rail network, there is a finite number of paths available to be utilised. Timetabling of coal trains on the rail line is controlled by Transport for NSW, Australian Rail Track Corporation and Hunter Valley Coal Chain Coordinator. Access to available rail paths for coal trains is undertaken in consultation with all these stakeholders. As such, Northern Coal Services has no control over the timetabling of the coal trains generated by the Project.

There is no doubt that additional coal trains from current and future proposed projects will cause additional queuing and delay for motorists at the Glebe Road, Adamstown and Clyde Street, Hamilton railway level crossings, however the Project does not propose to increase train movements in excess of its current approval.

The Glebe Road level crossing at Adamstown and the Clyde Street level crossing at Hamilton has recently been upgraded to the highest level of protection that is possible for a level crossing including a central median and pedestrian safety fence. Collision risk at this railway level crossing is considered to be low.

As there are a number of users of the rail line between Newstan Colliery Surface Site and the port of Newcastle and as other projects are likely to increase rail traffic on the subject rail line it is considered that any problems perceived as significant with the operation of the railway level crossings within Newcastle may require a regional solution such as closure of the level crossings (rerouting of traffic) or provision of an alternate freight rail line (Hexham to Toronto). Any regional solution needs to be considered at a more strategic planning level than for individual projects.

Movement of coal by rail to Vales Point Power Station has not been included in the Director General's Requirements which only list movements by rail to the port of Newcastle and/or Port Kembla. (Transport for NSW)

Although not included in the Director General's Requirements, the consideration of rail movements from the Newstan Colliery Surface Site to Vales Point Power Station has been included in the EIS.

Northern Coal Services is seeking to utilise existing available paths on the network to transport coal from the Newstan Colliery Surface Site to the Port of Newcastle and/or Port Kembla (for export) and/or Vales Points Power Station. If additional paths are made available in the future, consultation with various stakeholders to access those additional available paths will be undertaken by Northern Coal Services as required. Should paths not be available when required, that is a constraint to the ability of Northern Coal Services exporting coal from the Newstan Colliery Surface Site.

Rail access fees for coal on the RailCorp network are not "take or pay" as suggested by the EIS. (Transport for NSW)

Noted.

On page 365 of the EIS, it states that Clyde St in Hamilton North is crossed the Main Northern Railway Line, operated by RailCorp. This railway is leased to Australian Rail Track Corporation and is not operated by RailCorp. (Transport for NSW)

Noted.

3.1.13 Water Licencing

The capture and use of clean surface water runoff is limited to intermittent extraction from the Main By-Wash Dam at the Newstan Colliery Surface Site. This extraction is licensed under a water access licence (WAL18735) with a share component (licensed entitlement) of 750 units. Extraction under this licence is to be conducted in accordance with any conditions on the licence or nominated approval and the requirements of the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources. (NOW)

Extraction of water from the By-Wash Dam has and will continue to be undertaken in accordance with the conditions of Water Access Licence (WAL18735) and the requirements of the Water Sharing Plan for the Hunter Unregulated and Alluvial Water Sources

It is recommended that the proponents continue to liaise with the Office of Water to ensure all extraction and use of water is appropriately authorised. (NOW)

Northern Coal Services will continue to consult with the NSW Office of Water to ensure all extraction and use of water is appropriately authorised.

3.2 Response to Community Individual Submissions

3.2.1 Air Quality

There is concern is the increase of air pollution and thus the decrease in air quality. Regardless of national standards and emission guidelines, it is important for the NSW Government and Centennial Coal acknowledge and act on the concerns of the residents of West Lake Macquarie and the government representatives that represent the area regarding air pollution. (CLP148)

Centennial should implement additional sensitive receptors to the modelling and projections of air quality and greenhouse gas monitoring at Awaba, Blackalls Park, Fassifern, Fennell Bay, Toronto and Woodrising, with the findings reported to the Community Consultative Committee and LMCC. (CLP148)

If small particulate pollution has been widely accepted as detrimental to the health of individuals of all ages, then there should be regular and comprehensive monitoring and reporting to the community for areas such as Fennell Bay, Toronto, Bolton Point and Woodrising as these are growing population areas with large numbers of children (schools and sporting grounds) and elderly (age care facilities and villages). (CLP159 and CLP160)

Air quality impact assessment criteria adopted by the EPA are contained in the Approved Methods (DEC 2005). These criteria are derived from a range of sources and are the defining ambient air quality criteria for NSW. They have been developed in consultation with a number of organisations, including the National Health and Medical Research Council (NHMRC), National Environment Protection Council (NEPC), World Health Organisation (WHO) and the Australian and New Zealand Environment and Conservation Council (ANZECC). As detailed in Section 10.7.3 of the EIS, the air quality criteria adopted by SLR Consulting Pty Limited (SLR) as part of the Air Quality impact Assessment, provided as Appendix L to the EIS, conform to current NSW and National air quality criteria. The air quality criteria applicable to the Project are summarised in table 69 of the EIS.

SLR's Air Quality Impact Assessment for the Project concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended Particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.
- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.

- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

Given that the nominated receptors were chosen as being indicative of all surrounding receptors, it is concluded that air quality levels as a result of the Project at other receptors in the surrounding area would also be below the relevant criterion.

The locations of Centennial Newstan's air quality monitors are reflective of the National Environment Protection Measure (NEPM) Guidelines for setting up a monitor. The intent of the current location is to look at the impact directly from the mine. There is a lot of variability in background levels from typical sources (i.e. wood smoke and motor vehicle emissions) and it would therefore not give representative results as to the contribution from Newstan Colliery.

A Lower Hunter air quality monitoring network has been established in collaboration with the EPA, the OEH, NSW Health, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Nuclear Science and Technology Organisation (ANSTO).

This network allows for a real time air quality index that can be viewed on the EPA's website and allows the local community to view real time air quality data. A monthly report will also soon be made available on the EPA's website that will provide a monthly report written in plan English summarising and analysing available air quality data and meteorological information. The report will be published on the EPA's website and will assess the available data from monitoring stations operated by the OEH at Wyong and Wallsend and by industry at Lake Munmorah Public School, Wyee, Marks point, Dora Creek and Wakefield with the intent to provide a simplified report that is accessible and contains results that would be clearly understood to the general public.

Greenhouse gas is reported annually to the National Pollutant Inventory (NPI) which is a requirement of legislation between the Australian, state and territory governments under the National Environment Protection Measures (NEPMs).

Centennial should put in place a comprehensive air monitoring program that extended further afield than the 1-2 km from the sites as my concern is that the small particulate has a greater area of 'field of effect' due to its small size and ability to be carried further on the wind. (CLP159 and CLP160)

Centennial should put in place an extensive and effective dust (small particulate) monitoring program and report the findings to the community on a regular basis to ensure accountability, transparency and corporate responsibility. (CLP159 and CLP160)

A comprehensive air monitoring program should include appropriate and accurate air quality testing units. (CLP159 and CLP160)

Centennial Newstan undertake extensive dust monitoring as required by the Development Consent and Environment Protection Licence. As detailed in Section 10.7.2 of the EIS, ambient air quality monitoring has been performed by Centennial Newstan at the Newstan Colliery Surface Site for the following parameters:

- Monitoring of dust deposition (insoluble solids) has been undertaken since January 2007 using deposited dust gauges.

- Monitoring of Total Suspended Particulate (TSP) and PM_{10} has been undertaken since November 2006 using a High Volume Air Sampler (HVAS). The ambient air quality monitoring program has been incorporated into a wider environmental monitoring campaign, and includes TSP and PM_{10} measurements using a co-located HVAS.

- Continuous PM_{10} monitoring has been undertaken since March 2012 using co-located tapered element oscillating microbalance (TEOM).

- $PM_{2.5}$ monitoring has been performed since September 2011 using a co-located HVAS, with TSP and PM_{10}.

Centennial Mandalong has operated two dust deposition gauges in the vicinity of the Cooranbong Entry Site since September 1999. A continuous ambient particulate monitoring using a TEOM commenced at the Cooranbong Entry Site in July 2013 to monitor TSP and PM_{10}.

Data collected by the approved dust monitoring locations surrounding the Newstan Colliery Surface Site and Cooranbong Entry Site are specifically designed to measure the maximum pollutant levels that may occur due to the operations at these surface facilities. By moving the location of the dust monitoring stations further away from the surface facilities would result in the data being collected not being as accurate as they would be influenced by other sources of pollutants.

As detailed in Section 10.7.7 of the EIS, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site. The existing air quality monitoring programme is considered sufficient to identify impacts, manage operations and confirm compliance with the air quality standards for the Project.

TSP and PM_{10} results are posted monthly and are publically available on the Centennial Coal website (www.centennilcoal.com.au). Results are also presented to the Community Consultative Committee on a quarterly basis along with being reported within the Annual Environmental Management Report which is distribute to various government agencies and also publically available on the Centennial Coal website. All results are presented against the Development Consent and Environmental Protection Licence compliance criteria.

The increase of 28 truck movements to 32 per hour will accumulate to an extra 96 truck movements in a 24 hour period. In regards to greenhouse gas and air quality there will still be a cumulative increase in the effects of air pollution. (CLP148)

Dust emissions from the trucks transporting coal along the private haul roads has been considered within the air quality modelling scenarios detailed in Section 10.7.5 and presented in Table 72 of the EIS.

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment for the Project (provided as Appendix L to the EIS) which concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.

- The annual average TSP concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.

- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.

- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.

- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.

- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

A Greenhouse Gas Assessment was prepared by BDM Resources Pty Limited and provided as Appendix M to the EIS. The impacts on greenhouse gas emissions from diesel combustion as a result of trucks transporting coal along the private haul roads are considered in the Scope 1 emissions for the Project and presented in Section 10.8.2 of the EIS. The Greenhouse Gas Assessment concluded that the Project's Scope 1 and Scope 2 emissions amount to only a small proportion of the national total emission inventory with a contribution of 0.051 percent, which is considered materially insignificant. The Project's Scope 1 and Scope 2 emissions make a nominal contribution to the NSW total emission inventory at 0.175 percent. Australia's net greenhouse gas emissions account for 1.47 percent of the global emission balance. With the Project's Scope 1 and Scope 2 emissions accounting for 0.051 percent of Australia's total emissions, it will have an undetectable effect on global climate change.

Centennial should dedicate to research into $PM_{2.5}$, its distribution and fall out, as well as the health effects of this particulate matter on the population. (CLP148)

On-site ambient $PM_{2.5}$ monitoring has been performed at the Newstan Colliery Surface Site since September 2011 using a co-located High Volume Air Sampler (HVAS) with Total Suspended Particulate (TSP) and PM_{10}. The average PM 24 hour levels recorded at HVAS 1 is 7.6 $\mu g/m^3$ and the and average PM 24 hour levels recorded at HVAS 2 over this period is 9.5 $\mu g/m^3$.

Although there have been some exceedances of the PM24 hour average criteria, it is noted that the monitored $PM_{2.5}$ concentrations at Newstan Colliery Surface Site includes contributions from existing activities at Newstan Colliery Surface Site as well as other industrial facilities in the region. The average results are well below the criteria of 25 $\mu g/m^3$.

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment for the Project (provided as Appendix L to the EIS) which concluded:

- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios; and

- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

Northern Coal Services do not consider any additional contribution to research into $PM_{2.5}$ distribution, fall out or health effects as a result of its operations are considered necessary.

As detailed in Section 10.7.7 of the EIS, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site. The existing air quality monitoring programme is considered sufficient to identify impacts, manage operations and confirm compliance with the air quality standards for the Project.

Centennial should assess air quality impacts associated with emission products of combustion from vehicle engines. This was not carried out by the consultants. (CLP148)

Diesel carcinogens will also increase via this proposal. (CLP185)

As detailed in Section 2.4 of the Air Quality Impact Assessment provided as Appendix L to the EIS, It was considered appropriate to assume that the emissions due to combustion of fuel in vehicle engines on site will be negligible compared to the existing background levels. Background traffic volumes in the vicinity surrounding the Project Application Area are far greater than the increase in heavy vehicle traffic generation proposed as a result of the Project. As such, the emission products of combustion from vehicle engines were not considered further in the assessment.

All coal wagons should be covered. (CLP148, CLP159 and CLP160)

There are a number of contributing factors leading to particulate emissions from the transport of coal along the rail network being:

- Coal properties. The fines content and moisture content are the two coal properties likely to have the greatest influence on PM emissions. The relative dustiness of coal has been measured in terms of dust extinction moisture content (DEM) for coal. The DEM is the point at which there is sufficient moisture to prevent dust being raised from the surface.

- Train speed. Train travel speed influences the speed at which air travels across the coal surface. When this exceeds the threshold friction velocity for a particulate coal type, PM emissions will occur. Ambient wind speeds can add to this effect.

- Load profile. When wagons are loaded in an uneven manner, the surface area is increased and emission potential is greater. Load profiling creates a reduced surface area that is exposed to air flow.

- Travel distance. The emission factors used to estimate dust emissions from wagons adopted in Canada are dependent on the distance the train travels. In other words, longer distances result in higher emission estimates. The further a coal train has to travel, the greater the potential for the coal surface to dry out.

- Ambient conditions. Ambient conditions can increase the rate at which the coal surface dries, particularly in summer. Local winds can increase the speed at which air travels across the coal surface.

- Leakage through wagon doors. Leakage can occur through gaps in the wagon doors or when doors are not closed properly following unloading.

- Residual coal / carry back in unloaded wagons. Coal remaining in wagons after unloading can be lead to fugitive emissions or leakage as the train travels back to the mine. Residual coal is generally caused when coal properties (high moisture, 'sticky' coal) make unloading difficult.

- Spilled coal. Poor loading practices can result in coal spill on sills, shear plates and bogies of the wagons. Similarly, when unloading, ploughing can result in coal being collected on the bogie as the train moves through the unloading station.

- Spilled coal on wagons (referred to as parasitic coal) can be entrained by the wind as the train moves or can drop onto the track and become re-entrained during high winds or train pass-bys.

Northern Coal Services implements controls to minimise or prevent coal spills and dust emissions from the top of wagons during transport by maintaining the moisture content of the coal above the DEM levels. Northern Coal Services has established the DEM through the standard testing procedure as outlined in Australian Standard AS-4156.6-2000. Train coal samples indicate that the moisture content of the coal is above the DEM. In the unlikely event that additional dust suppression is required for the transport of coal via rail, then a water cart is also available to add additional moisture.

The average train speed of coal trains transporting coal along the rail networks is between 30-40 km/hour. Train speeds are already considered to be low and reducing this further is seen as exacerbating congestion issues.

The 'garden bed' load profile is not possible to be established through the current process of loading of trains at the Newstan Colliery Surface Site using a front end loader however Northern Coal Services manages the prevention of spills by under loading the wagons (i.e. not fill them to capacity) to ensure the top of the coal profile is below the wagon gunwhale (sill).

The average travel distance for coal trains from the Newstan Colliery Surface Site is a relatively short travel distance to the port when compared to the distance trains transporting coal from other mines have to travel.

On site management measures have been implemented by Northern Coal Services to reduce the risks associated with parasitic coal from train wagons leaving the Newstan Colliery Surface Site. To do this, wagons are cleaned using a water cart to remove any parasitic coal prior to the train leaving site. Training on the risks and the correct train loading procedures are provided to all staff involved in the train loading operations through regular tool box talks.

Dust from coal trains wagons is a contentious issue in the community. Ongoing research and monitoring, by both industry and government agencies has been undertaken and is providing a better understanding air quality along the coal transport corridor, particularly in the Hunter region of NSW.

Scientific studies to date have generally found that fugitive dust from coal trains is a relatively small source of ambient particulate matter (Connell Hatch, 2008; Environ, 2012; Katestone, 2013, Ryan et al 2014). While many of the scientific studies to date have found that fugitive dust from coal trains is not a significant source of ambient particulate matter, ongoing work in regards to this issue is continuing to provide a better understanding of the composition and source of particulate matter. Nevertheless, fugitive dust from coal trains remains a significant community concern and the industry is committed to identifying areas of improvement in management practices. At this stage however, covering coal train wagons is not considered as being a feasible solution to manage impacts from coal trains transporting coal from the Newstan Colliery Surface Site.

3.2.2 Biodiversity

Approximately 20% of the local population of Tetratheca juncea will be removed, which is a significant impact and therefore must be offset. Offset ratios should be in accordance with the NSW Biobanking Guidelines. (CLP148)

The offsets proposed in the assessment are not actual offsets but mitigations which are not consistent the EPBC Act offset guidelines or NSW offsetting guidelines for significant impacts. (CLP148)

The proposed 'offsets' listed under the offsets heading are predominantly mitigation. (CLP154)

No formal offsets are proposed, which is inconsistent with the EPBC Act Offset policy. In particular offsets for Tetratheca juncea must occur. (CLP154)

Centennial should implement Offsets to meet the guidelines of the EPBC Act and NSW Offsetting guidelines. (CLP159 and CLP160)

Impacts to threatened flora, fauna and their habitat has been avoided through the detailed designing of the project and through minimising areas required to be disturbed.. Two disturbance footprints are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site; and

- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

In total, the Project will result in approximately 21.38 ha of disturbance. Of that area 12.63 ha is already cleared / disturbed with the remaining area made up of 8.75 ha of remnant native vegetation in varying condition. Both these disturbance areas have been located in areas that are predominantly already cleared and disturbed and adjacent to existing areas of disturbance and established access routes. The location and design of the two disturbance areas have been so as to limit the amount of vegetation required to be cleared and the potential of habitat fragmentation occurring.

As detailed within Section 4.3.2.3 of the Flora and Fauna Impact Assessment provided as Appendix K to the EIS, a total of 376 Tetratheca juncea clumps are located and proposed to be removed within Site 1. The original layout of Site 1 contained an additional 425 clumps of Tetratheca juncea to the immediate north of Site 1. However, a redesign of Site 1 has avoided impacts to the additional 425 clumps. The immediate surrounding vegetation type (MU30) at Site 1 is preferred habitat for Tetratheca juncea and following additional targeted surveys it was established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west and number at least 1,958 clumps. Due to the noted availability of potential habitat surrounding Site 1, which wasn't surveyed, additional surveys within the region would most likely result in a much larger estimate of the local population.

The original layout of Site 2 also contained 219 Tetratheca juncea clumps. However, following the re-design of the site layout, all 219 recorded clumps of Tetratheca juncea within Site 2 will be avoided.

Table 2 of the "*Referral guidelines for the vulnerable Black-eyed Susan, Tetratheca juncea*" (August 2011) provide thresholds of what is deemed a high risk of significant impacts on Black-eyed Susan. This includes the loss of greater than 25% of a subpopulation or 1000 plant clumps (whichever is lesser). The removal of 376 clumps within Site 1 equates to the removal of up to 19.2% of the recorded subpopulation of Tetratheca juncea, however the actual percentage is likely to be substantially less.

As detailed within the Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy (October 2012), offsets are not required where the impacts of a proposed action are not thought to be significant or could reasonably be avoided or mitigated. An Assessment of significance under the EPBC Act was undertaken for all EPBC Act listed vulnerable and/or endangered flora and is provided as Appendix 3 to the Flora and Fauna Impact Assessment. EPBC Act Assessment of Significant concluded that no Matters of National Environmental Significance which were detected or considered likely to occur within the Project Application Area will be significantly impacted by the Project and as such no direct offsets are required under the EPBC Act biodiversity offsets policy.

A number of additional mitigation and management measures are identified in Section 10.4.9 of the EIS that will further minimise potential impacts to threatened flora and fauna.

A variety of indirect offset measures are proposed to compensate for the residual impacts of the Project. It is proposed as part of the compensation measures to:

- Develop and implement a Tetratheca juncea translocation research program to build on the current knowledge regarding translocation of this species. The 376 clumps of Tetratheca juncea from within Study Area 1 will be translocated and monitored in accordance with the proposed research program.

- Nest boxes will be installed at a ratio of 1:1 (i.e. one nest box for every habitat hollow removed). The design and installation of nest boxes will draw on the information obtained from the five year research program undertaken by Centennial Mandalong into the utilisation of different nest box designs and aspects.

- Northern Coal Services will fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of Tetratheca juncea from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of Tetratheca juncea.

The proposed research programme has been developed with a focus on addressing the priority actions identified by the OEH and the DotE for Tetratheca juncea as part of this species Recovery Plan.

The NSW biodiversity offsets policy for major projects (OEH 2014) commenced a 12-18 month transitional implementation period on 1 October 2014. During this period, proponents and the consent authority will apply the policy to new major projects and certain existing projects in consultation with stakeholders. The Project was issued Director General's Requirements on 20 March 2012 which outlined the general requirements and key issues to be addressed within the EIS. The Director General's Requirements were subsequently re-issued by the DP&E on 7 August 2013. The Flora and Fauna Impact Assessment was finalised in April 2014 prior to the release of the NSW biodiversity offset policy for major projects. As such, the NSW biodiversity offset policy for major projects does not apply to the Project and subsequently, no assessment against the NSW biodiversity offset policy for major projects has been undertaken or is required to be undertaken.

Northern Coal Services consider the indirect compensatory measures proposed adequately compensate for the residual impacts to threatened flora species impacted as a result of the Project and that the compensatory measures proposed provide an overall net benefit to the ongoing understanding of Tetratheca juncea. The knowledge gained as a result of the proposed compensatory measures will lead to improved management of this species. No direct offsets or additional biodiversity mitigation measures are proposed.

Centennial Coal should commence negotiations with the Land and Property Management Authority to secure land to facilitate the beginning of long waited Awaba Conservation Area. I believe land that should begin the Awaba Conservation Area include properties DP755218, lots 88-93. (CLP148)

Parcels of crown land should be offset into the Awaba Conservation Area for the conservation and protection of biological diversity and ecological integrity, in particular DP 755218 – Lots 88-93. (CLP159 and CLP160)

The Project does not propose any direct offsets. Lots 88-93 within Deposited Plan 755218 are Crown land over which Centennial Newstan holds Consolidated Coal Lease (CCL) 746. The Department of Primary Industries – Crown Lands Division is responsible for the management of these parcels of land. Northern Coal Services do not support land being secured into a State Conservation Area where potential coal reserves could become sterilised and the land use is inconsistent with existing mining approvals and mining titles.

Jigadee Estate, 1174 Freemans Drive Cooranbong, should be a point of operation for the research projects as it is owned by Centennial Coal and is known to have significant biodiversity and a number of threatened species including Tetratheca juncea on site. (CLP148)

Part of the Tetratheca juncea study should include maintenance and monitoring of Jigadee Estate which has significant biodiversity and a number of threatened species including Tetratheca juncea. (CLP159 and CLP160)

As detailed in Section 10.4.9 of the EIS, Northern Coal Services will commit to fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of Tetratheca juncea from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of Tetratheca juncea. The proposed research programme has been developed with a focus on addressing the priority actions identified by the OEH and the Commonwealth DotE for Tetratheca juncea as part of this species Recovery Plan. Details of the research programme including monitoring locations to be established will be determined during the research programmes scoping phase. Monitoring locations will be based on sites that provide benefit to the research proposal and assist in providing outcomes consistent with the purpose of the research programme.

There is an inadequate survey of the bat alley. While surveys have occurred in 1998 that showed that pregnant Bent-wings were using the Bat Alley, the current survey did not complete adequate surveys to determine if the site is a maternity roost. (CLP154)

The number of bats using the bat alley roost is not known. This roost may be very important for threatened cave dependent bat species, however this is not known from the current inadequate surveys. (CLP154)

There is no rationale for providing a 30 metre buffer from the bat alley to the impact area. Why was this distance chosen? Will any monitoring occur to determine if bat numbers decline post

construction? To do this, the number of bats within the bat alley needs to be determined first. (CLP154)

An active bat roost cave, in the form of a disused mine shaft (Bat Alley), is known to occur within close proximity to Site 1. Two harp traps were placed in front of the main cave roost entrance (drift entrance) along a track to the north of Site 1 over four consecutive nights. Traps were checked early each morning, with any captured bats identified and released at point of capture. The location of each trap line is shown on Figure 2.

A total of eight harp trap nights were undertaken within Site 1 during surveys.

A monitoring program was undertaken at Bat Alley to monitor microbat species presence and to assess any likely impacts as a result of the Project.

Microbat echolocation calls were recorded using two Anabat II Detector and CF ZCAIM units set to remotely record for the entire night (6pm to 6am). Two Anabats were placed within close proximity to Bat Alley to the north of Site 1 over four nights in May 2012, resulting in eight nights of bat call recording. Site 1 had four consecutive nights of sampling, with emphasis placed on those areas deemed likely to provide potential foraging and flyway sites for microbats. Bat call analysis was undertaken by Anna McConville who is experienced in the analysis of bat echolocation calls.

Four additional surveys were undertaken by RPS Australia East Pty Limited (RPS) and Glenn Hoye of Fly by Night Bat Surveys Pty Ltd on:

- The evenings of the 30th and 31st August 2012
- The evenings of the 5th and 6th December 2012
- The evening of the 18th January 2013; and
- The evenings of the 11th and 13th March 2013.

Surveys were undertaken using harp traps, visual inspections, anabat detections and video camera with infrared nightlight.

The number of bats recorded utilising the site were much lower than that indicative of a maternity roost being present within the workings, suggesting that the workings are not being used for breeding. Additional information regarding these surveys and the conclusions of them has been included in Section 3.4.4 and Section 4.4.4.1 of the revised Flora and Fauna Impact Assessment provided as **Appendix 7** to this RTS.

In order to minimise the potential for impact on bat species utilising the site as a roosting area, an exclusion or non-disturbance zone has been incorporated into the design of the surface disturbance area for Site 1 around Bat Alley to maintain a buffer of vegetation around the disused mine drift entrance and to reduce the potential for direct impacts on bat species utilising this site. The buffer will maintain connectivity with surrounding vegetation and not impact on the foraging ability of bats utilising Bat Alley as a roost. This is consistent with advice sought from RPS. Additionally, the Project design will incorporate light and sound barrier walls around the proposed ROM coal stockpile in this locality. The installation of a wall around the proposed coal stockpile area at Site 1 will reduce the potential for impacts from noise and light on bat species utilising Bat Alley.

Ongoing fragmentation of remaining bush land places the fragile flora and fauna under unsustainable stress causing cruelty, illness, harm, death and increasing toll of lost legally protected and threatened species. This includes downstream aquatic and marine species e.g. Seagrass, wetlands, soaks, fish nurseries and migratory life. (CLP185)

Two disturbance footprints are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site; and

- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

In total, the Project will result in approximately 21.38 ha of disturbance. Of that area 12.63 ha is already cleared / disturbed with the remaining area made up of 8.75 ha of remnant native vegetation in varying condition. Both these disturbance areas have been located in areas that are predominantly already cleared and disturbed and adjacent to existing areas of disturbance and established access routes. The location and design of the two disturbance areas have been so as to limit the amount of vegetation required to be cleared and the potential of habitat fragmentation occurring.

As detailed in Section 4.5.2 of the Flora and Fauna Impact Assessment, the Lake Macquarie Native Vegetation and Corridors Map (Lake Macquarie City Council 2011) detail a mixture of 'Corridor of Remnant Native Vegetation', 'Corridor of Partially Cleared Remnant Native Vegetation', and 'Partially Cleared Remnant Vegetation' at both Sites 1 and 2. Both sites were adjacent to 'Widely Interfaced Crossing Point'. Site 1 had limited value as a corridor and habitat linkage as it is bordered on its southern and eastern side by a coal stockpile and other coal handling infrastructure. Site 2 consists of mostly cleared lands and regrowth vegetation and is surrounded by remnant vegetation. Therefore, the corridor and habitat linkage value of Site 2 is also limited.

A number of mitigation and management measures have been identified to minimise the potential for impacts of the Project on ecological receptors with compensatory measures proposed to compensate for the impacts that will occur.

3.2.3 Climate Change

The climatic conditions, already evident with increased weather extremes and the fact that coal is scientifically proven to be linked to climate change, surely must be considered as a greater priority. (CLP185)

A Greenhouse Gas Assessment was prepared by BDM Resources Pty Limited and provided as Appendix M to the EIS. The Greenhouse Gas Assessment concluded that the Project's Scope 1 and Scope 2 emissions amount to only a small proportion of the national total emission inventory with a contribution of 0.051 percent, which is considered materially insignificant. The Project's Scope 1 and Scope 2 emissions make a nominal contribution to the NSW total emission inventory at 0.175 percent. Australia's net greenhouse gas emissions account for 1.47 percent of the global emission balance. With the Project's Scope 1 and Scope 2 emissions accounting for 0.051 percent of Australia's total emissions, it will have an undetectable effect on global climate change.

3.2.4 Consultation

Centennial should closely monitor and communicate their progress and findings to the Community Consultative Committee, LT Creek Sustainable Neighbourhood Group, LMCC and OEH in regards to:

1. the nesting box program

2. the Tetratheca juncea translocation research project

3. the development and implementation of the research project investigating genetic patterns among and within the populations of Tetratheca juncea. (CLP148)

Centennial should put in place and actively engage/maintain/report on to the local community: the nesting box program and the relocation/study for Tetratheca juncea. (CLP159 and CLP160)

Northern Coal Services will provide updates on the research and monitoring programmes to the Community Consultative Committees and report on the results annually within the Annual Environmental Management Report which is distribute to various government agencies and also publically available on the Centennial Coal website (www.centennialcoal.com.au). The LT Creek Sustainable Neighborhood Group is represented on the Newstan Community Consultative Committee.

Question whether or not communities such as Fennell Bay, Toronto, Bolton Point and Woodrising have been adequately consulted with and considered. (CLP159 and CLP160)

Many locals were surprised to actually learn of this proposed projects existence and the submission deadline of November 17. (CLP185)

Section 7.2.1 of the EIS details the community consultation undertaken regarding the Project. Throughout the course of the Project, three letters were prepared by Northern Coal Services and distributed to the landholders and residents within the Project's potential affectation areas, which included residents of Fassifern, Blackalls Park, Wakefield and Dora Creek. These letters provided information regarding the status of the Project and environmental assessment work.

Although residents of Fennell Bay, Toronto, Bolton Point and Woodrising are located well beyond the extent of any impacts arising from the Project, Northern Coal Services provided regular Project progress updates in the Lakes Mail (local newspaper) throughout the course of the Project which are delivered to these areas and publicised information regarding the project on the Centennial Coal website (www.centennialcoal.com.au).

Community consultation undertaken since the submission of the EIS for public exhibition is provided in **Section 4** of this RTS.

A public notice advertising the public exhibition period for the EIS was placed by the NSW Department of planning an Environment in the Lakes Mail on the 21st August 2014.

Accurate community complaints and procedures along with proper publicly available record keeping, have been an issue. (CLP185)

Failed community consultation, historically has been a serious issue with Centennial and the subject of many complaints. (CLP185)

Centennial is unwilling to address wider community concerns and has undertaken an effort to distort true community opposition and complaints. (CLP185)

Centennial Newstan readily and truthfully address community concerns in a timely manner. Complaints and enquiries received are addressed in accordance with the Community Complaints and Enquiries procedure and maintained within a database. All community complaints and enquiries are addressed within the monthly website monitoring reports which can be found on the Centennial website (www.centennialcoal.com.au) and are discussed at the sites respective Community Consultative Committee meetings held quarterly.

3.2.5 Economic

We currently have a coal glut. Therefore can there really be any economic justification or indeed any sensible rational gain obtained by approving this project in its current form. (CLP185)

Coal mining in Australia is still warranted as the electricity generation industry remains heavily reliant on coal-fuelled generation. Recent research by Pitt & Sherry (2014) demonstrate that black coal demand for electricity generation has been declining in recent years while alternative fuel sources such as gas, wind and other renewable have been on the rise. However, their research shows that to date black coal is still the highest fuel source used for electricity generation, and they provide the following statistics:

'Shares of total generation in the year ended June 2014 were black coal 50.7%, brown coal 22.3%, gas 12.7%, hydro 9.6% and wind 4.7%. These are the lowest shares of both black and brown coal, and the highest shares of wind, since Cedex® data starts in 2006, and in fact, almost certainly ever'.

The observations of Pitt and Sherry (2014) are supported by data from the Australian Bureau of Statistics (ABS). **Figure 2** provides data on electricity generation by fuel type for the period 2011/2012, and shows that coal represents the highest fuel source for electricity generation in the period 2011/2012. Approximately 65% of the total electricity generated in Australia was from coal while natural gas provided approximately 23% of the total demand. In comparison the combined renewable fuel sources met less than 10% of Australia's fuel source demand for electricity generation.

While it can be anticipated, based on research by Pitt and Sherry (2014), that use of alternative and renewable sources will continue to increase, the transition to a point where these sources supplant coal as the predominant fuel source in the future will clearly take a significant period of time. This is especially the case given the availability of coal resources, the simplistic methods of mining of coal and conversion to electricity compared to renewables, and the extensive investment already sunk into coal-fired generation capacity in Australia.

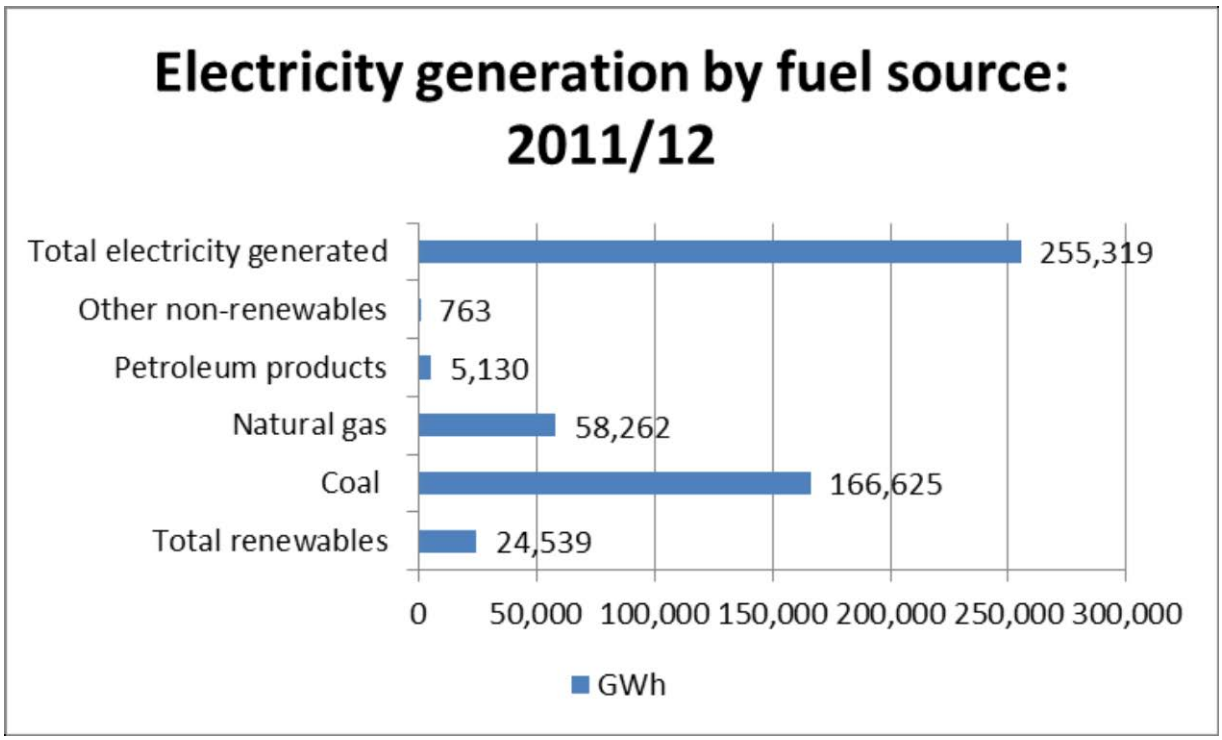


Figure 2 - Electricity Generation by Fuel Source 2011/2012

3.2.6 General

Centennial Coal has failed to adhere to regulations guidelines and conditions of consent on numerous occasions. Many past incidents and breaches have been documented in community correspondences media articles and through prosecutions via the EPA. (CLP185)

Question Centennials genuine capability to contain pollutants and discharges, be they via air water or land. (CLP185)

Centennial Coal is committed to continual improvement in the environmental management of the Company's operations. Centennial Newstan and Centennial Mandalong currently have stringent conditions under which discharges to land air and water can occur which are enforced through the respective operations Development Consent, Environmental Protection Licence and various other mining authorities. Recorded exceedances of these conditions have occurred at times in the past and have been reported in accordance with the requirements of the respective consent or licence.

Northern Coal Services has been proactive in managing the potential for future exceedances of licence conditions to occur and has made many infrastructural upgrades and improvements at the Newstan Colliery Surface Site and Cooranbong Entry Site which include:

- The construction of a Clean Water Treatment Plant in 2013 to prevent high total suspended solids being discharged from LDP001 and better manage water on site;
- The construction in 2012 of a 6m high bund wall to the south-eastern end of the Rail Loop stockpile to prevent noise affecting the residents of Fassifern;

- The enlargement of the final pollution control dam in 2012 from 18ML to 50ML to increase the dirty water storage capacity on site in a heavy rainfall event;

- Upgrades to the dirty water management system at the Cooranbong Entry Site to reduce the potential for discharges of water that do not meet the sites Environmental Protection Licence limits for water discharges; and

- Cladding of the Coal Preparation Plant at the Cooranbong Entry Site in noise attenuating panels to reduce the potential for exceedances of noise criteria at the site.

Results of all environmental monitoring are reported on the Centennial Coal website (www.centennialcoal.com.au) on a monthly basis and all non compliances are reported to the respective Community Consultative Committees and annually in the Environmental Management Report (also available on the Centennial Coal website).

3.2.7 Hazardous Materials

Concerned over extreme bushfire risks and the fact that this industry has created a ready stockpile of fuel, chemicals and volatile materials near a large population. (CLP185)

As detailed in Section 10.12 of the EIS, dangerous goods and other hazardous materials are legislated under the Work Health and Safety Act 2011 and the impending Workplace Health and Safety (Mines) Act 2013 (which, upon commencement, will repeal the Coal Mine Health and Safety Act 2002).

Centennial Newstan and Centennial Mandalong currently hold all necessary approvals under these Acts and maintain a system for managing dangerous goods and hazardous materials that satisfies the requirements of the legislation and relevant WorkCover NSW codes of practice.

Given that that Project is largely seeking a continuation of existing surface activities associated with the approved Newstan Colliery and Mandalong Mine operations, there is no plan to introduce additional classes of dangerous goods or hazardous materials. The dangerous goods and hazardous materials currently used at Newstan Colliery Surface Site and Cooranbong Entry Site, which will continue to be used, are:

- Oils and greases, including engine coolants, hydraulic oil, transmission oil and gear oil;

- Diesel;

- Solsenic;

- Gases, including oxygen, acetelyne, nitrogen, helium, argon, methane and liquid petroleum gas;

- Mining chemicals (chemical inserts for roof support, mine grouts, shotcrete); and

- Other general use chemicals, including calcium lime rust remover (CLR), rat poison, general paints, coagulator, cleaning substances and dust suppression polymer.

The dangerous goods will continue to be stored at the Newstan Colliery Surface Site and Cooranbong Entry Site using the current storage systems, with the same controls and same management systems. With the continued implementation of best management practices for these materials within the Project Application Area, along with the effective implementation of an approved EMS, Emergency Management

Plan, Pollution Incidence Response Management Plan (PIRMP) and workplace health and safety management systems, the Project should not pose a significant risk in relation to its locality, to human health, life or property or the biophysical environment. Further, by employing the mitigation and management strategies identified in this EIS, the Project should not result in the emission of a polluting discharge in a manner which would pose a significant risk or impact to the local environment or surrounding populace.

Kleinfelder was engaged by Northern Coal Services to undertake a bushfire risk assessment for the Project for the purposes of asset protection and public safety. A copy of the Bushfire Risk Assessment is provided as Appendix Q to the EIS.

The Bushfire Risk Assessment focused on the Project's three surface infrastructure sites, being the Newstan Colliery Surface Site, Cooranbong Entry Site and Hawkmount Quarry. The Bushfire Risk Assessment was carried out with reference to relevant legislation and guidelines, including the NSW Rural Fires Act 1997 and Planning for Bushfire Protection (NSW Rural Fire Service 2006). Significant findings of the Bushfire Risk Assessment and recommendations are presented in Section 10.13 of the EIS. It was concluded that with the commitments detailed in Section 10.13.4 of the EIS implemented, the Project will provide protection to human life and minimise impacts on assets from the threat of bush fire.

3.2.8 Infrastructure

Under the existing approval for Newstan, the train loading system is to be automated when export exceeds 3 Mtpa. This condition should remain the same. (CLP148, CLP159 and CLP160)

An Air Quality Impact Assessment was prepared by SLR Consulting Pty Limited (SLR) to support the Project and was provided as Appendix L to the EIS. In order to assess the worst case impacts from the Project, SLR modelled a total of 10 different operational scenarios:

- Eight scenarios associated with the operations at the Newstan Colliery Surface Site; and
- Two scenarios associated with the operations at the Cooranbong Entry Site.

A description of the scenarios assessed for the Cooranbong Entry Site and Newstan Colliery Surface Site is provided in Tables 71 and 72 of the EIS respectively. SLR's Air Quality Impact Assessment for the Project concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.

- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.

- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.

- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

An automatic train loading facility will be installed to meet operational efficiencies which will subsequently result in the air quality criteria being achieved for the life of the Project. Limits on when an automatic train loading facility to be installed is not required to ensure compliance with the air quality criteria.

Northern Coal Services will continue to implement the dust management practices to minimise the impacts on air quality as a result of the Projects operations. Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved. Additionally, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site.

The pollution control dam's integrity and its ability and capacity to contain the toxic black contents from the washery, is worrying to say the least. The approval of these pollution control dams really should have had any potentially increased capacity considered during their initial planning approval and construction phase. (CLP185)

The following design criterion was/is applicable to both Southern Reject Emplacement Area tailings dams:

- Parsons Brinkerhoff was commissioned by Centennial Newstan to carry out the geotechnical investigations and design of the tailings dams and water management structures.

- Parsons Brinkerhof, in consultation with Centennial Newstan, completed the geotechnical investigation and design.

- A peer review of the design was completed by Connell Wagner, as required by the Dam Safety Committee Guidelines.

- The design and geotechnical information was submitted to and endorsed by the Dam Safety Committee.

- Parsons Brinkerhof, in consultation with Centennial Newstan, completed the technical specification and associated drawings.

- Centennial Fassifern prepared the tender document and contract which was awarded to Keller Civil Engineers Pty Ltd.

To ensure dam wall security and compliance with the technical specification, construction geotechnical testing is performed by Coffey Geotechnics and monitored by the designer (Parsons Brinkerhof) who also submits the "as built" construction reports to the Dam Safety Committee for review.

The Dam Safety Committee issues a "Dam Construction Certificate" after construction has been completed in accordance with the design drawings and specifications. The Dam Safety Committee issued a Dam Construction Certificate for the stage 1 dam on 24 April 2007.

With reference to the tailings dam wall security and runoff risk, the following issues were considered and included in the design, construction, monitoring and operation of both tailings dams:

- The tailings dams have been designed, with reference, to the NSW Dams Safety Committee Information sheets DSC13 March 2002(b) "Consequence Categories for Dams", and DSC 19 June 2005 "Tailings Dams", and the Australian National Committee On Large Dams (ANCOLD) publications "Guidelines on the Assessment of the Consequences of Dam Failure" (May 2000) and "Guidelines on Tailings Dam Design, Construction and Operation" October 1999).

- Consequence considerations included, dam and reservoir data, topographic data, downstream community information, natural environment, services and business implications, flood affected zone, potential damages and losses, population at risk and environmental consequences.

- The "Flood Consequence Categories" (FCC) was evaluated based on the ANCOLD Guidelines. This consequence category is based on the 'worst case' consequences that result for failures to occur in association with a flood. The Newstan tailings dams design criterion was based on a FCC of High Consequence (High C).

- The emergency dam flood storage capacity used, for FCC of High C, was based on the volume of runoff generated from a 1 in 100,000 year Average Recurrence Interval (ARI) storm event, but not less than 50% of the volume generated from the Probable Maximum Flood (PMF).

- A minimum freeboard of 0.4m to the peak water level during the design event was adopted based on the recommendation of the ANCOLD guidelines for Tailings Dam Design, Construction and Operation. Rainfall depths were calculated using Australian Rainfall and Runoff and Bulletin 53 (Estimation of Probable Maximum Precipitation in Australia). A hydrologic model was developed for the tailings dam to determine the design event duration. Assuming direct translation of runoff hydrographs, the 45 minute duration storm event produced the critical peak flow, which resulted in an estimated runoff volume of 140,000m^3. As such, the emergency flood storage capacity provided for at each stage of the tailings dam is adequate to contain the design 1 in 100,000 ARI flood event.

- In terms of dam wall security, Parsons Brinkerhof completed a geotechnical investigation and assessment to determine, the suitability of foundation material for the tailings dam wall and key depths for foundations and high wall interfaces. Other issues investigated included auger hole sealing and suitable parameters for slope design and stability of the embankments.

- A vertical sand filter is included in the design of the main tailings dam embankment to provide piping protection and the interception of seepage. The dam design also incorporates sand drains to facilitate controlled embankment and foundation drainage and seepage interception along the coal seam/earth fill interface. A seepage collector drain comprising a geotextile membrane collects the seepage from the vertical sand filter and sand drains and conveys the seepage downstream to the water management structures.

- Embankment stability analysis was considered for the tailings storage under steady state seepage conditions and earthquake loading. Slope stability analysis was carried out for all stages on the main embankment to RL 30, RL40 and RL52.5m.

- Earthquake analysis was carried out in accordance with Dam Safety Committee and ANCOLD guidelines. The seismic loading adopted in the design was reviewed by Kevin McCue, Director of the Australian Seismological Centre.

- In accordance with the Parsons Brinkerhof design, tailings slurry is deposited uniformly along the tailings dam wall to form a beach against the upstream face of the embankment. Decanted water is returned to the Fassifern seam via a borehole decant facility. This method ensures the tailings is partially consolidated (semi fluid). In the event of a catastrophic embankment failure, only a portion of the total storage is likely to be mobilised.

- An emergency spillway is included in the final design to accommodate the peak flow rate resulting from the 1 in 100,000 year ARI storm event. Temporary spillways of equivalent capacity are provided at each stage of construction.

- Surveillance, monitoring and training programs were developed in accordance with requirements of the ANCOLD Guidelines on Dam Safety Management (2003) for the assigned, High C, consequence rating. Newstan mining personnel have been trained and assessed by Parsons Brinkerhof to carry out surveillance, monitoring and reporting. Maintenance is completed by Keller Civil Engineers under the direction of the Principal, Centennial Newstan.

- To reduce the risk of runoff entering the tailings dam catchment, a clean water diversion drain has been designed by Centennial Fassifern and is currently under construction. (Approximately 1 km of the 1.6 km drain has been constructed to date). The clean water diversion drain is designed to accommodate an average storm recurrence interval (ARI) of 20 years with a storm duration period of 3 hours. When complete the clean water diversion drain will intercept over 100 Ha of catchment and will divert up to 44,000m^3 of clean water in any one storm event.

3.2.9 Noise

The noise and sounds of trains braking and the coal carriages rumbling during the night, has disturbed sleep patterns of many residents already. (CLP185)

In 2012 Centennial Newstan constructed a 6m high bund wall at the south-eastern end of the Rail Loop stockpile. Initial monitoring results saw a 3 dBA reduction in noise received on the outer side of the bund wall. No noise complaints have been received in regard to noise at the Newstan Colliery Surface Site since the construction of the noise bund.

Existing rail traffic noise levels exceed criteria from the Rail Infrastructure Noise Guideline (EPA 2013) at 25m from the rail line during the daytime and up to 100m from the rail line during the night time. The Noise Impact Assessment prepared by SLR and provided as Appendix N to the EIS determined that the Project will not noticeably increase rail noise levels (less than 2 dBA increase to each of the LAeq(day) and LAeq(night)).

3.2.10 Rehabilitation

The ongoing inability to have remediated so much of the western side of Lake Macquarie which Centennial having occupied for such an extended part of our European history, draws one to conclude that they are not serious or they are incapable of undertaking genuinely remediation. (CLP185)

As detailed within Section 10.14.6 of the EIS, due to the nature of the Project's operations, the need for progressive rehabilitation, particularly revegetation, is relatively low. However Northern Coal Services will adopt a progressive approach to rehabilitation as needed.

SLR Consulting Pty Limited (SLR) was engaged by Northern Coal Services to prepare a Decommissioning and Rehabilitation Strategy for the Project to address the methodologies and management strategies for post-operational closure and rehabilitation. The two primary purposes of the Strategy were to establish objectives for the decommissioning and rehabilitation of disturbed land within the Project Application Area and derive the most appropriate options for closure in terms of performance and cost. Key aspects include:

- Establishing an overall vision for closure, with general objectives for the rehabilitation and ultimate closure of the site;
- Identifying the preferred final land use options;
- Defining objectives and targets to achieve the preferred final land use options; and
- Describing the communication and consultation process for the preferred options.

A copy of the Decommissioning and Rehabilitation Strategy is provided as Appendix R to the EIS with significant findings and recommendations summarised in Section 10.14 of the EIS.

All rehabilitation and associated monitoring and management actions will be incorporated into the Mine Operations Plan for the Project taking into consideration the commitments made in the EIS and relevant consent conditions. Rehabilitation will be undertaken to the satisfaction of the Secretary of Department of Trade and Investment, Regional Infrastructure and Services.

3.2.11 Social

The Social Impact Assessment fails to take into consideration the suburb of Fennell Bay in its assessment and statistical analysis, thus not giving an accurate representation of the community. Toronto, the nearest population center and a growing town, only receives a fleeting mention but is not considered in any statistical analysis. Yet it is less than four kilometres away from Newstan. (CLP148)

When undertaking a Social Impact Assessment, the initial scoping exercise will include the collection of a demographic and population profile for all areas surrounding the Project Application Area which includes (but is not limited to) Fennell Bay and Toronto. However, a full demographic and population profile is not always incorporated into the final Social Impact Assessment when:

- the demographic and population characteristics will not change;
- inclusion of all information can be lengthy and not necessarily add value to the determination of social impact;
- information about the area's demographic and population profile is readily available to the public (this information is available on Council's website and via the Australian Bureau of Statistics); and
- the Project has a comprehensive profile of the area, available in its Stakeholder Engagement Plan.

What is included in the Social Impact Assessment is information relevant to the potential areas of affectation, determined by the Project description and findings of other specialist consultant's reports (in particular air quality, noise, visual, water quality).

The Social Impact Assessment has not acknowledged the percentage of residents that are on pensions or self-funded retirees. (CLP148)

The Social Impact Assessment has considered a range of demographic and population data and the inclusion of information relating to the percentage of pensioners and self-funded retirees does not have a bearing on the outcome of the Social Impact Assessment as a result of this Project. A complete age profile of the surrounding state suburbs is found in **Table 12** below.

Table 12 - Age Profile for Suburbs Surrounding the Project Application Area

Age	Dora Creek		Awaba		Fassifern		Blackalls Park		Wakefield		Fennel Bay		Toronto	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
0-4 years	86	5.1	22	6.3	23	3.7	138	5.0	4	2.2	83	5.6	319	5.9
5-9 years	77	4.6	33	9.5	23	3.7	184	6.7	6	3.3	77	5.2	304	5.6
10-14 years	109	6.5	26	7.4	52	8.4	186	6.7	17	9.4	89	6.0	307	5.7
15-19 years	112	6.7	23	6.6	48	7.7	197	7.1	19	10.6	104	7.1	368	6.8
20-24 years	84	5.0	34	9.7	44	7.1	208	7.5	6	3.3	96	6.5	327	6.0
25-29 years	89	5.3	15	4.3	41	6.6	154	5.6	6	3.3	63	4.3	270	5.0
30-34 years	77	4.6	16	4.6	27	4.3	132	4.8	7	3.9	67	4.5	231	4.3
35-39 years	70	4.2	25	7.2	39	6.3	175	6.3	6	3.3	84	5.7	306	5.6
40-44 years	92	5.5	32	9.2	37	6.0	162	5.9	14	7.8	74	5.0	313	5.8
45-49 years	110	6.6	29	8.3	48	7.7	187	6.8	23	12.8	99	6.7	297	5.5
50-54 years	128	7.7	21	6.0	42	6.8	178	6.4	23	12.8	91	6.2	335	6.2
55-59 years	128	7.7	20	5.7	51	8.2	190	6.9	11	6.1	111	7.5	339	6.2
60-64 years	108	6.5	19	5.4	52	8.4	183	6.6	9	5.0	150	10.2	407	7.5
65-69 years	123	7.4	12	3.4	35	5.6	158	5.7	7	3.9	103	7.0	357	6.6
70-74 years	109	6.5	10	2.9	26	4.2	115	4.2	7	3.9	63	4.3	283	5.2
75-79 years	80	4.8	5	1.4	12	1.9	75	2.7	9	5.0	53	3.6	228	4.2

Age	Dora Creek		Awaba		Fassifern		Blackalls Park		Wakefield		Fennel Bay		Toronto	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
80-84 years	45	2.7	4	1.1	12	1.9	78	2.8	3	1.7	37	2.5	208	3.8
85 years and over	44	2.6	3	0.9	9	1.4	61	2.2	3	1.7	29	2.0	231	4.3

The Social Impact Assessment fails to acknowledge in its summary of air quality modelling and projections that NC6, Fassifern Public School may have exceedences of PM_{10}, depending on the scenario. (CLP148)

The Social Impact Assessment considered all scenarios modelled in the Air Quality Impact Assessment prepared by SLR Consulting Pty Limited (SLR). As stated in the SLR report and referred to in the Social Impact Assessment, all air quality criterion can be achieved at all sensitive receptors (which includes Fassifern Public School: NC6) around the Newstan surface facility when coal transfers and rail loading is automated which will be implemented as required to achieve operational efficiencies.

Proposed 24/7 operations for all this increased activity are unreasonable for residents and will affect property values negatively. (CLP185)

The existing core Project elements operate 24/7 and amenity impacts across the Project Application Area will not be compromised when new/improved coal handling infrastructure in commissioned if all mitigation measures are in place.

Property values can be adversely affected if a property is subject to adverse amenity impacts that:

- require acquisition or mitigation outlined in a Negotiated Agreement;
- land is sterilised and can no longer achieve its highest and best use;
- the dominant land use changes from its existing form to an alternate and undesirable use.

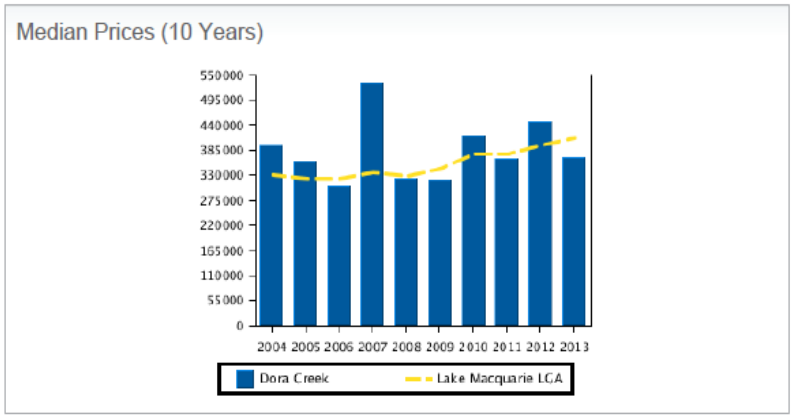
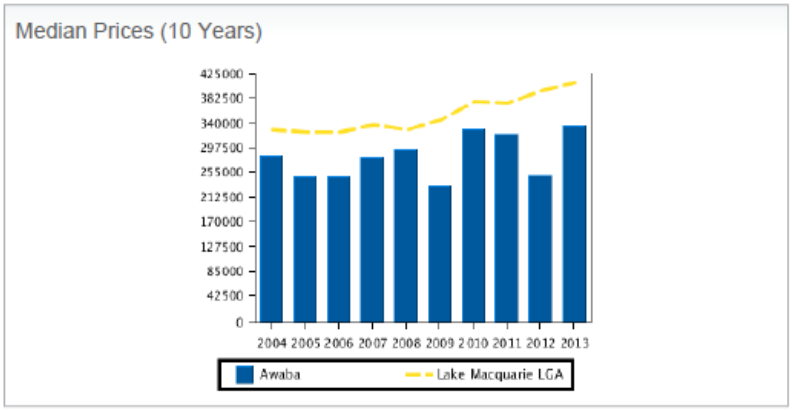
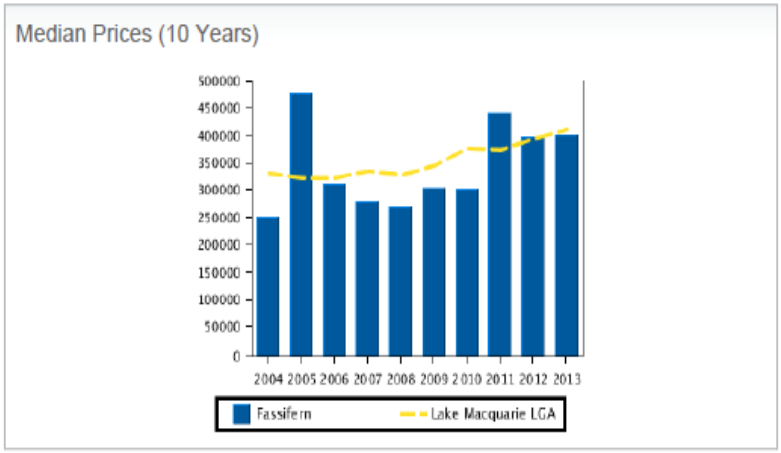
The Project will results in:

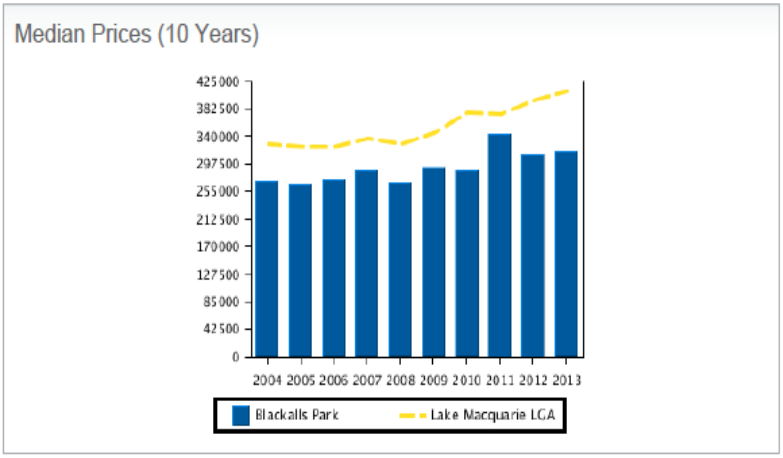
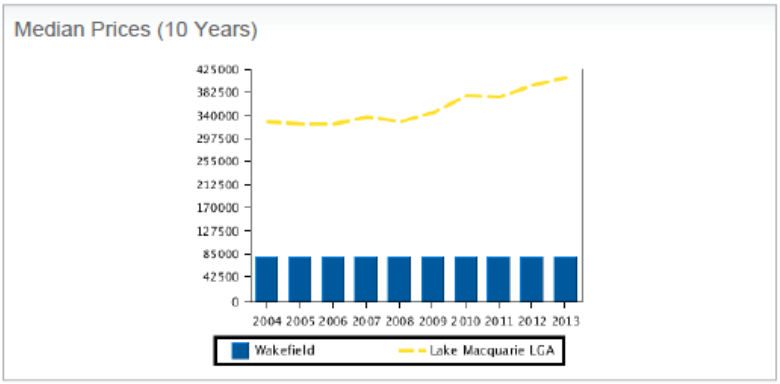
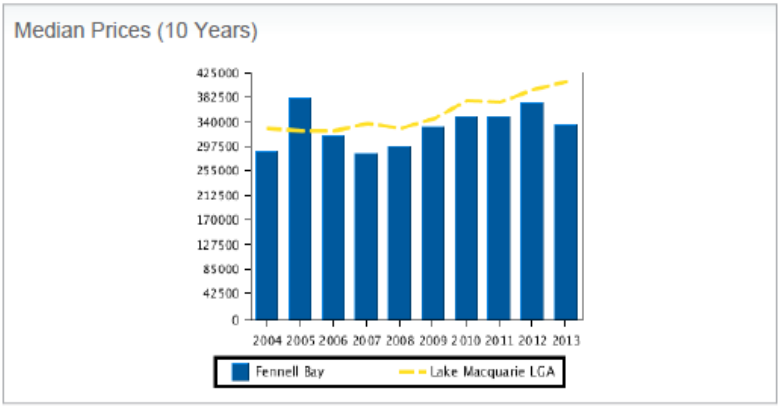
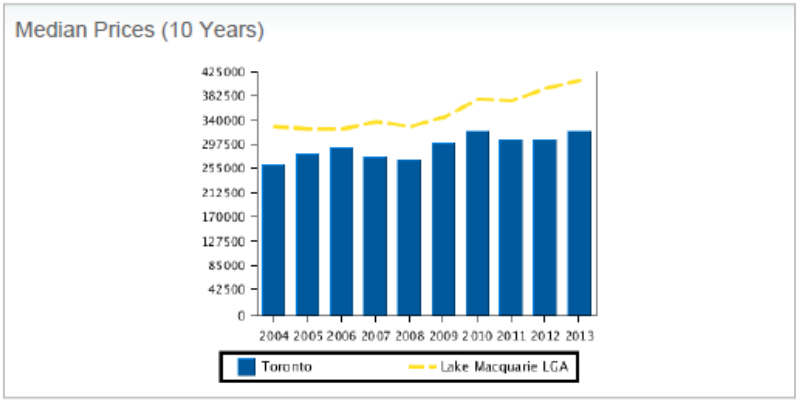
- No requirement to purchase property as a means of managing impact on social amenity.
- No impact on surrounding land use or viability.
- No significant change to the economic profile of the community except for the potential for incidental economic benefit via localised spending.
- No change to the social fabric of the area.
- No change to how residents or visitors utilise the area.

However, a ‘financial value’ can sometimes be more accurately described as an ‘intrinsic value’. An intrinsic value is the connection that a person (or family / community) has to their property or the area in general where they live (or work, visit etc.). If they see these values being threatened and the connection to the land is at risk or is broken, it is described as “… a form of homesickness one gets when one is still at home” and may detract from an individual’s sense of connection to the place and therefore represents a loss of value.

With regards to property values, general trends for the Lake Macquarie Local Government Area have, over the past 10 years, undergone growth as found in **Table 13** below.

Table 13 - Median House Prices and Trends for Suburbs Surrounding the Project Application Area

Suburb	Median House Price (November 2014)	10 Year Trend
Dora Creek	Currently the median sales price of houses in the area is $449,500	
Awaba	Currently the median sales price of houses in the area is $650,000	
Fassifern	Currently the median sales price of houses in the area is $410,000	

Blackalls Park	Currently the median sales price of houses in the area is $394,000	
Wakefield	Currently the median sales price of houses in the area is $78,000*. *Note: Insufficient sales data available for Wakefield.	
Fennell Bay	Currently the median sales price of houses in the area is $335,000.	
Toronto	Currently the median sales price of houses in the area is $295,000	

3.2.12 Train Movements

Centennial claims that the amount of train movements will remain the same, eight per day, there would need to be variance in the number of locomotives and wagons to haul the additional 5 Mtpa. (CLP148)

Northern Coal Services currently has approval through DA 73-11-98 for up to 8 trains per day to transport coal from the Newstan Colliery Surface Site. Eight trains per day are not currently utilised. The Project is seeking to utilise up to a maximum of 8 trains per day, as is currently approved, to transport coal from the Newstan Colliery Site.

Centennial Coal has at least a fleet of seven C44ACi Standard Gauge Heavy Haul Locomotives and in trials three of these locomotives could haul 50 wagons of coal from Fassifern to the Port of Newcastle. On page 205, under 8.1 Project Optimisation, projections of coal haulage could be up to 60 wagons with a maximum loading rate of 4500 tonnes per hour. This would mean another locomotive would be needed. If this is the optimum haulage to move 8 Mtpa of coal, this will have a significant impact on air quality and greenhouse gas on the residents of west Lake Macquarie. (CLP148)

In the period up until 2012, Centennial's coal was hauled from Newstan to the Port of Newcastle using around 46 wagons and 8 DC Locos of various models, 4 locos up front and 4 bank locos. The average coal hauled per loco was approximately 450t/loco.

In 2012, Centennial's own AC locos (C44ACi) were commissioned. The AC locos are quieter and significantly more fuel efficient. Around the same time the DC loco configuration was upgraded to 3,000 HP G class and 3,000 HP C class locos, which allows for a quieter configuration with no bank locos.

Currently Centennial utilises 46 wagons to haul coal between Newstan to the Port of Newcastle, with either 3 Centennial owned AC locos or 4 SSR owned DC locos. The average coal hauled per loco is approximately 1200t/loco for the Centennial owned AC locos and approximately 900t/loco for the SSR owned DC locos. As it can be seen there has been a significant improvement in the tonnes of coal that can be hauled per loco as well as individual locos are quieter and more fuel efficient.

During the Project Optimisation for the coal handling and preparation infrastructure at the Newstan Colliery Surface Site, the design was undertaken to comply with the HVCCC operational requirements for the Newstan rail loop, which includes catering for up to a maximum of 60 wagons and a maximum load rate of 4,500 tonnes per hour. If Northern Coal Services was to operate in the future at this maximum of 60 wagons, and if trials of hauling 60 wagons did indicate that 4 Centennial owned AC locos were required, the average coal hauled per Centennial owned AC locos would remain at approximately 1200t/loco.

The Northern Coal Logistics EIS assessed the transportation of 8Mtpa. The impacts due to hauling 8 Mtpa with 60 wagons and 4 AC locos should remain similar to the current haulage system of 46 wagons and 3 AC or 4 DC locos.

Making coal carriages longer and yet still uncovered, is unreasonable. (CLP185)

As detailed in Section 3.8.1 of the EIS, up to eight trains per day are approved to transport coal from the Newstan Colliery Surface Site. As is detailed in Section 4.8.1, the Project does not propose to increase the number of trains transporting coal from the Newstan Colliery Surface Site above the currently approved maximum of eight trains per day.

There are a number of contributing factors leading to particulate emissions from the transport of coal along the rail network being:

- Coal properties. The fines content and moisture content are the two coal properties likely to have the greatest influence on PM emissions. The relative dustiness of coal has been measured in terms of dust extinction moisture content (DEM) for coal. The DEM is the point at which there is sufficient moisture to prevent dust being raised from the surface.

- Train speed. Train travel speed influences the speed at which air travels across the coal surface. When this exceeds the threshold friction velocity for a particulate coal type, PM emissions will occur. Ambient wind speeds can add to this effect.

- Load profile. When wagons are loaded in an uneven manner, the surface area is increased and emission potential is greater. Load profiling creates a reduced surface area that is exposed to air flow.

- Travel distance. The emission factors used to estimate dust emissions from wagons adopted in Canada are dependent on the distance the train travels. In other words, longer distances result in higher emission estimates. The further a coal train has to travel, the greater the potential for the coal surface to dry out.

- Ambient conditions. Ambient conditions can increase the rate at which the coal surface dries, particularly in summer. Local winds can increase the speed at which air travels across the coal surface.

- Leakage through wagon doors. Leakage can occur through gaps in the wagon doors or when doors are not closed properly following unloading.

- Residual coal / carry back in unloaded wagons. Coal remaining in wagons after unloading can be lead to fugitive emissions or leakage as the train travels back to the mine. Residual coal is generally caused when coal properties (high moisture, ‘sticky’ coal) make unloading difficult.

- Spilled coal. Poor loading practices can result in coal spill on sills, shear plates and bogies of the wagons. Similarly, when unloading, ploughing can result in coal being collected on the bogie as the train moves through the unloading station.

- Spilled coal on wagons (referred to as parasitic coal) can be entrained by the wind as the train moves or can drop onto the track and become re-entrained during high winds or train pass-bys.

Northern Coal Services implements controls to minimise or prevent coal spills and dust emissions from the top of wagons during transport by maintaining the moisture content of the coal above the DEM levels. Northern Coal Services has established the DEM through the standard testing procedure as outlined in Australian Standard AS-4156.6-2000. Train coal samples indicate that the moisture content of the coal is above the DEM. In the unlikely event that additional dust suppression is required for the transport of coal via rail, then a water cart is also available to add additional moisture.

The average train speed of coal trains transporting coal along the rail networks is between 30-40 km/hour. Train speeds are already considered to be low and reducing this further is seen as exacerbating congestion issues.

The 'garden bed' load profile is not possible to be established through the current process of loading of trains at the Newstan Colliery Surface Site using a front end loader however Northern Coal Services manages the prevention of spills by under loading the wagons (i.e. not fill them to capacity) to ensure the top of the coal profile is below the wagon gunwhale (sill).

The average travel distance for coal trains from the Newstan Colliery Surface Site is a relatively short travel distance to the port when compared to the distance trains transporting coal from other mines have to travel.

On site management measures have been implemented by Northern Coal Services to reduce the risks associated with parasitic coal from train wagons leaving the Newstan Colliery Surface Site. To do this, wagons are cleaned using a water cart to remove any parasitic coal prior to the train leaving site. Training on the risks and the correct train loading procedures are provided to all staff involved in the train loading operations through regular tool box talks.

Dust from coal trains wagons is a contentious issue in the community. Ongoing research and monitoring, by both industry and government agencies has been undertaken and is providing a better understanding air quality along the coal transport corridor, particularly in the Hunter region of NSW.

Scientific studies to date have generally found that fugitive dust from coal trains is a relatively small source of ambient particulate matter (Connell Hatch, 2008; Environ, 2012; Katestone, 2013, Ryan et al 2014). While many of the scientific studies to date have found that fugitive dust from coal trains is not a significant source of ambient particulate matter, ongoing work in regards to this issue is continuing to provide a better understanding of the composition and source of particulate matter. Nevertheless, fugitive dust from coal trains remains a significant community concern and the industry is committed to identifying areas of improvement in management practices.

3.2.13 Visual

The nocturnal lighting of the mines operations are also impacting negatively. (CLP185)

A visual impact assessment has been undertaken by Green Bean Design for the Project in order to determine the likely visual significance of the Project on people living and working in, or travelling through, the surrounding landscape. A copy of the Visual Impact Assessment is provided as Appendix P to the EIS.

The Visual Impact Assessment concludes that the Project will have a negligible to low visual impact on people living in or travelling through the area. This is attributed to the following:

- The Project Application Area is located within a landscape context of sloping and ridgeline landforms with moderate to dense tree cover that will combine to result in an overall low level of visibility and a negligible to low magnitude of visual significance.

- Landform and tree cover will result in a high visual absorption capability for the existing landscape to accommodate the Project.

- The Project Application Area is not visible from more distant urban centres surrounding Lake Macquarie or major transport corridors, including the M1 Pacific Motorway.

- Transitory and short-term passenger views from the Main Northern Railway Line will be largely contained by tree cover extending along and beyond the rail corridor. Short distance views west toward Hawkmount Quarry from the rail corridor will also be screened or partially filtered by tree cover.

- There are no significant views toward the Project's surface sites and haul roads from surrounding dedicated public lookouts. Distant pubic vantage points are unlikely to be impacted by the Project.

- Distant views (i.e. in excess of 3 kilometres) toward the Project Application area are likely to be influenced by atmospheric conditions which will tend to further reduce the visibility.

- The extent and condition of existing tree cover surrounding and within the Project Application Area will also limit the potential for direct, indirect or sequential cumulative visual impacts in association with existing industrial infrastructure and/or other mining activities beyond the Project Application Area.

The Project will include additional low level intensity night lighting around some constructed elements at the Newstan Colliery Surface Site. This will include individual and directional spot lighting, and will avoid broad area or floodlighting in order to minimise the potential for "sky glow". No additional lighting is proposed to be installed at the Cooranbong Entry Site, and no lighting will be required at Hawkmount Quarry.

As committed to in Section 10.11.4 of the EIS, all new lighting associated with the upgrade of the Newstan Colliery Surface Site will be low level intensity lighting comprising individual and directional spot lighting design to minimise light spill. There will be no broad area or floodlighting, with the exception of that required for emergency maintenance and incidents.

No complaints have been received to date relating to light emissions from the Newstan Colliery Surface Site or Cooranbong Entry Site.

In regards to the potential impacts from lighting on biodiversity, the Project design will incorporate light and sound barrier walls around the proposed new coal stockpile area at the Newstan Colliery Surface Site. The installation of a wall around the proposed coal stockpile area will reduce the potential for impacts from noise and light on bat species utilising Bat Alley.

3.2.14 Water Management

LT Creek and Stony Creeks both can no longer be used as indefinite discharge points. (CLP185)

Under Centennial Newstan's current Development Consent and Environmental Protection Licence, Centennial Newstan has approved Licenced Discharge Points for LDP1 and LDP17 which enable the site to discharge water under strict licence conditions into LT Creek and Stony Creek. Discharges from these points are monitored strictly for specific pollutants as outlined within the EPL and are also required to adhere to the POEO Act 1997. Cessation of discharges would lead to significant impacts on the downstream environments that have become suited to and reliant on the discharges that have been occurring over many years.

3.3 Response to Special Interest Group Submissions

3.3.1 Air Quality

Concerns of the residents generally and of the LT Creek Sustainable Neighbourhood Group include the increase of coal dust including Total suspended particles, PM_{10} and $PM_{2.5}$. (LT Creek Sustainable Neighbourhood Group)

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment (provided as Appendix L to the EIS) which concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended Particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.
- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.
- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

Given that the nominated receptors were chosen as being indicative of all surrounding receptors, it is concluded that air quality levels as a result of the Project at other receptors in the surrounding area would also be below the relevant criterion.

The increase of 28 truck movements to 32 per hour will accumulate to an extra 96 truck movements in a 24 hour period. In regards to greenhouse gas and air quality there will still be a cumulative increase in the effects of air pollution. (LT Creek Sustainable Neighbourhood Group)

The use of the private haul road to Newstan colliery and rail haulage contribute to increased fine particulate matter in the atmosphere of the Lower Hunter. These fine particles are so injurious to human health and especially the health of children. Fine particles of dust from coal haulage by road and rail and smoke stack emissions from coal burning power stations are a major contributing factor to high levels of asthma in the population of Lake Macquarie and the Hunter

Valley. Royalties to the NSW government from coal mining will be rapidly offset by increased public health care costs. (Community Environment Network)

Dust emissions from the trucks transporting coal along the private haul roads has been considered within the air quality modelling scenarios detailed in Section 10.7.5 and presented in Table 72 of the EIS.

SLR's assessment has been completed in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (Department of Environment and Conservation (DEC) 2005). Air quality impact assessment criteria adopted by the EPA are contained in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005). These criteria are derived from a range of sources and are the defining ambient air quality criteria for NSW. They have been developed in consultation with a number of organisations, including the National Health and Medical Research Council (NHMRC), National Environment Protection Council (NEPC), World Health Organisation (WHO) and ANZECC.

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment for the Project (provided as Appendix L to the EIS) which concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended Particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.
- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.
- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

As Northern Coal Services has demonstrated it can achieve the air quality criteria adopted by the EPA and contained within the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005), no impacts to the communities health as a result of the Project are expected to occur.

A Greenhouse Gas Assessment was prepared by BDM Resources Pty Limited and provided as Appendix M to the EIS. The impacts on greenhouse gas emissions from diesel combustion as a result of trucks transporting coal along the private haul roads are considered in the Scope 1 emissions for the Project and presented in Section 10.8.2 of the EIS. The Greenhouse Gas Assessment concluded that the Project's Scope 1 and Scope 2 emissions amount to only a small proportion of the national total emission inventory with a contribution of 0.051 percent, which is considered materially insignificant. The Project's Scope 1 and Scope 2 emissions make a nominal contribution to the NSW total emission inventory at 0.175 percent. Australia's net greenhouse gas emissions account for 1.47 percent of the global emission

balance. With the Project's Scope 1 and Scope 2 emissions accounting for 0.051 percent of Australia's total emissions, it will have an undetectable effect on global climate change.

Centennial should implement additional sensitive receptors to the modelling and projections of air quality and greenhouse gas monitoring at Awaba, Blackalls Park, Fassifern, Fennell Bay, Toronto and Woodrising, with the findings reported to the Community Consultative Committee and LMCC. (LT Creek Sustainable Neighbourhood Group)

The locations of Centennial Newstan's air quality monitors are reflective of the National Environment Protection Measure (NEPM) Guidelines for setting up a monitor. The intent of the current location is to look at the impact directly from the mine. There is a lot of variability in background levels from typical sources (i.e. wood smoke and motor vehicle emissions) and it would therefore not give representative results as to the contribution from Newstan Colliery.

A Lower Hunter air quality monitoring network has been established in collaboration with the EPA, the OEH, NSW Health, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Nuclear Science and Technology Organisation (ANSTO).

This network allows for a real time air quality index that can be viewed on the EPA's website and allows the local community to view real time air quality data. A monthly report will also soon be made available on the EPA's website that will provide a monthly report written in plan English summarising and analysing available air quality data and meteorological information. The report will be published on the EPA's website and will assess the available data from monitoring stations operated by the OEH at Wyong and Wallsend and by industry at Lake Munmorah Public School, Wyee, Marks point, Dora Creek and Wakefield with the intent to provide a simplified report that is accessible and contains results that would be clearly understood to the general public.

All coal wagons should be covered. (LT Creek Sustainable Neighbourhood Group)

Covered wagons should be made a mandatory requirement for all Mining Projects. (Rathmines Progress Association)

Nothing is mentioned regarding fugitive emissions from uncovered coal wagons from the Wallarah 2 Coal Project transporting five million tons of coal per annum for 28 years or Centennial Coal transporting eight million tons of coal per annum for the next thirty years in uncovered wagons. The return trip of these empty uncovered wagons also emit fine coal particles of coal (venturi effect) to the atmosphere in our surrounding areas. (Rathmines Progress Association)

It is mentioned in this EIS that RailCorp, Australian Rail Track Corporation and Hunter Valley Coal Chain are in control of timetabling coal transport. Indeed it is possible that other collieries may transfer their coal via Port Kembla if delay time to Port Newcastle became unacceptable. This would result in more uncovered coal wagons travelling through our area. (Rathmines Progress Association)

This project applies for a combined total increase (from 4 million tonnes to 8 million tonnes per annum) for shipping from Newcastle or Port Kembla. All the rail trips will originate from the Newstan train loading loop, these additional movements double the risk of coal dust to the

suburban communities of Lake Macquarie, Newcastle, Sydney Metropolitan Area and communities to the south to Port Kembla. (Rathmines Progress Association)

Due to the large increase in coal operations and transportation of coal by the Project we submit the social implications for the planned increases of transportation of coal in uncovered wagons venting fines into the atmosphere in Lake Macquarie coupled with the double whammy of increased coal ash fallout by Eraring Power station in our areas is completely unacceptable. (Rathmines Progress Association)

There are a number of contributing factors leading to particulate emissions from the transport of coal along the rail network being:

- Coal properties. The fines content and moisture content are the two coal properties likely to have the greatest influence on PM emissions. The relative dustiness of coal has been measured in terms of dust extinction moisture content (DEM) for coal. The DEM is the point at which there is sufficient moisture to prevent dust being raised from the surface.

- Train speed. Train travel speed influences the speed at which air travels across the coal surface. When this exceeds the threshold friction velocity for a particulate coal type, PM emissions will occur. Ambient wind speeds can add to this effect.

- Load profile. When wagons are loaded in an uneven manner, the surface area is increased and emission potential is greater. Load profiling creates a reduced surface area that is exposed to air flow.

- Travel distance. The emission factors used to estimate dust emissions from wagons adopted in Canada are dependent on the distance the train travels. In other words, longer distances result in higher emission estimates. The further a coal train has to travel, the greater the potential for the coal surface to dry out.

- Ambient conditions. Ambient conditions can increase the rate at which the coal surface dries, particularly in summer. Local winds can increase the speed at which air travels across the coal surface.

- Leakage through wagon doors. Leakage can occur through gaps in the wagon doors or when doors are not closed properly following unloading.

- Residual coal / carry back in unloaded wagons. Coal remaining in wagons after unloading can be lead to fugitive emissions or leakage as the train travels back to the mine. Residual coal is generally caused when coal properties (high moisture, ‘sticky’ coal) make unloading difficult.

- Spilled coal. Poor loading practices can result in coal spill on sills, shear plates and bogies of the wagons. Similarly, when unloading, ploughing can result in coal being collected on the bogie as the train moves through the unloading station.

- Spilled coal on wagons (referred to as parasitic coal) can be entrained by the wind as the train moves or can drop onto the track and become re-entrained during high winds or train pass-bys.

Northern Coal Services implements controls to minimise or prevent coal spills and dust emissions from the top of wagons during transport by maintaining the moisture content of the coal above the DEM levels. Northern Coal Services has established the DEM through the standard testing procedure as outlined in Australian Standard AS-4156.6-2000. Train coal samples indicate that the moisture content of the coal is above the DEM. In the unlikely event that additional dust suppression is required for the transport of coal via rail, then a water cart is also available to add additional moisture.

The average train speed of coal trains transporting coal along the rail networks is between 30-40 km/hour. Train speeds are already considered to be low and reducing this further is seen as exacerbating congestion issues.

The 'garden bed' load profile is not possible to be established through the current process of loading of trains at the Newstan Colliery Surface Site using a front end loader however Northern Coal Services manages the prevention of spills by under loading the wagons (i.e. not fill them to capacity) to ensure the top of the coal profile is below the wagon gunwhale (sill).

The average travel distance for coal trains from the Newstan Colliery Surface Site is a relatively short travel distance to the port when compared to the distance trains transporting coal from other mines have to travel.

On site management measures have been implemented by Northern Coal Services to reduce the risks associated with parasitic coal from train wagons leaving the Newstan Colliery Surface Site. To do this, wagons are cleaned using a water cart to remove any parasitic coal prior to the train leaving site. Training on the risks and the correct train loading procedures are provided to all staff involved in the train loading operations through regular tool box talks.

Dust from coal trains wagons is a contentious issue in the community. Ongoing research and monitoring, by both industry and government agencies has been undertaken and is providing a better understanding air quality along the coal transport corridor, particularly in the Hunter region of NSW.

Scientific studies to date have generally found that fugitive dust from coal trains is a relatively small source of ambient particulate matter (Connell Hatch, 2008; Environ, 2012; Katestone, 2013, Ryan et al 2014). While many of the scientific studies to date have found that fugitive dust from coal trains is not a significant source of ambient particulate matter, ongoing work in regards to this issue is continuing to provide a better understanding of the composition and source of particulate matter. Nevertheless, fugitive dust from coal trains remains a significant community concern and the industry is committed to identifying areas of improvement in management practices. At this stage however, covering coal train wagons is not considered as being a feasible solution to manage impacts from coal trains transporting coal from the Newstan Colliery Surface Site

Centennial should dedicate to research into $PM_{2.5}$, its distribution and fall out, as well as the health effects of this particulate matter on the population. (LT Creek Sustainable Neighbourhood Group)

On-site ambient $PM_{2.5}$ monitoring has been performed at the Newstan Colliery Surface Site since September 2011 using a co-located High Volume Air Sampler (HVAS) with Total Suspended Particulate (TSP) and PM_{10}. The average PM 24 hour levels recorded at HVAS 1 is 7.6 µg/m^3 and the and average PM 24 hour levels recorded at HVAS 2 over this period is 9.5 µg/m^3.

Although there have been some exceedances of the PM24 hour average criteria, it is noted that the monitored $PM_{2.5}$ concentrations at Newstan Colliery Surface Site includes contributions from existing activities at Newstan Colliery Surface Site as well as other industrial facilities in the region. The average results are well below the criteria of 25 µg/m^3.

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment for the Project (provided as Appendix L to the EIS) which concludes:

- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios; and

- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

Northern Coal Services do not consider any additional contribution to research into $PM_{2.5}$ distribution, fall out or health effects as a result of its operations are considered necessary.

As detailed in Section 10.7.7 of the EIS, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site. The existing air quality monitoring programme is considered sufficient to identify impacts, manage operations and confirm compliance with the air quality standards for the Project.

Centennial should assess air quality impacts associated with emission products of combustion from vehicle engines. This was not carried out by the consultants. (LT Creek Sustainable Neighbourhood Group)

As detailed in Section 2.4 of the Air Quality Impact Assessment provided as Appendix L to the EIS, It was considered appropriate to assume that the emissions due to combustion of fuel in vehicle engines on site will be negligible compared to the existing background levels. Background traffic volumes in the vicinity surrounding the Project Application Area are far greater than the increase in heavy vehicle traffic generation proposed as a result of the Project. As such, the emission products of combustion from vehicle engines were not considered further in the assessment.

It is noted in this EIS that the only EPA independent monitored sites are at Newcastle, Wallsend and Beresfield a distance of approximately 17.5 km, 12.5 km and 22 km respectively from Newstan Mine. Our Association believes such distances from independent monitored EPA sites are too great to properly reflect our local areas. (Rathmines Progress Association)

As detailed in Section 7.3 of the Air Quality impact Assessment provided as Appendix L to the EIS, particulate data (PM_{10} and $PM_{2.5}$) from three NSW EPA air quality monitoring stations were obtained to assist in the determination of the background particulate environment excluding the impacts of power stations and Project-related sources. Data for the years 2006, 2007, 2008, 2009 and 2010 was obtained for Newcastle, Beresfield and Wallsend.

The analysis undertaken of the data from these three stations is presented in Section 7.3 of the Air Quality Impact Assessment and indicate that in general, higher concentrations of PM_{10} and $PM_{2.5}$ are measured at Beresfield when compared with Wallsend. Also, higher concentrations of PM_{10} are measured at Newcastle when compared with Wallsend.

This is unsurprising given the location of the Newcastle site in an urban location, with a not insignificant contribution to particulate concentrations from vehicle traffic and industrial sources located in the area. The Beresfield station is also located near to a major road and the influence from vehicle traffic in the particulate monitoring record will be observed.

Data from the Wallsend station shows lower maximum concentrations and lower annual average particulate concentrations than the other two sites in the area. The Wallsend station is located approximately 9 km from the urban centre of Newcastle and although it will experience some contribution from vehicle traffic, the impact will not be as significant as that experienced within Newcastle. Additionally, impacts from industry will be markedly lower at Wallsend.

Based on the statistical analysis and discussion of the particulate monitoring data for the three stations, it was concluded that the use of the Wallsend PM_{10} and $PM_{2.5}$ data as a "regional background" dataset is appropriate and valid. The prevailing air quality conditions experienced in the area surrounding the Project site (not considering the effects of nearby power stations or Project activities) is expected to be most similar to those experienced at Wallsend.

The use of this data is considered appropriate for determining ambient air quality data for use in the modelling required to assess the impacts as a result of the proposed Project.

It states on page 307 of this EIS "limited research has been undertaken to assess the fraction of PM_{10} from a wide range of sources which would be emitted as $PM_{2.5}$ and as such, publicly available emission rates for $PM_{2.5}$ are not available". Given the lack of reliable evidence they adopted an eight year old document, namely "Fugitive Dust Emission Factors MRI dated 2006" to calculate the emission rates for $PM_{2.5}$. (Rathmines Progress Association)

On-site ambient $PM_{2.5}$ monitoring has been performed at the Newstan Colliery Surface Site since September 2011 using a co-located High Volume Air Sampler (HVAS) with Total Suspended particulate (TSP) and PM_{10}. The average PM 24 hour levels recorded at HVAS 1 is 7.6 $\mu g/m^3$ and the and average PM 24 hour levels recorded at HVAS 2 over this period is 9.5 $\mu g/m^3$.

As the monitoring data was measured on a 1-in-6-day cycle, it is not suitable for use in a contemporaneous cumulative impact analysis. No emission factors for $PM_{2.5}$ are provided within the NPI EETM for Mining and only limited emission factors for $PM_{2.5}$ are provided in US EPA AP 42. As such, SLR Consulting Pty Limited (SLR) relied on published research information conducted by the Midwest Research Institute (MRI) on behalf of the Western Regional Air Partnership (WRAP) with findings published within the document entitled 'Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors' (MRI 2006). The use of this information to calculate $PM_{2.5}$ articulate emissions are considered appropriate for the Project.

3.3.2 Biodiversity

Parcels of land should be offset into the Awaba Conservation Area for the conservation and protection of biological diversity and ecological integrity. (LT Creek Sustainable Neighbourhood Group)

The Project does not propose any direct offsets. Lots 88-93 within Deposited Plan 755218 are Crown land over which Centennial Newstan holds Consolidated Coal Lease (CCL) 746. The Department of Primary Industries – Crown Lands Division is responsible for the management of these parcels of land. Northern Coal Services do not support land being secured into a State Conservation Area where potential coal reserves could become sterilised and the land use is inconsistent with existing mining approvals and mining titles.

The RPS ecological assessment undertook ultrasonic bat detection adjacent to the shaft; however this occurred in May, with night temperatures going down as low as eight Degrees Celsius. Ultrasonic surveys under these conditions are not adequate for any bat species, in particular adjacent to a potentially important bat roost. Eight harp traps nights are also inconsistent with the federal guidelines for bat surveys, which specify a minimum survey effort of 20 harp trap nights. (LT Creek Sustainable Neighbourhood Group)

Potential inadequacy of the 30 metre buffer around Bat Alley. (LT Creek Sustainable Neighbourhood Group)

An active bat roost cave, in the form of a disused mine shaft (Bat Alley), is known to occur within close proximity to Site 1. Two harp traps were placed in front of the main cave roost entrance (drift entrance) along a track to the north of Site 1 over four consecutive nights. Traps were checked early each morning, with any captured bats identified and released at point of capture. The location of each trap line is shown on Figure 2.

A total of eight harp trap nights were undertaken within Site 1 during surveys.

A monitoring program was undertaken at Bat Alley to monitor microbat species presence and to assess any likely impacts as a result of the Project.

Microbat echolocation calls were recorded using two Anabat II Detector and CF ZCAIM units set to remotely record for the entire night (6pm to 6am). Two Anabats were placed within close proximity to Bat Alley to the north of Site 1 over four nights in May 2012, resulting in eight nights of bat call recording. Site 1 had four consecutive nights of sampling, with emphasis placed on those areas deemed likely to provide potential foraging and flyway sites for microbats. Bat call analysis was undertaken by Anna McConville who is experienced in the analysis of bat echolocation calls.

Four additional surveys were undertaken by RPS Australia East Pty Limited (RPS) and Glenn Hoye of Fly by Night Bat Surveys Pty Ltd on:

- The evenings of the 30th and 31st August 2012
- The evenings of the 5th and 6th December 2012
- The evening of the 18th January 2013; and
- The evenings of the 11th and 13th March 2013.

Surveys were undertaken using harp traps, visual inspections, anabat detections and video camera with infrared nightlight.

The number of bats recorded utilising the site were much lower than that indicative of a maternity roost being present within the workings, suggesting that the workings are not being used for breeding. Additional information regarding these surveys and the conclusions of them has been included in Section 3.4.4 and Section 4.4.4.1 of the revised Flora and Fauna Impact Assessment provided as **Appendix 7** to this RTS.

In order to minimise the potential for impact on bat species utilising the site as a roosting area, an exclusion or non-disturbance zone has been incorporated into the design of the surface disturbance area for Site 1 around Bat Alley to maintain a buffer of vegetation around the disused mine drift entrance and to reduce the potential for direct impacts on bat species utilising this site. The buffer will maintain connectivity with surrounding vegetation and not impact on the foraging ability of bats utilising Bat Alley as a roost. This is consistent with advice sought from RPS. Additionally, the Project design will

incorporate light and sound barrier walls around the proposed ROM coal stockpile in this locality. The installation of a wall around the proposed coal stockpile area at Site 1 will reduce the potential for impacts from noise and light on bat species utilising Bat Alley.

Jigadee Estate, 1174 Freemans Drive Cooranbong, should be a point of operation for the research projects as it is owned by Centennial Coal and is known to have significant biodiversity and a number of threatened species including Tetratheca juncea on site. (LT Creek Sustainable Neighbourhood Group)

As detailed in Section 10.4.9 of the EIS, Northern Coal Services will commit to fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of Tetratheca juncea from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of Tetratheca juncea. The proposed research programme has been developed with a focus on addressing the priority actions identified by OEH and DotE for Tetratheca juncea as part of this species Recovery Plan. Details of the research programme including monitoring locations to be established will be determined during the research programmes scoping phase. Monitoring locations will be based on sites that provide benefit to the research proposal and assist in providing outcomes consistent with the purpose of the research programme.

3.3.3 Climate Change

Climate change science predicts accelerated global warming if global dependency on fossil fuels such as coal continues. (Community Environment Network)

The expansion planned for Cooranbong and Newstan Collieries will only contribute further to climate change and global warming. (Community Environment Network)

Expansion of rail loading facilities will increase the tonnage of coal exported and further increase the consumption of fossil fuels overseas. The increased emissions of CO2 will result in further global atmospheric warming. (Community Environment Network)

A Greenhouse Gas Assessment was prepared by BDM Resources Pty Limited and provided as Appendix M to the EIS. The Greenhouse Gas Assessment concluded that the Project's Scope 1 and Scope 2 emissions amount to only a small proportion of the national total emission inventory with a contribution of 0.051 percent, which is considered materially insignificant. The Project's Scope 1 and Scope 2 emissions make a nominal contribution to the NSW total emission inventory at 0.175 percent. Australia's net greenhouse gas emissions account for 1.47 percent of the global emission balance. With the Project's Scope 1 and Scope 2 emissions accounting for 0.051 percent of Australia's total emissions, it will have an undetectable effect on global climate change.

3.3.4 Consultation

Centennial should closely monitor and communicate their progress and findings to the Community Consultative Committee, LT Creek Sustainable Neighbourhood Group, LMCC and OEH in regards to:

1. the nesting box program

2. the Tetratheca juncea translocation research project

3. the development and implementation of the research project investigating genetic patterns among and within the populations of Tetratheca juncea. (LT Creek Sustainable Neighbourhood Group)

Northern Coal Services will provide updates on the research and monitoring programmes to the Community Consultative Committees and report on the results annually within the Annual Environmental Management Report which is distribute to various government agencies and also publically available on the Centennial Coal website (www.centennialcoal.com.au). The LT Creek Sustainable Neighbourhood Group is represented on the Newstan Community Consultative Committee.

3.3.5 Economic

NSW is experiencing a reduced demand for electricity sourced from coal fired power stations such as Earing. As a member of Eraring Power Station Community Forum, Community Environment Network was made aware of this downward trend - which is likely to continue in the foreseeable future – thus reducing its overall demands for coal from the Mandalong and Newstan mine. (Community Environment Network)

Further uptake of renewable forms of energy in Australia and globally will continue to reduce the total demand for coal thus reducing the need to continue and expand coal production at the proposed sites.

Home owners and businesses are responding to climate change with increased uptake of renewable sources of energy. Global demand for coal is weakening. The local and global community increasingly supports the move to renewable energy both privately and publicly. Community Environment Network strongly urges the NSW government to withhold consent to the upgrades of surface sites at the Newstan and Mandalong coal mines and to focus strongly on facilitating the switch from dirty fossil fuels to clean renewable sources of energy such as solar and wind.

Coal mining in Australia is still warranted as the electricity generation industry remains heavily reliant on coal-fuelled generation. Recent research by Pitt & Sherry (2014) demonstrate that black coal demand for electricity generation has been declining in recent years while alternative fuel sources such as gas, wind and other renewable have been on the rise. However, their research shows that to date black coal is still the highest fuel source used for electricity generation, and they provide the following statistics:

‘Shares of total generation in the year ended June 2014 were black coal 50.7%, brown coal 22.3%, gas 12.7%, hydro 9.6% and wind 4.7%. These are the lowest shares of both black and brown coal, and the highest shares of wind, since Cedex® data starts in 2006, and in fact, almost certainly ever’.

The observations of Pitt and Sherry (2014) are supported by data from the Australian Bureau of Statistics (ABS). **Figure 2** provides data on electricity generation by fuel type for the period 2011/2012, and shows that coal represents the highest fuel source for electricity generation in the period 2011/2012. Approximately 65% of the total electricity generated in Australia was from coal while natural gas provided approximately 23% of the total demand. In comparison the combined renewable fuel sources met less than 10% of Australia's fuel source demand for electricity generation.

While it can be anticipated, based on research by Pitt and Sherry (2014), that use of alternative and renewable sources will continue to increase, the transition to a point where these sources supplant coal as the predominant fuel source in the future will clearly take a significant period of time. This is especially the case given the availability of coal resources, the simplistic methods of mining of coal and conversion to electricity compared to renewables, and the extensive investment already sunk into coal-fired generation capacity in Australia.

3.3.6 General

The State government should move away from giving consent to projects that are environmentally and/or socially damaging. The NSW government should be supporting the development of renewable energy sources such as solar and wind. The proposed development seeks to expedite further mining of coal which is one of the most polluting sources of energy and proven to be injurious to public health especially that of children. (Community Environment Network)

The Project is designed to provide flexibility to Northern Coal Services in distributing its coal products from the Newstan Colliery Surface Site and Cooranbong Entry Site into various domestic and export markets in order to meet changing market conditions and contractual requirements into the future.

An Environmental Impact Statement has been prepared which has assessed the impacts of the project on all environmental and social aspects. As part of the EIS, an Air Quality Impact Assessment was prepared by SLR to support the Project and provided as Appendix L to the EIS. The Air Quality Impact Assessment was completed in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (Department of Environment and Conservation (DEC) 2005). Air quality impact assessment criteria adopted by the EPA are contained in the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005). These criteria are derived from a range of sources and are the defining ambient air quality criteria for NSW. They have been developed in consultation with a number of organisations, including the National Health and Medical Research Council (NHMRC), National Environment Protection Council (NEPC), World Health Organisation (WHO) and ANZECC.

Northern Coal Services has demonstrated it can achieve the air quality criteria adopted by the EPA and contained within the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC 2005), no impacts to the communities health as a result of the Project are expected to occur.

Coal mining in Australia is still warranted as the electricity generation industry remains heavily reliant on coal-fuelled generation. Recent research by Pitt & Sherry (2014) demonstrate that black coal demand for electricity generation has been declining in recent years while alternative fuel sources such as gas, wind and other renewable have been on the rise. However, their research shows that to date black coal is still the highest fuel source used for electricity generation. While it can be anticipated, based on research by Pitt and Sherry (2014), that use of alternative and renewable sources will continue to increase, the transition to a point where these sources supplant coal as the predominant fuel source in the future will clearly take a significant period of time. This is especially the case given the availability of coal resources,

the simplistic methods of mining of coal and conversion to electricity compared to renewables, and the extensive investment already sunk into coal-fired generation capacity in Australia.

3.3.7 Infrastructure

Under the existing approval for Newstan, the train loading system is to be automated when export exceeds 3 Mtpa. This condition should remain the same. (LT Creek Sustainable Neighbourhood Group)

The high readings at Fassifern Public School are of concern. Centennial Coal proposes to automate coal transfers at 6 million tonnes per annum. Considering the current high readings we suggest they should advance their automation schedule. (Rathmines Progress Association)

SLR Consulting Pty Limited (SLR) prepared an Air Quality Impact Assessment for Project (provided as Appendix L to the EIS). In order to assess the worst case impacts from the Project, SLR modelled a total of 10 different operational scenarios:

- Eight scenarios associated with the operations at the Newstan Colliery Surface Site; and
- Two scenarios associated with the operations at the Cooranbong Entry Site.

A description of the scenarios assessed for the Cooranbong Entry Site and Newstan Colliery Surface Site is provided in Tables 71 and 72 of the EIS respectively. SLR's Air Quality Impact Assessment for the Project concludes:

- The annual average deposited dust concentrations are unlikely to exceed the criteria at any of the identified sensitive receptors for all modelled scenarios.
- The annual average Total Suspended Particulate (TSP) concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.
- The annual average $PM_{2.5}$ concentrations are unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios.
- The 24-hour average PM_{10} concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations are likely to exceed the criterion for three of the modelled scenarios at NC6 (Fassifern Public School) for the Newstan Colliery Surface Site.
- Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved.
- The 24-hour average $PM_{2.5}$ concentrations are unlikely to exceed the criterion at any of the identified sensitive receptors for all modelled scenarios.

An automatic train loading facility will be installed to meet operational efficiencies which will subsequently result in the air quality criteria being achieved for the life of the Project. Consent conditions on handling, processing or export volumes on when an automatic train loading facility is to be installed is not required to ensure compliance with the air quality criteria.

Northern Coal Services will continue to implement the dust management practices to minimise the impacts on air quality as a result of the Projects operations. Automation of operations at the Newstan Colliery Surface Site, implemented as required to meet operational efficiencies, will result in the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site being achieved. Additionally, Northern Coal Services will continue the existing air quality monitoring program at Newstan Colliery Surface Site and Cooranbong Entry Site.

3.3.8 Noise

EIS Appendix N - Noise - Section 3.6.4 Private Haul Roads - the study refers to road traffic noise assessments at the Newstan Surface Site and Cooranbong Entry Site however does not adequately consider the Newstan-Eraring Haul Roads other than to indicate it is a sealed road with drainage. There is no cumulative assessment of noise due to the increased number of vehicle movements and co-incidental movements which may impact on local receptors. (Origin Energy)

A Noise Impact Assessment was undertaken by SLR Consulting Pty Limited (SLR) to support the Project and provided as Appendix N to the EIS. The Noise Impact Assessment considered 6 operating scenarios for the Newstan Colliery Surface Site which incorporated the utilisation of heavy vehicle movements along the entire private haul road network. As presented in Table 42 of the Noise Impact Assessment, Scenario 1 (the existing Scenario) considered the operation of up to 28 two way vehicle movements at any point along the haul road network in a one hour period as is currently approved. Scenarios 2 to 6 considered the proposed increase to 32 two way heavy vehicle movements along the private haul road network at any point.

As detailed in Section 10.9.4 of the EIS, Northern Coal Services has adopted a fleet of haulage trucks that are designed to meet European E5 Standards and are typically quieter than standard haulage trucks used on public roads.

The noise mitigation and management measures implemented for the private haul roads are:

- All haul truck operating meet and pass European E5 standards;
- All haul trucks meet and surpass Australian Design Rules (ADR) standards in terms of exhaust and engine braking noise;
- All haul truck engine braking systems are controlled by an electronic control unit (ECU), so braking system only operates when required reducing unwanted noise from the engine brake;
- The haul trucks are speed limited to 85 kilometres per hour;
- Air bag suspension is fitted to all haul truck trailers and dollys;
- Tread design on tyres used for all trailers is designed to reduce road rolling noise when traveling;

- The haul roads are all fully sealed;
- The loading of haul trucks is staggered to prevent bunching on the haul roads; and
- Road deformation inspections are undertaken every 12 months.

The noise modelling undertaken by SLR as part of the Noise Impact Assessment predict that once the mitigation works currently being implemented for the existing CPP and transfer tower are completed at the Newstan Colliery Surface Site, only a 2 dBA exceedance is predicted during night time temperature inversions at NC3. With the mitigation and management measure implemented as detailed in Section 10.9.6 of the EIS, compliance with the project specific noise criteria at all other sensitive receivers surrounding the Project Application Area is predicted to be achieved.

As detailed in Section 10.9.6 of the EIS, a real-time noise monitor has been installed at the Cooranbong Entry Site, and Northern Coal Services will complete the installation of a real-time noise monitor at the Newstan Colliery Surface. When noise levels from either site are identified as approaching the project-specific noise criteria, a review of operations will be undertaken and adaptive management measures implemented to ensure noise levels are maintained below the below the relevant criteria.

3.3.9 Social

The Social Impact Assessment fails to take into consideration the suburb of Fennell Bay in its assessment and statistical analysis, thus not giving an accurate representation of the community. (LT Creek Sustainable Neighbourhood Group)

When undertaking a Social Impact Assessment, the initial scoping exercise will include the collection of a demographic and population profile for all areas surrounding the Project Application Area which includes (but is not limited to) Fennell Bay and Toronto. However, a full demographic and population profile is not always incorporated into the final Social Impact Assessment when:

- the demographic and population characteristics will not change;
- inclusion of all information can be lengthy and not necessarily add value to the determination of social impact;
- information about the area's demographic and population profile is readily available to the public (this information is available on Council's website and via the Australian Bureau of Statistics); and
- the Project has a comprehensive profile of the area, available in its Stakeholder Engagement Plan.

What is included in the Social Impact Assessment is information relevant to the potential areas of affectation, determined by the Project description and findings of other specialist consultant's reports (in particular air quality, noise, visual, water quality).

The Social Impact Assessment fails to acknowledge in its summary of air quality modelling and projections that NC6, Fassifern Public School may have exceedences of PM_{10}, depending on the scenario. (LT Creek Sustainable Neighbourhood Group)

The Social Impact Assessment considered all scenarios modelled in the Air Quality Impact Assessment prepared by SLR Consulting Pty Limited (SLR). As stated in the SLR report and referred to in the Social Impact Assessment, all air quality criterion can be achieved at all sensitive receptors (which includes Fassifern Public School: NC6) around the Newstan surface facility when coal transfers and rail loading is automated which will be implemented as required to achieve operational efficiencies.

3.3.10 Traffic

EIS Appendix 0 - Traffic- Section 7.3 Internal Coal Transport- the study does not adequately address the impacts both directly in relation to the users of the Private Haul Road or in fact any potential external effects such as additional noise, additional luminous pollution during hours of darkness and the additional interaction with local subsidence areas. (Origin Energy)

A Noise Impact Assessment was undertaken by SLR Consulting Pty Limited (SLR) to support the Project and provided as Appendix O to the EIS. The Noise Impact Assessment considered 6 operating scenarios for the Newstan Colliery Surface Site which incorporated the utilisation of heavy vehicle movements along the entire private haul road network. As presented in Table 42 of the Noise Impact Assessment, Scenario 1 (the existing Scenario) considered the operation of up to 28 two way vehicle movements at any point along the haul road network in a one hour period as is currently approved. Scenarios 2 to 6 considered the proposed increase to 32 two way heavy vehicle movements along the private haul road network at any point.

As detailed in Section 10.9.4 of the EIS, Northern Coal Services has adopted a fleet of haulage trucks that are designed to meet European E5 Standards and are typically quieter than standard haulage trucks used on public roads.

The noise mitigation and management measures implemented for the private haul roads are:

- All haul truck operating meet and pass European E5 standards;
- All haul trucks meet and surpass Australian Design Rules (ADR) standards in terms of exhaust and engine braking noise;
- All haul truck engine braking systems are controlled by an electronic control unit (ECU), so braking system only operates when required reducing unwanted noise from the engine brake;
- The haul trucks are speed limited to 85 kilometres per hour;
- Air bag suspension is fitted to all haul truck trailers and dollys;
- Tread design on tyres used for all trailers is designed to reduce road rolling noise when traveling;
- The haul roads are all fully sealed;
- The loading of haul trucks is staggered to prevent bunching on the haul roads; and
- Road deformation inspections are undertaken every 12 months.

The noise modelling undertaken by SLR as part of the Noise Impact Assessment predict that once the mitigation works currently being implemented for the existing CPP and transfer tower are completed at the Newstan Colliery Surface Site, only a 2 dBA exceedance is predicted during night time temperature

inversions at NC3. With the mitigation and management measure implemented as detailed in Section 10.9.6 of the EIS, compliance with the project specific noise criteria at all other sensitive receivers surrounding the Project Application Area is predicted to be achieved.

As detailed in Section 10.9.6 of the EIS, a real-time noise monitor has been installed at the Cooranbong Entry Site, and Northern Coal Services will complete the installation of a real-time noise monitor at the Newstan Colliery Surface. When noise levels from either site are identified as approaching the project-specific noise criteria, a review of operations will be undertaken and adaptive management measures implemented to ensure noise levels are maintained below the below the relevant criteria.

The visual Impact Assessment prepared by green bean Design and provided as Appendix P to the EIS considered visual impacts from the entire Project Application Area on sensitive receptors including the private haul roads. A visual assessment of impacts from the Newstan-Eraring private haul road is presented in Section 7.6 of the Visual Impact Assessment. The Visual Impact Assessment concluded that the operation of the Newstan-Eraring private haul road would result in no discernible deterioration in the existing view and impacts would be negligible.

No complaints have been received by Centennial in relation to visual impacts associated with haul truck movements along private haul roads in the past. It is unlikely the additional truck movements would result in any significant impacts above those currently experienced.

Visual inspections of the haul road are undertaken by Northern Coal Services and where road deterioration is identified as a result of vehicle movements, repairs are undertaken in consultation with Origin Energy.

3.3.11 Train Movements

Centennial claims that the amount of train movements will remain the same, eight per day, there would need to be variance in the number of locomotives and wagons to haul the additional 5 Mtpa. (LT Creek Sustainable Neighbourhood Group)

Northern Coal Services currently has approval through DA 73-11-98 for up to 8 trains per day to transport coal from the Newstan Colliery Surface Site. Eight trains per day are not currently utilised. The Project is seeking to utilise up to a maximum of 8 trains per day, as is currently approved, to transport coal from the Newstan Colliery Surface Site.

Centennial Coal has at least a fleet of seven C44ACi Standard Gauge Heavy Haul Locomotives and in trials three of these locomotives could haul 50 wagons of coal from Fassifern to the Port of Newcastle. On page 205, under 8.1 Project Optimisation, projections of coal haulage could be up to 60 wagons with a maximum loading rate of 4500 tonnes per hour. This would mean another locomotive would be needed. If this is the optimum haulage to move 8 Mtpa of coal, this will have a significant impact on air quality and greenhouse gas on the residents of west Lake Macquarie. (LT Creek Sustainable Neighbourhood Group)

In the period up until 2012, Centennial's coal was hauled from Newstan to the Port of Newcastle using around 46 wagons and 8 DC Locos of various models, 4 locos up front and 4 bank locos. The average coal hauled per loco was approximately 450t/loco.

In 2012, Centennial's own AC locos (C44ACi) were commissioned. The AC locos are quieter and significantly more fuel efficient. Around the same time the DC loco configuration was upgraded to 3,000 HP G class and 3,000 HP C class locos, which allows for a quieter configuration with no bank locos.

Currently Centennial utilises 46 wagons to haul coal between Newstan to the Port of Newcastle, with either 3 Centennial owned AC locos or 4 SSR owned DC locos. The average coal hauled per loco is approximately 1200t/loco for the Centennial owned AC locos and approximately 900t/loco for the SSR owned DC locos. As it can be seen there has been a significant improvement in the tonnes of coal that can be hauled per loco as well as individual locos are quieter and more fuel efficient.

During the Project Optimisation for the coal handling and preparation infrastructure at the Newstan Colliery Surface Site, the design was undertaken to comply with the HVCCC operational requirements for the Newstan rail loop, which includes catering for up to a maximum of 60 wagons and a maximum load rate of 4,500 tonnes per hour. If Northern Coal Services was to operate in the future at this maximum of 60 wagons, and if trials of hauling 60 wagons did indicate that 4 Centennial owned AC locos were required, the average coal hauled per Centennial owned AC locos would remain at approximately 1200t/loco.

The Northern Coal Logistics EIS assessed the transportation of 8Mtpa. The impacts due to hauling 8 Mtpa with 60 wagons and 4 AC locos should remain similar to the current haulage system of 46 wagons and 3 AC or 4 DC locos.

There is discrepancies in the Project EIS and the Wallarah No. 2 Project regarding the number of trains from the Wallarah No. 2 Project. (Rathmines Progress Association)

Regardless of the number of trains proposed to utilise the rail network, there is a finite number of paths available to be utilised. Timetabling of coal trains on the rail line is controlled by Transport for NSW, Australian Rail Track Corporation and Hunter Valley Coal Chain Coordinator. Access to available rail paths for coal trains is undertaken in consultation with all these stakeholders. As such, Northern Coal Services has no control over the timetabling of the coal trains generated by the Project.

3.3.12 Visual

EIS Appendix P - Visual - Sections 5.4 - Private Haul Roads and Section 7. 9 - Night Time Lighting do not address the additional or cumulative impacts of additional haul truck movement lighting. (Origin Energy)

The visual Impact Assessment prepared by green bean Design and provided as Appendix P to the EIS considered visual impacts from the entire Project Application Area on sensitive receptors including the private haul roads. A visual assessment of impacts from the Newstan-Eraring private haul road is presented in Section 7.6 of the Visual Impact Assessment. The Visual Impact Assessment concluded that

the operation of the Newstan-Eraring private haul road would result in no discernible deterioration in the existing view from sensitive receptors and impacts would be negligible.

No complaints have been received by Centennial in relation to visual impacts associated with haul truck movements along private haul roads in the past. It is unlikely the additional truck movements would result in any significant impacts above those currently experienced.

3.4 Response to Positive Submissions

The Northern Coal Logistics received a total of 218 submissions from the public and special interest groups.

The distribution of the public submissions is:

- Support: 95%
- Object:4%
- Comments:1%

The distribution of the Special Interest Group submissions is:

- Support:84%
- Object:3%
- Comments:13%

The source of the person / group making the positive submissions came from the following Local Government Areas:

- Lake Macquarie: 48%
- Newcastle: 24%
- Central Coast: 12%
- Cessnock:: 7%
- Maitland: 6%
- Port Stephens: 2%
- Other: 1%

The analysis of all positive submissions found the following key themes:

Theme	% of Submissions	Comments
Positive Employment Impact	32	Strong messages that jobs and job security is required. Concern about the decline in the minerals / energy sector and reduced opportunities for jobs in the region. Centennial Coal is a large employer both directly and indirectly and ongoing employment and job security is important for families. Approval of the Project shows confidence in the sector and will support other Centennial projects therefore increasing employment opportunities.

Theme	% of Submissions	Comments
		Investment in this project gives confidence in the re-opening of Newstan.
Support to Local Business	22	Flow-on effects to other business including; • contractors who support the mining industry and also invest in their own employment, training and research and development; • the energy supply chain is local and people are mindful of the direct correlation between both industries; • spending of wages and participation in events in the local community is vital to the wellbeing of the community.
Benefit of Local Spending	11	The benefit of secure employment for families who invest in the financial and social economy of the place where they live. This includes investment in housing, education, supporting their local community through local spending, participation in community events and activities. People are connected to their community through these activities and employment is identified as a key driver for these benefits. All local businesses benefit through spending of wages.
Sponsorship	9	Centennial Coal is recognised as being a major sponsor (both financially and in-kind) of local community events, charities and projects. Centennial Coal provided over $80,000 to 44 groups in the 2013 – 2014 financial year.
Environmental Performance	9	The environmental performance of the project was recognised and environmental performance is important to local residents who enjoy the key features such as Lake Macquarie and the recreation areas throughout the coast and region. The investment made in the water treatment facility at Newstan and VAM RAB at Mandalong is seen as evidence to the commitment to environmental performance.
Operational	8	Centennial is committed to utilising private haul roads and rail for the transportation of coal meaning that local road networks are safer. The use and upgrade of existing infrastructure is seen as being positive.
Family	4	A risk to secure employment together with a downturn to the industry across the region has signalled that families may need to consider relocation in order to seek employment. The contribution that families make to the social and financial economy would therefore be lost.
Long History of Mining	3	The long history of mining in the local government area and also the multi-generational employment history amongst families. Many people would not know that mining operations exist in Lake Macquarie.

Theme	% of Submissions	Comments
Training	1	Contractors recognise the importance of secure employment and the have confidence when companies such as Centennial Coal invest in their operations. This mean that contractors will invest in: • training of staff through apprenticeships and traineeships; • research and development; • invest in the area via continuing to support their locally based operations; • allows contractors to employ local people.
Flexibility	1	The Project is recognised as offering a flexible approach to mine operations across Centennials northern operations.

There are many social benefits of long term business and industry investment in any community. Residents are more likely to purchase their home and participate in the social and financial economy of the area where they live. I.e. residents are less likely to be transient. If however, there are no jobs in the industry sector where they work people will potentially relocate and the social and economic contribution will be lost. Population stability and growth require secure employment and adequate hard infrastructure (roads, water supply etc.) and soft infrastructure (social activities, health care, schooling etc.). Investment in both hard and soft infrastructure requires population growth and critical mass (numbers).

The social benefits of staying in the community mean:

- Investment in housing etc.
- Long term planning for the future via education, family planning etc.
- Participation in social activities and maintenance of social ties.
- Long term planning by other businesses that rely on the sector (directly or indirectly).
- Investment and confidence.
- Growth, rather than changing needs (i.e. an ageing community).

This is relevant to both direct employment and also contractor employment as highlighted in the submissions.

The socio-economic contribution that mine related employment is significant. As seen through these submissions 99% have come from the local region indicating that there is significant and localised benefit of Centennials northern operations.

Surveys of mine related employment (undertaken by James Marshall & Co.) has found that Centennial employees are more likely to own their own home and have worked in the industry for over 10 years. The majority of employees are married with children and have lived in their current area for most of their life.

Employees and their families also participate in local activities which includes, for example, volunteering their time to coach junior sports, membership in service organisations such as the rural fire service, help in our school canteen and participate in P & C meetings. Employee's children attend local kindergartens and schools, attend the local gyms, participate in athletics, swimming, dancing, basketball, water skiing etc. Involvement in these activities is usually in the immediate area where they live but also includes regional participation.

Living in the local area also means that there is a positive contribution into the local economy via direct spending. The majority of wages are spent in the communities where the workforce lives. Other than mortgage costs, food and household expenditure (groceries, household supplies, gardening, cleaning and repairs) is the highest expenditure item with as much as 30% of the weekly wage of those surveyed being spent in the community where they live.

It is evident that employees have a strong financial and social interaction with the local surrounding community. The continued mine related employment generated by these projects will potentially maintain a relatively stable population base demonstrated by the long term housing tenure of some employees in the local government area.

This will mean that services and infrastructure will remain viable as they will benefit from the above mentioned flow on effects over the extended life of the Project. It is not expected that the ongoing operation of the Project will create any additional demand for services and infrastructure.

For the 2013 / 2014 financial year Centennial Coal supported 729 external contractor firms throughout Australia with 642 of these firms based in New South Wales / ACT. The financial contribution to the NSW/ACT firms for the period is as follows:

Table 14 – Expenditure Analysis NSW/ACT 2013-2014 Financial Year

Purpose	Amount ($)
Operating Expenses Paid to Contractors	690,978,708
Capital Expenditure Paid to Contractors	333,259,633
Other Operating Goods and Services	887,975,330
Other Capital Goods and Services	44,665,652
TOTAL	1,956,879,323

This contribution is significant financial income to the Hunter region and state. The contribution is not limited to the mining industry sector, but includes (and not limited to):

- Engineering;
- Printing services;
- Security;
- Health and Safety;

- Environmental Science and Research;
- Mine technology;
- Drilling;
- Surveying; and
- Earth moving.

It is also noted that the financial contribution made to companies outside of the region does not represent escape expenditure. While difficult to accurately quantify, it is safe to assume that many external contractors will direct money back into the local economy via accommodation, food, fuel, engagement of additional contract support services etc. This type of expenditure would not occur if funds remained within the local government area. Therefore the indirect spend is significant to the local area.

4 Consultation

Since the public exhibition of the EIS, Northern Coal Services has continued to undertake consultation with the community and relevant government agencies regarding the Project. A summary of the consultation undertaken since the submission of the EIS for public exhibition is detailed below.

4.1 Community

- **August 21 2014** – Public Notice placed in the Lakes Mail advising the community that an application for the Northern Coal logistics Project had been lodged with DP&E.
- **19 September 2014** – Invitation to residents surrounding the Project Application Area to attend a drop-in information session where information regarding the Project was to be provided.
- **25 and 29 September 2014** - Presentation to the Newstan/Awaba CCC members providing an overview of the Project and assessments undertaken.
- **30 September 2014** – Drop-in Information session held providing information on the Project. Information displayed at the drop-in information session was made available on the Centennial Coal website (www.centennialcoal.com.au)
- **10 October 2014** – Thank you letters sent to those individuals who attended the projects drop-in information session and provision of contact details for the Project team should they have any further questions.
- **16 October** – Public Notice placed in the Lakes Mail by DP&E advising of the public exhibition of the EIS.
- **16 October 2014** – Letter to residents surrounding the Project Application Area advising them of the public exhibition of the EIS, where the EIS can be viewed and of the opportunity to make a submission regarding the Project.
- **21 October 2014** – Presentation provided to the Mandalong CCC providing an overview of the Project.
- **29 October 2014** – Site visit with two community individuals to show the current dust monitoring equipment established at the Newstan Colliery Surface Site to monitor dust impacts from the sites operations.

4.2 LT Creek Sustainable Neighbourhood Group

- 15 December 2014 – Site visit with representatives from the LT Creek Sustainable Neighbourhood group to view the Stony Creek LDP017 infrastructure.

4.3 Commonwealth Department of the Environment

- **24 October 2014** - Submission of supplementary information in accordance with EPBC referral 2013/6906 determination.

4.4 Transport for NSW

- **5 December 2014** – Phone hook up with representatives from Transport for NSW to discuss issues raised in their submission on the EIS.

4.5 DPI – Crown lands Division

- **11 October 2014** – meeting with a representative from DPI – Crown Lands Division to discuss issues raised in their submission on the EIS.

5 References

- ANZECC (2000), Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australia and New Zealand Environment and Conservation Council and Agricultural and Resource Management Council of Australia and New Zealand.
- BDM Resources (2014) Northern Coal Logistics Project, Greenhouse Gas Report for EIS.
- BMT WBM (2011) LT Creek Flood Study, Final Report, R.N1355.001.03, April 2011, Lake Macquarie City Council.
- Bureau of Meteorology (2003), The Estimation of Probable Maximum Precipitation in Australia: Generalised Short-Duration Method, Bureau of Meteorology, Melbourne, Australia.
- DECC (2007), Swamp schlerophyll forest on coastal flood plains, Department of Environment and Climate Change NSW.
- DECC (2008), Managing Urban Stormwater: Soils and Construction, Volume 2E, Mines and Quarries, Department of Environment and Climate Change NSW.
- DIPNR (2005), NSW Floodplain Development Manual, Department of Infrastructure, Planning and Natural Resources.
- Green Bean Design (2014) Northern Coal Logistics Project, Visual Impact Assessment.
- GHD (2014) Northern Coal Logistics Project, Water Impact Assessment.
- IE Aust (1987), Australian Rainfall and Runoff – A Guide to Flood Estimation, Institution of Engineers, Australia.
- Industry & Investment NSW (2009), Salt tolerant species: Prime facts for profitable, adaptive and sustainable primary industries, Prime fact 780, Industry & Investment NSW Government.
- Intersect Traffic (2014) Traffic Impact Assessment, Northern Coal Services, Northern Coal Logistics Project.
- James Marshall & Co (2014) Social Impact Assessment, Northern Coal Logistics Project
- Pitt and Sherry (2014). CEDEX: Electricity emissions update - data to 30 June 2014; Looking back over two years with a price on emissions.
- RPS Australia East (2014a) Northern Coal Logistics Project, Flora and Fauna Assessment
- RPS Australia East (2014b) Cultural Heritage Impact Assessment, Northern Coal Services, Northern Coal Logistics Project.
- SLR Consulting Australia (2014c) Northern Coal Logistics Project, Air Quality Impact Assessment.
- SLR Consulting Australia (2014d) Northern Coal Logistics Project, Noise and Vibration Impact Assessment.
- SLR Consulting Australia (2014e) Northern Coal Logistics Project, Decommissioning and Rehabilitation Strategy.
- wmawater (2012) Lake Macquarie Waterway Flood Study, Lake Macquarie City Council.

6 Abbreviations

ANSTO	Australian Nuclear Science and Technology Organisation
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CHP	coal handling plant
Cooranbong Entry Site	Mandalong Mine - Cooranbong Entry Site
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	the Dust Extinction Moisture
DotE	Commonwealth Department of the Environment
DotE	Department of the Environment
DP&E	NSW Department of Planning and Environment
DRE	Division of Resources and Energy
EIS	Environmental Impact Statement
ENM	Excavated Natural Marerial
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environmental Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
ha	hectares
HVAS	High Volume Air Sampler
km	kilometre
km/hr	kilometres per hour
LDPs	Licenced Discharge Points
LMCC	Lake Macqurie City Council
mg/L	miligrams per litre
million tonnes per annum	mtpa
ML/day	Megalitres per day
NEPM	National Environment Protection Measure
NHMRC	National Health and Medical Research Council

Northern Coal Services	Centennial Northern Coal Services Pty Limited
NOW	NSW Office of Water
NPI	National Pollutant Inventory
NREA	Colliery Northern Rejects Emplacement Area
NSW	New South Wales
OEH	Office of Environment and Heritage
PMF	probably maximum flood
PO	Permissive occupancy
RMS	Roads and maritime Service
RO	Reverse Osmosis
ROM	run of mine
RPS	RPS Australia East Pty limited
RTS	Response to Submissions
SLR	SLR Consulting Pty Limited
SREA	Southern Rejects Emplacement Area
SSD	State Significant Development
TEOM	tapered element oscillating microbalance
the Project	Northern Coal Logistics Project
TSP	Total Suspended Particulates
ug/m3	micrograms per cubic metre
VENM	Vigin Excavated Natural Material
vph	vehicles per hour
WHO	World Health Organisation

7 Appendices

Appendix 1 – Community Individual Submission Register

Northern Coal Logistics Project

Community Individual Submission Register

Centennial ID	Department ID
CLP001	111481
CLP002	111891
CLP003	111752
CLP004	111626
CLP005	111893
CLP006	111887
CLP007	111993
CLP008	111885
CLP009	111395
CLP010	111756
CLP011	111861
CLP012	111853
CLP013	111851
CLP014	111847
CLP015	111908
CLP016	111857
CLP017	111855
CLP018	111842
CLP019	111646
CLP020	111487
CLP021	111527
CLP022	111966
CLP023	111974
CLP024	111929
CLP025	111927
CLP026	111962
CLP027	111918
CLP028	111931
CLP029	111942
CLP030	111953
CLP031	111958
CLP032	111912
CLP033	111964
CLP034	111978
CLP035	111988
CLP036	111986
CLP037	111916
CLP038	111914
CLP039	111921
CLP040	111940
CLP041	111937
CLP042	112023
CLP043	112017

Centennial ID	Department ID
CLP050	112021
CLP051	112047
CLP052	112053
CLP053	111999
CLP054	112057
CLP055	112051
CLP056	112037
CLP057	112035
CLP058	112033
CLP059	112011
CLP060	112009
CLP061	112120
CLP062	112110
CLP063	112091
CLP064	112061
CLP065	112069
CLP066	112067
CLP067	112104
CLP068	112100
CLP069	112112
CLP070	112093
CLP071	112059
CLP072	112122
CLP073	112124
CLP074	112114
CLP075	112108
CLP076	112097
CLP077	112063
CLP078	112077
CLP079	112085
CLP080	112083
CLP081	112193
CLP082	112195
CLP083	112158
CLP084	112148
CLP085	112152
CLP086	112144
CLP087	112138
CLP088	112150
CLP089	112183
CLP090	112170
CLP091	112134
CLP092	112162

Northern Coal Logistics Project

Community Individual Submission Register

Centennial ID	Department ID
CLP044	112025
CLP045	112015
CLP046	112041
CLP047	112029
CLP048	112019
CLP049	112049
CLP099	112128
CLP100	112126
CLP101	112282
CLP102	112220
CLP103	112261
CLP104	112253
CLP105	112278
CLP106	112267
CLP107	112224
CLP108	112276
CLP109	112208
CLP110	112230
CLP111	112249
CLP112	112240
CLP113	112255
CLP114	112273
CLP115	112271
CLP116	112284
CLP117	112280
CLP118	112243
CLP119	112232
CLP120	112216
CLP121	112342
CLP122	112331
CLP123	112356
CLP124	112337
CLP125	112309
CLP126	112292
CLP127	112313
CLP128	112327
CLP129	112319
CLP130	112288
CLP131	112323
CLP132	112329
CLP133	112296
CLP134	112360
CLP135	112333

Centennial ID	Department ID
CLP093	112168
CLP094	112166
CLP095	112185
CLP096	112189
CLP097	112187
CLP098	112132
CLP148	112401
CLP149	112370
CLP150	112368
CLP151	112382
CLP152	112372
CLP153	112366
CLP154	112378
CLP155	112375
CLP156	112396
CLP157	112407
CLP158	112417
CLP159	112423
CLP160	112421
CLP161	112455
CLP162	112475
CLP163	112445
CLP164	112461
CLP165	112465
CLP166	112457
CLP167	112433
CLP168	112473
CLP169	112471
CLP170	112469
CLP171	112459
CLP172	112479
CLP173	112431
CLP174	112477
CLP175	112467
CLP176	112463
CLP177	112451
CLP178	112429
CLP179	112427
CLP180	112449
CLP181	112485
CLP182	112487
CLP183	112514
CLP184	112508

Northern Coal Logistics Project

Community Individual Submission Register

Centennial ID	Department ID
CLP136	112294
CLP137	112335
CLP138	112347
CLP139	112290
CLP140	112311
CLP141	112405
CLP142	112419
CLP143	112403
CLP144	112392
CLP145	112386
CLP146	112384
CLP147	112380

Centennial ID	Department ID
CLP185	112495
CLP186	112516
CLP187	112518

Appendix 2 – Special Interest Group Submission Register

Northern Coal Logistics Project

Special Interest Group Submission Register

Centennial ID	Department ID	Name
CLP188	112286	AC Whalan & Co Pty Ltd, Singleton, NSW
CLP189	112197	Rescan International, Somersby, NSW
CLP190	112164	Hyva Pacific, Thornton, NSW
CLP191	112089	Noble engineering services, Beresfield, NSW
CLP192	112106	Fenner Dunlop ACE, Somersby, NSW
CLP193	112102	Rutherford Projects, Tomago, NSW
CLP194	112160	Macquarie Manufacturing Pty Ltd, Rathmines, NSW
CLP195	112095	REYN Consultancy, Bolton Point, NSW
CLP196	112218	Strike Force Services, Maitland , NSW
CLP197	112045	Quarry Mining, Beresfield, NSW
CLP198	112116	Longwall Haul (Aust.) Pty Limited, REDHEAD, NSW
CLP199	111960	Simscada Pty Ltd, Charlestown, NSW
CLP200	112013	LT Creek SNG, Blackalls Park, NSW
CLP201	112235	Ampcontrol Pty Limited, Tomago, NSW
CLP202	112043	R&D Technology PTY LTD, CARDIFF, NSW
CLP203	112339	NEPEAN Power Pty Ltd, Thornton, NSW
CLP204	112156	MRA Engineering, Warabrook, NSW
CLP205	112228	PKF Lawler Partners, NEWCASTLE WEST, NSW
CLP206	111859	Wheeler Cranes & Services Pty Ltd, Tomago, NSW
CLP207	112140	PH Conveyors, newcastle, NSW
CLP208	112510	AllightSykes, Cardiff, NSW
CLP209	112503	Androck Engineering & Mining Pty Ltd, Rutherford, NSW
CLP210	112411	Newcastle Express Couriers, ELEEBANA, NSW
CLP211	112520	No Open Cut Mine For Awaba, Awaba, NSW
CLP212	112358	Yates Security Group Pty Ltd, Waterloo, NSW
CLP213	112354	The UGM Group, NSW, NSW
CLP214	112415	Water Treatment Services, Bolwarra Heights, NSW
CLP215	112499	Origin Energy, Eraring, NSW
CLP216	112435	Toronto Chamber of Commerce, TORONTO, NSW
CLP217	112345	Rathmines Progress Association, Rathmines, NSW

Appendix 3 – Revised Clean Water Plant Ecotoxicology Assessment

Centennial Coal

GHD



CLEAN WATER TREATMENT PLANT

ECOTOXICOLOGY ASSESSMENT

Centennial Newstan

December 2014

Centennial Coal Environment Matters

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Appendix A – Ecotoxicology Reports

Appendix B – Water Quality Reports

Glossary

Acute toxicity	The ability of a substance to cause severe biological harm or death from a single exposure.
Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates and carbonates. It is expressed in units of calcium carbonate ($CaCO_3$).
Anion	A negatively charged ion.
Bioassay	An experimental test used to evaluate the relative potency of a chemical by measuring its effect on a living organism relative to a control.
Bioavailability	The fraction of the total of a chemical in the surrounding environment that is available to be taken up by an organism. The environment may include water, sediment, soil, suspended particles and food.
Cation	A positively charged ion.
Chronic toxicity	The ability of a substance to cause severe biological harm or death from prolonged exposure.
Direct toxicity assessment	The use of toxicity tests to determine the acute and/or chronic toxicity of mixtures of compounds in ambient waters.
Discharge	The quantity of water per unit time, for example cubic metres per second or megalitres per day.
Ecotoxicology	Scientific study of the effects of toxic substances on living organisms.
Effect concentration	The concentration of a substance in water where a certain percent of test organisms exhibit a certain response or effect after a specified exposure period. For example, EC_{10} is the concentration where 10 percent of the test organisms exhibit a response.
Electrical conductivity	A measure of the concentration of dissolved salts or ions in water.
Hardness	The concentration of multivalent cations present in water. Generally, hardness is a measure of the concentration of calcium and magnesium ions in water and is expressed in units of calcium carbonate ($CaCO_3$) equivalent. Hardness may influence the toxicity and bioavailability of substances in water.
Ion	An electrically charged atom.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated with the site's Environment Protection Licence.

Longwall mining	Underground coal mining where a block of coal is mined using a longwall shearer, supported by roadway development that is created using a continuous miner unit.
No observed effect concentration	The highest tested concentration of a substance in water at which no effect is observable in test organisms in a given population (compared to the control sample).
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Physicochemical	Refers to the physical (e.g. temperature, electrical conductivity) and chemical (e.g. concentrations of nitrate, mercury) characteristics of water.
Total dissolved solids	A measure of the inorganic and organic substances dissolved in water.
Total Kjeldahl nitrogen	The sum of the concentrations of organic nitrogen, ammonia (NH_4) and ammonium (NH_4^+) in water.
Total nitrogen	A measure of organic and inorganic nitrogen forms in water. The sum of concentrations of total Kjeldahl nitrogen, nitrite and nitrate.
Total phosphorus	A measure of the organic and inorganic phosphorus in particulate and soluble forms.
Total suspended solids	A measure of the filterable matter suspended in water.
Toxicity	The inherent potential or capacity of a substance to cause adverse effects in a living organism.
Trigger value	The concentration or load of physicochemical characteristic of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. Indicates a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.
Turbidity	A measure of the clarity of water. Turbidity in excess of 5 NTU is just noticeable to the average person.

Abbreviations

Centennial Newstan	Centennial Newstan Pty Ltd
CWP	Clean Water Plant
DO	Dissolved oxygen
DTA	Direct toxicity assessment
EC	Effect concentration
EPL	Environment Protection Licence
ESA	Ecotox Services Australasia
GHD	GHD Pty Ltd
km	Kilometre
LDP	Licensed discharge point
ML/day	Megalitre per day
NATA	National Association of Testing Authorities
NOEC	No observable effect concentration
SSTV	Site-specific trigger value
TDS	Total dissolved solids
TSS	Total suspended solids

1. Introduction

1.1 Background

Newstan Colliery is an existing underground coal mine owned and operated by Centennial Newstan Pty Limited (Centennial Newstan). It is located approximately 25 km south-west of Newcastle on the western side of Lake Macquarie, as shown in Figure 1-1.

Mining operations at Newstan Colliery first commenced in 1887 and mining has been undertaken within the Young Wallsend, Great Northern, Fassifern, Borehole and West Borehole coal seams. Mining methods utilised at the mine include a combination of modern longwall retreat and bord and pillar mining methods. Centennial Newstan currently has approval to produce up to 3.5 million tonnes per annum of run of mine coal under Development Consent DA 73-11-98.

Discharge of mine water at Newstan Colliery is regulated by Environment Protection Licence (EPL) 395, issued to Centennial Newstan by the NSW Environment Protection Authority under the *Protection of the Environment Operations Act 1997*. In October 2012, Centennial Newstan was granted approval to increase the volumetric limit of discharges through Licenced Discharge Point (LDP) 001 into the northern arm of LT Creek from 7 ML/day to 11 ML/day. Additional requirements were subsequently added to EPL 395, including the construction of a water treatment plant.

Construction of the plant, referred to as the Clean Water Plant (CWP), was completed in late 2013 and water was first treated on 2 December 2013. The CWP employs coagulation, flocculation, sedimentation and filtration treatment to reduce the turbidity and concentration of total suspended solids (TSS) and total (unfiltered) metals before water is discharged from Newstan Colliery to LT Creek via LDP001. In addition, ultra-violet treatment is used to disinfect water that is transferred underground for operational reuse due to the potential for human contact.

GHD Pty Ltd (GHD) was commissioned by Centennial Newstan to conduct an ecotoxicological study to assess the toxicity and chemical constituents of the treated discharge water. Results were compared to previous ecotoxicology assessments as well as site-specific trigger values (SSTVs) and discharge limits specified by EPL 395 for selected parameters.

1.2 Previous Toxicity Assessments

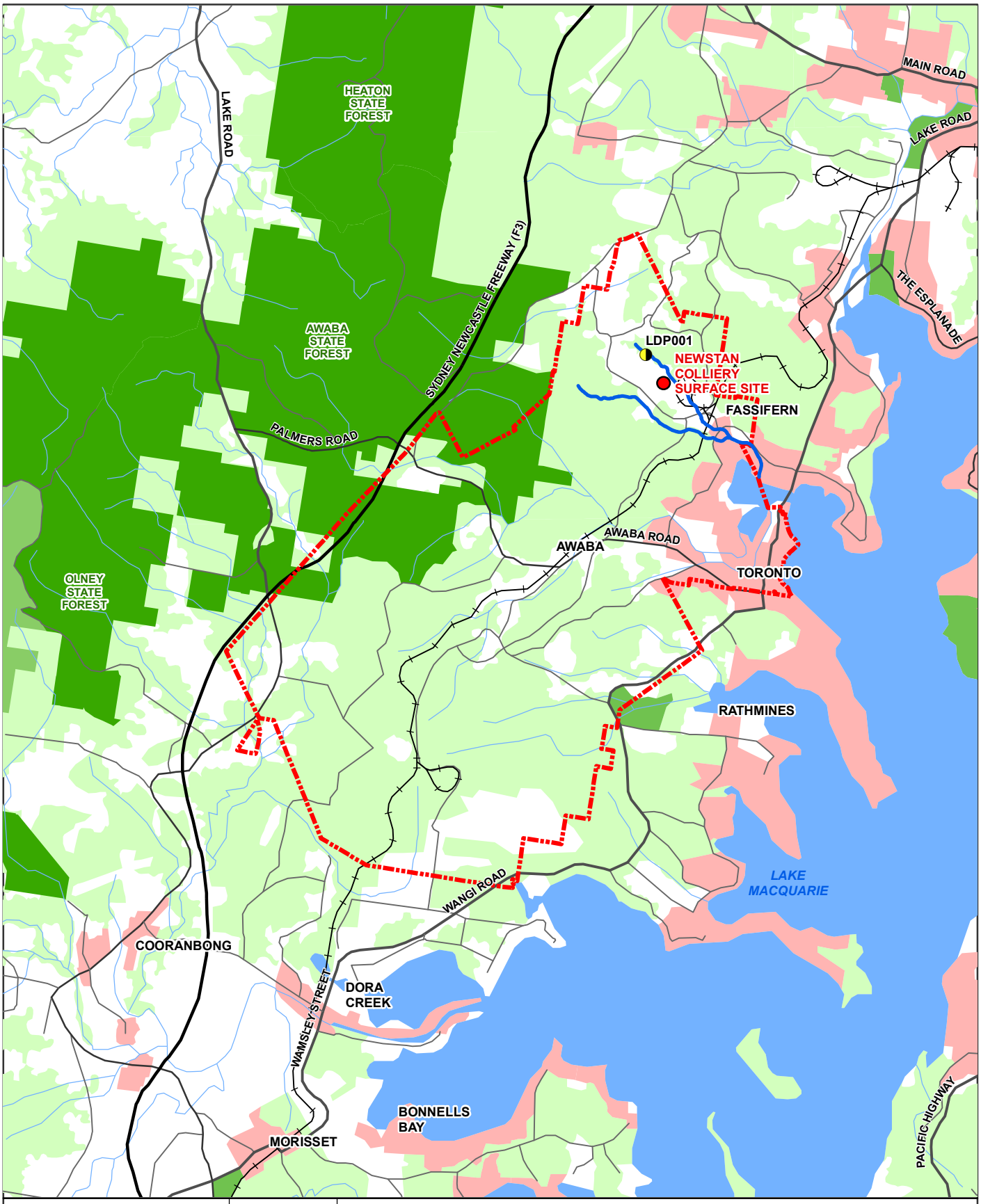
An ecotoxicological assessment of untreated LDP001 discharge was performed in May 2011 (GHD, 2011) using a number of freshwater species and test protocols. The results showed that the untreated discharge had no acute toxicity and low chronic toxicity, with the cladoceran reproduction bioassay and fish post hatch survival bioassay showing the most sensitivity to the sample.

Following this, an ecotoxicological assessment of laboratory treated discharge representative of the proposed discharge from the CWP was performed in April 2012 (GHD, 2012). The study found that the laboratory treated discharge water had lower toxicity than the untreated discharge tested in 2011 (GHD, 2011).

1.3 Scope of Work

This report details the ecotoxicological assessment and provides the results for water quality testing from the discharge at LDP001 treated by the CWP. The scope of work included the following:

- Provide details of sample collection at the CWP and toxicity and water quality testing conducted.
- Interpret toxicity and water quality testing results from the samples of water collected.
- Compare results with previous ecotoxicology assessments and with SSTVs and EPL limits specified for LDP001.



1:100,133 for A4

0 375 750 1,500 2,250 3,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

GHD

LEGEND

- LT Creek
- Newstan Colliery Holding Boundary
- Watercourse
- Licensed Discharge Point
- Existing Rail
- Freeway
- Principal Road
- Secondary Road
- Minor Road
- Watercourse Area
- Built Up Area
- Nature Conservation
- State Forest
- Forest Or Shrub

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LOCATION	Newstan
SEAM	Fassifern
DRAWN	S.M.
CHECKED	S.G.
APPROVED	S.G.
SCALE	Refer to scalebar

Clean Water Treatment Plant Ecotoxicology Assessment

Locality Plan

Centennial Newstan

DATE 30/06/2014

Figure1-1

GIS Filename: G:\22\0105001\GIS\Maps\Hunter\Newstan\Deliverables\221668107\221668107_01_ LocalityPlan.mxd

© Centennial: Holding Boundary 2012 ; Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3 2006

2. Methodology

Two rounds of ecotoxicology assessment were conducted in May and November 2014, referred to as round one and round two of testing respectively.

2.1 Sample Collection

2.1.1 Round One of Testing

Water samples were collected on 14 May 2014 from the composite sampler at LDP001 by a GHD Environmental Scientist. The composite sampler provided 24 samples of water over the space of 24 hours (one sample per hour), which were mixed on site to provide a batch sample of LDP001 discharge.

Samples arrived at the Ecotox Services Australasia (ESA) laboratory for toxicity testing and the ALS Environment Division laboratory for water quality analysis in Sydney on 15 May 2014 and testing commenced immediately upon receipt of the samples.

2.1.2 Round Two of Testing

Due to the large volume of water required for toxicity testing for the second round of testing, two batch samples were collected from the composite sampler at LDP001. Water samples were collected on 12 and 13 November 2014 by a GHD Environmental Scientist. For each day of sampling, 24 samples of water over the space of 24 hours (one sample per hour) were collected and mixed on site to provide a batch sample of LDP001 discharge. The batch samples collected on 12 and 13 November 2014 are referred to as LDP001-A and LDP001-B respectively.

Samples arrived at the ESA laboratory for toxicity testing on 13 November 2014 (LDP001-A sample) and on 14 November 2014 (LDP001-B sample). Samples arrived at the ALS Environment Division laboratory for water quality analysis on 14 November 2014 (both LDP001-A and LDP001-B samples). Testing at both laboratories commence immediately upon receipt of the samples.

2.2 Ecotoxicology Assessment

2.2.1 Direct Toxicity Assessment

Direct toxicity assessment (DTA) is a common method used to determine the toxicity of mixtures of compounds in ambient waters. The method provides an integrated measure of effects and accounts for interactions (synergistic, additive and ameliorative) within a mixture, therefore closely simulating the effects in the receiving waterway. To ensure a close simulation of the toxic effects of the discharge, site-specific testing was undertaken using species indigenous to, or representative of, the receiving ecosystem.

DTA was performed on the treated water from the CWP discharged from Newstan Colliery at LDP001. The DTA methodology followed Section 8.3.6 of ANZECC and ARMCANZ (2000), which provides an increased level of confidence that the derived targets will not cause adverse environmental effects to receiving ecosystems.

Toxicity testing involves exposing laboratory test species to a range of concentrations of sampled water for a specified exposure period. At the end of the exposure period, specific end points are assessed, such as species survival, reproduction or growth. Statistical analysis of the results provide the effect concentration (EC) of the discharge where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibited inhibited reproductive capacity and the no observable effect concentration (NOEC) of the discharge, which represents the highest tested concentration that has no effect on the test organisms (when compared to the results of the control sample).

2.2.2 Species Tested

Toxicity testing of sampled water was performed using the ANZECC and ARMCANZ (2000) protocol with species endemic to, or representative of, the receiving environment. Where possible, chronic bioassays were performed using National Association of Testing Authorities (NATA) accredited tests.

Round One of Testing

Based on the results of previous toxicity testing (GHD, 2011; GHD, 2012), the most sensitive test species was determined to be the freshwater cladoceran. This species was selected for the first round of testing to assess the toxicity of water discharged through LDP001 treated by the CWP. The seven day partial life-cycle (chronic) toxicity test was performed using the freshwater cladoceran *Ceriodaphnia cf. dubia* based on the protocol specified by USEPA (2002) and Bailey *et al.* (2000).

Round Two of Testing

The following freshwater species and test protocols were used in round two of testing:

- Seven day partial life-cycle test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) and Bailey *et al.* (2000) protocols. This bioassay was conducted with the LDP001-A sample collected.
- 10 day fish embryonic development and post-hatch survival test using the freshwater eastern rainbowfish *Melanotaeia splendida splendida*, based on the USEPA (2002) protocol. This bioassay was conducted with the LDP001-A sample collected.
- 10 day survival test using the freshwater shrimp *Paratya australiensis*, based on the USEPA (1996) protocol. This bioassay was conducted with the LDP001-B sample collected. Note this bioassay is not NATA accredited.

2.2.3 Concentrations Tested

ESA recommended the use of laboratory dilution water to provide a more accurate indication of the toxicity of the sample compared to using upstream water as a diluent which may have confounded the test results. ESA used in-house diluents for all dilutions and controls to ensure the toxicity observed can be attributed directly to the sample tested. All samples were serially diluted with the appropriate diluent to achieve the test concentration.

Concentrations used in all bioassays for both rounds of testing were 0%, 3.1%. 6.3%, 12.5%, 25%, 50% and 100%.

2.3 Water Quality Assessment

Round One of Testing

The sample of treated discharge from LDP001 collected in round one of testing was analysed for the parameters listed in Table 2-1 at the NATA accredited facilities at the ALS Environmental Division Laboratory.

Table 2-1 Round One of Testing: Water Quality Parameters

Category	Parameters
Field measurements	Dissolved oxygen (DO), electrical conductivity, pH, turbidity.
Nutrients	Nitrate + nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus.
Anions	Alkalinity (bicarbonate and total), chloride, sulfate.
Cations	Calcium, magnesium, potassium, sodium.
Dissolved metals	Aluminium, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, zinc.
Other parameters	Ammonia, total dissolved solids (TDS), TSS.

Round Two of Testing

The samples of treated discharge from LDP001 collected in round two of testing were analysed for the parameters listed in Table 2-2 at the NATA accredited facilities at the ALS Environmental Division Laboratory.

Table 2-2 Round Two of Testing: Water Quality Parameters

Category	Parameters
Field measurements	DO, electrical conductivity, pH, turbidity.
Nutrients	Nitrate + nitrite, total Kjeldahl nitrogen, total nitrogen, total phosphorus.
Anions	Alkalinity (bicarbonate and total), chloride, sulfate.
Cations	Calcium, magnesium, potassium, sodium.
Dissolved metals	Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, molybdenum, mercury, nickel, selenium, tin, titanium, vanadium, zinc.
Other parameters	Oil and grease, TDS, total hardness, TSS.

3. Results and Discussion

3.1 Ecotoxicology Assessment

Both rounds of toxicity testing performed by ESA fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met. Copies of the toxicity reports are provided in Appendix A. A summary of the results is provided in Table 3-1, along with the results of the previous toxicity assessments of untreated discharge (GHD, 2011) and laboratory treated discharge (GHD, 2012). It should be noted that the test duration of the bioassays conducted in 2011 and 2012 may differ from the bioassays conducted in 2014, as specified in Table 3-1, and this should be considered as part of the interpretation of results.

The results provided in Table 3-1 present the EC of the discharge where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibited inhibited reproductive capacity. The NOEC values represent the highest tested concentration that has no effect on the test organisms (when compared to the results of the control sample).

Round One of Testing

The results of toxicity testing presented in Table 3-1 show that the treated discharge from the CWP sampled in round one of testing was not acutely toxic to the test species, as indicated by the NOEC of 100% of the treated discharge water from the survival test. The acute toxicity was the same for the untreated and laboratory treated discharge from previous toxicity testing of the same bioassay.

The discharge treated by the CWP was found to be slightly less chronically toxic than the untreated discharge, as indicated by the EC_{50} and NOEC results of the cladoceran reproduction test. The EC_{50} results for the cladoceran reproduction test meet the criterion of 50% discharge concentration limit as specified in Section U3.2 of EPL 395.

However, the EC_{10} result for the reproduction test is lower for the treated discharge than both the untreated and laboratory treated discharge. This is most likely a result of the inclusion in the statistical analysis of an anomalous result for one of the ten replicates at the 12.5% concentration, which reported zero young produced. Therefore, it is recommended that the NOEC be used as the indicator of toxicity in place of the EC_{10} value. The NOEC result of 50% concentration of treated discharge indicates that there is no significant difference in the effect on cladoceran reproduction between the control sample and the 50% concentration.

Any chronic toxicity in the CWP treated discharge may be attributed to increased bioavailability of metals and nutrients due to the removal of suspended matter by the CWP. Many contaminants, such as trace metals, may adsorb to suspended matter which reduces the fraction of the contaminant in the water that organisms can take up (the bioavailable fraction). Removal of TSS, which is targeted by the CWP treatment processes, removes the ability of suspended particles to bind with metals and to reduce the potential toxicity to aquatic organisms. This may have resulted in some chronic toxicity of treated discharge water.

It is expected that discharge through LDP001 is not chronically toxic at the edge of the mixing zone. As discussed by GHD (2011), water quality monitoring has found that metal concentrations decrease from the discharge location at LDP001 to monitoring point WMP3, which is located downstream of the Main By-Wash Dam. The results of water quality monitoring indicate that the wetland system acts as a filter and removes additional dissolved metals from the water, which is expected to result in a decrease in chronic toxicity due to mixing with ambient water within the Main By-Wash Dam.

Table 3-1 Summary of Ecotoxicology Assessment Results

Bioassay	Endpoint	Discharge concentration (95% confidence limits)			
		Untreated discharge (May 2011)[(a)]	Laboratory treated discharge (April 2012)[(b)]	CWP treated discharge (May 2014)[(c)]	CWP treated discharge (November 2014)[(d)]
Cladoceran	Survival	EC_{10} = >100%	EC_{10} = >100%	EC_{10} = >100%	EC_{10} = >100%
		EC_{50} = >100%	EC_{50} = >100%	EC_{50} = >100%	EC_{50} = >100%
		NOEC = 100%	NOEC = 100%	NOEC = 100%	NOEC = 100%
	Reproduction	EC_{10} = 28.3% (9.3%–34.0%)	EC_{10} = 56.1% (13.3%–57.8%)	EC_{10} = 9.1%[(e)]	N/A
		EC_{50} = 78.4%[(e)]	EC_{50} = 86.0% (77.8%–90.8%)	EC_{50} = 81.7%[(e)]	EC_{50} = >100%
		NOEC = 25%	NOEC = 50%	NOEC = 50%	NOEC = 50%
Rainbowfish	Survival	EC_{10} = 26.2% (3.1%–36.3%)	–	–	N/A
		EC_{50} = 37.9% (3.1%–48.1%)	–	–	EC_{50} = >100%
		NOEC = 25%	–	–	NOEC = 100%

Bioassay	Endpoint	Discharge concentration (95% confidence limits)			
		Untreated discharge (May 2011)[(a)]	Laboratory treated discharge (April 2012)[(b)]	CWP treated discharge (May 2014)[(c)]	CWP treated discharge (November 2014)[(d)]
Shrimp	Survival	EC_{10} = >100%	EC_{10} = >100%	–	EC_{10} = >100%
		EC_{50} = >100%	EC_{50} = >100%	–	EC_{50} = >100%
		NOEC = 100%	NOEC = 100%	–	NOEC = 100%

(a) Seven day freshwater cladoceran test, 12 day eastern rainbowfish test and 96 hour freshwater shrimp test.

(b) Seven day freshwater cladoceran test and 96 hour freshwater shrimp test. Eastern rainbowfish test not conducted.

(c) Seven day freshwater cladoceran test. Eastern rainbowfish test and freshwater shrimp test not conducted.

(d) Seven day freshwater cladoceran test and 10 day eastern rainbowfish test using LDP001-A sample. 10 day freshwater shrimp test using LDP001-B sample.

(e) 95% confidence limits not available.

N/A Results not reliable due to interrupted dose response in the sample.

Round Two of Testing

The results of the most recent toxicity testing conducted in November 2014 presented in Table 3-1 show that the treated discharge from the CWP is not acutely or chronically toxic to the test species. The EC_{50} results for all three bioassays meet the criteria of 50% discharge concentration limit as specified in Section U3.2 of EPL 395.

The sample from round two was slightly less chronically toxic to the cladoceran bioassay compared to the sample from round one, as indicated by the EC_{50} results. The reason for this improvement is unclear based on a review of water quality data alone, however may be attributable to a more favourable balance between the major cations and anions in the treated water for round two.

3.2 Water Quality Assessment

The results of water quality analysis for the treated water from the CWP discharged at LDP001 are provided in Table 3-2. Copies of the full reports are provided in Appendix B. The results from similar assessments for untreated and laboratory treated water are also provided, along with the limits specified by EPL 395 and SSTVs for LDP001. SSTVs were previously derived for LT Creek based on a review of default trigger values recommended by ANZECC and ARMCANZ (2000) and water quality observed at reference sites (GHD, 2011). Exceedences of the EPL 395 concentration limits and/or SSTVs are shown in bold.

As seen in Table 3-2, none of the parameters analysed for the water treated by the CWP in the first round of testing in May 2014 were found to exceed SSTVs or EPL 395 discharge limits. The SSTV for electrical conductivity was exceeded for both samples collected during the second round of testing in November 2014, however levels remained below the EPL limit of 3,250 µS/cm for both samples. Although the electrical conductivity reported in round two of testing exceeded the ANZECC and ARMCANZ (2000) default trigger value of 2,200 µS/cm, this did not appear to affect the toxicity of the sample to the cladoceran bioassay.

The chemistry of the CWP discharge is similar to that of the laboratory treated discharge, with a reduction in turbidity, electrical conductivity, TSS and dissolved metals compared to the results for untreated discharge.

Table 3-2 Summary of Water Quality Assessment Results

Parameters	Units	EPL 395 concentration limits	SSTVs (GHD, 2011)	Untreated discharge (May 2011)	Laboratory treated discharge (April 2012)	CWP treated discharge (May 2014)	CWP treated discharge (November 2014)[a]	CWP treated discharge (November 2014)[b]
Physicochemical parameters								
pH	pH unit	6.5–8.5	6.5–8.5	7.01	7.87	8.1	7.41	7.60
DO	mg/L	N/A	N/A	–	8.22	7.80	7.57	7.61
Electrical conductivity	µS/cm	3,250	2,200	**2,540**	2,200	1,452	**2,600**	**2,610**
TDS	mg/L	N/A	N/A	1,730	–	1,220	1,690	1,700
TSS	mg/L	50	50	6	–	8	<5	<5
Turbidity	NTU	N/A	50	9.4	–	0.0	0.0	0.0
Total hardness as $CaCO_3$	mg/L	N/A	N/A	–	–	–	117	126
Nutrients								
Nitrate + nitrite as N	mg/L	N/A	N/A	0.02	0.04	0.22	0.21	0.22
Total Kjeldahl nitrogen	mg/L	2.6	N/A	0.2	<0.5	0.2	<0.1	0.1
Total nitrogen	mg/L	2.7	0.5	0.2	<0.5	0.4	0.2	0.3
Total phosphorus	mg/L	0.41	0.05	<0.01	<0.05	0.02	<0.01	<0.01
Anions								
Bicarbonate alkalinity as $CaCO_3$	mg/L	711	N/A	652	–	534	575	582

Parameters	Units	EPL 395 concentration limits	SSTVs (GHD, 2011)	Untreated discharge (May 2011)	Laboratory treated discharge (April 2012)	CWP treated discharge (May 2014)	CWP treated discharge (November 2014)[(a)]	CWP treated discharge (November 2014)[(b)]
Total alkalinity $CaCO_3$	mg/L	N/A	N/A	652	662	534	575	582
Chloride	mg/L	516	N/A	440	235	313	454	455
Sulfate	mg/L	232	N/A	132	190	114	137	133
Cations								
Calcium	mg/L	38	N/A	26	33.4	18	32	34
Magnesium	mg/L	16	N/A	9	9.9	7.0	9	10
Potassium	mg/L	6	N/A	4	9.9	3	4	4
Sodium	mg/L	635	N/A	621	483	427	575	578
Dissolved metals								
Aluminium	mg/L	0.22	0.68	0.16	<0.010	<0.01	<0.01	<0.01
Antimony	mg/L	0.009	N/A	<0.001	–	–	<0.001	<0.001
Arsenic	mg/L	0.042	0.024	**0.029**	<0.0005	<0.001	<0.001	<0.001
Barium	mg/L	0.25	N/A	0.173	–	0.109	0.106	0.108
Beryllium	mg/L	0.004	N/A	<0.001	<0.001	–	<0.001	<0.001
Boron	mg/L	0.37	0.37	0.24	0.182	–	0.21	0.21
Cadmium	mg/L	0.0004	0.00054	<0.0001	<0.001	<0.0001	<0.0001	<0.0001

Parameters	Units	EPL 395 concentration limits	SSTVs (GHD, 2011)	Untreated discharge (May 2011)	Laboratory treated discharge (April 2012)	CWP treated discharge (May 2014)	CWP treated discharge (November 2014)[(a)]	CWP treated discharge (November 2014)[(b)]
Chromium	mg/L	0.006	0.0025	<0.001	<0.002	<0.001	<0.001	<0.001
Cobalt	mg/L	0.003	N/A	0.003	<0.002	<0.001	<0.001	<0.001
Copper	mg/L	0.007	0.0035	<0.001	<0.002	0.003	0.002	0.002
Iron	mg/L	230	0.30	0.05	<0.01	<0.05	<0.05	<0.05
Lead	mg/L	0.023	0.0136	0.007	0.003	0.003	0.005	0.005
Lithium	mg/L	0.164	N/A	0.160	0.144	–	0.138	0.134
Manganese	mg/L	1.2	1.9	0.105	0.138	<0.001	<0.001	<0.001
Mercury	mg/L	0.0006	0.0006	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.045	N/A	0.039	0.017	–	0.015	0.016
Nickel	mg/L	0.024	0.0275	0.016	0.009	0.010	0.009	0.009
Selenium	mg/L	0.011	0.03	**0.12**	<0.0005	–	<0.01	<0.01
Silver	mg/L	<0.001	0.00005	<0.001	<0.001	–	<0.001	<0.001
Strontium	mg/L	N/A	N/A	–	–	–	1.97	1.95
Tin	mg/L	0.003	N/A	<0.001	–	–	<0.001	<0.001
Titanium	mg/L	0.01	N/A	<0.01	–	–	<0.01	<0.01
Vanadium	mg/L	<0.01	N/A	<0.01	<0.01	–	<0.01	<0.01

Parameters	Units	EPL 395 concentration limits	SSTVs (GHD, 2011)	Untreated discharge (May 2011)	Laboratory treated discharge (April 2012)	CWP treated discharge (May 2014)	CWP treated discharge (November 2014)[(a)]	CWP treated discharge (November 2014)[(b)]
Zinc	mg/L	0.04	0.02	0.012	0.002	–	0.006	<0.005
Other parameters								
Ammonia as N	mg/L	N/A	0.9	0.12	–	<0.01	–	–
Oil and grease	mg/L	N/A	N/A	<5	–	–	<5	<5
Silica	mg/L	24.8	N/A	14.2	13.0	–	11.8	12.0

(a) LDP001-A sample results.

(b) LDP001-B sample results.

4. Conclusions

DTA testing during the first round of investigations in May 2014 found that the treated discharge from the CWP was not acutely toxic to the test species, which was found to be the same for the untreated and laboratory treated discharge. The treated discharge was also found to be slightly less chronically toxic than the untreated discharge testing in 2011 (GHD, 2011) and similar to the laboratory treated discharge tested in 2012 (GHD, 2012), based on the EC_{50} and NOEC results.

The results of the second round of toxicity testing in November 2014 show that the treated discharge from the CWP is not acutely or chronically toxic to the test species, based on the EC_{50} and NOEC results.

The results of toxicity testing indicate that the CWP discharge through LDP001 meets the requirements of Section U3.2 of EPL 395, where the EC_{50} was found to not exceed a discharge concentration limit of 50% for the following bioassays:

- Cladoceran reproduction test.
- Eastern rainbowfish embryo development and post-hatch survival test.
- Freshwater shrimp survival test.

Water quality monitoring of the discharge through LDP001 show that the chemistry of the treated discharge from the CWP is similar to that of the laboratory treated discharge, with a reduction in turbidity, electrical conductivity, TSS and metals compared to monitoring of untreated discharge. For round one of testing, none of the parameters analysed for the water treated by the CWP were found to exceed SSTVs or the limits specified by EPL 395. The SSTV for electrical conductivity was exceeded for both samples collected during the second round of testing in November 2014, however levels remained below the EPL limit of 3,250 µS/cm for both samples and the exceedance did not affect the toxicity of the samples.

Additional toxicity testing is not required at this point in time. Impacts of discharge from LDP001 will be managed by the ongoing water, sediment and macroinvertebrate monitoring program in place at Newstan Colliery.

5. References

ANZECC and ARMCANZ (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000), Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: Method Development and Validation, *Environmental Toxicology and Chemistry*, 19:88–93.

GHD (2011), *LT Creek Ecotoxicological Assessment and Trigger Values*, GHD Pty Ltd, prepared for Centennial Newstan Pty Ltd.

GHD (2012), *Treated Discharge Water Ecotoxicology*, GHD Pty Ltd, prepared for Centennial Newstan Pty Ltd.

USEPA (1996), *Ecological Effect Test Guidelines*, OPPTS 850.1045, Panaeid Acute Toxicity Test, public draft, United States Environmental Protection Agency.

USEPA (2002), *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, fourth edition, United States Environmental Protection Agency.

Appendices

Appendix A – Ecotoxicology Reports

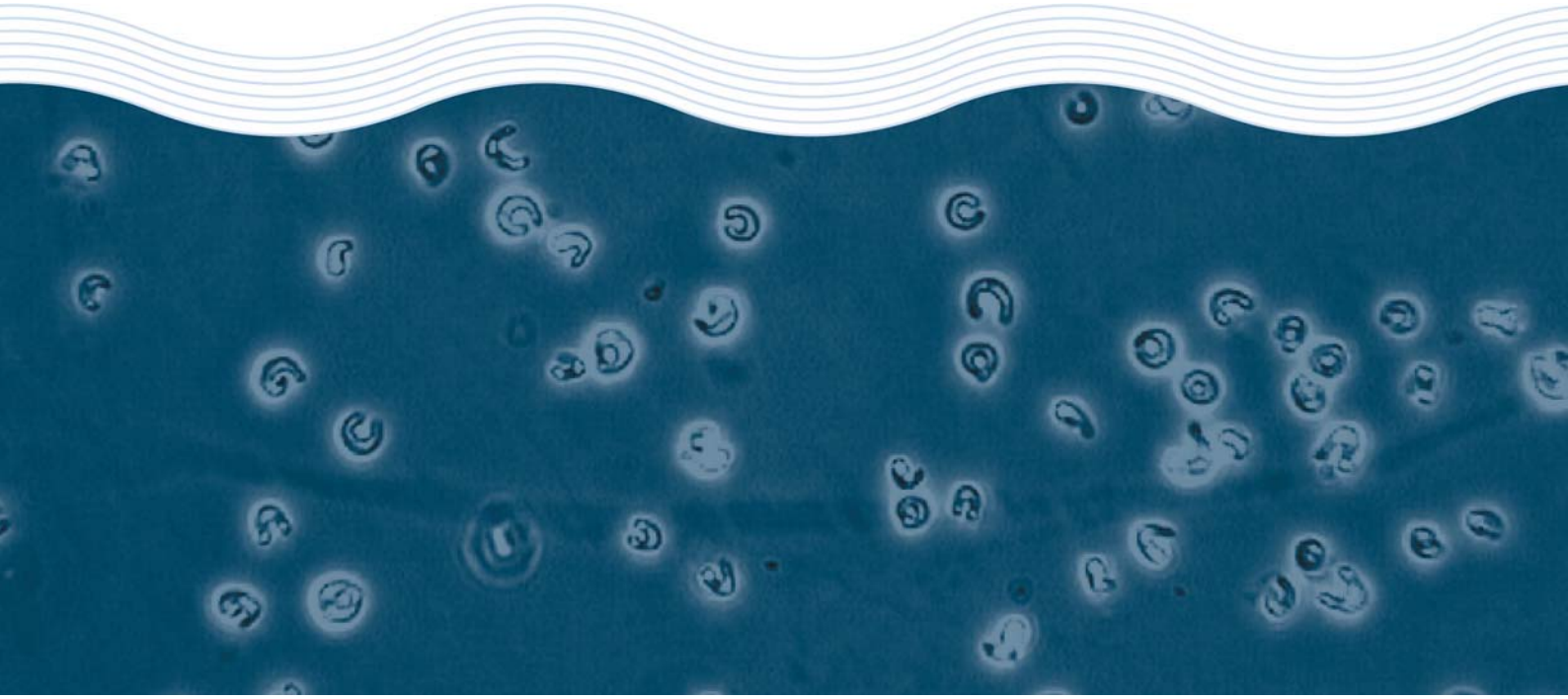
ecotox
SERVICES AUSTRALASIA

Toxicity Assessment of a Freshwater Sample

GHD Pty Ltd

Test Report

May 2014



Toxicity Assessment of a Freshwater Sample

GHD Pty Ltd

Test Report

May 2014

ECOTOX Services Australasia Pty Ltd ABN>45 094 714 904
unit 27/2 chaplin drive lane cove nsw 2066 T>61 2 9420 9481 F>61 2 9420 9484 W>www.ecotox.com.au

Toxicity Test Report: TR1128/7

This document is issued in accordance with NATA's accreditation requirements

Client:	GHD Pty Ltd Level 3, 24 Honeysuckle Drive Newcastle NSW 2300	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1128 14 May 2014 15 May 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1128_q01

Lab ID No.:	Sample Name:	Sample Description:
6634	LDP001	Aqueous sample, pH 8.1, conductivity 2200µS/cm, total ammonia <2.0mg/L*. Sample received at 6ºC in apparent good condition

*Ammonia analysis is not covered by Ecotox Services Australasia's scope of accreditation

Test Performed:	Partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia cf dubia*
Test Protocol:	ESA SOP 102 (ESA 2013), based on USEPA (2002) and Bailey *et al*. (2000)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was serially diluted with Dilute Mineral Water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	16 May 2014 at 1300h

Sample 6634: *LDP001*

Concentration (%)	% Survival at 7 days (Mean ± SD)
DMW Control	100 ± 0.0
3.1	100 ± 0.0
6.3	100 ± 0.0
12.5	90.0 ± 31.6
25	90.0 ± 31.6
50	100 ± 0.0
100	90.0 ± 31.6

7 day EC10 (survival) = >100%
7 day EC50 (survival) = >100%
NOEC = 100%
LOEC = >100%

Sample 6634: *LDP001*

Concentration (%)	Number of Young (Mean ± SD)
DMW Control	18.0 ± 4.5
3.1	17.7 ± 5.0
6.3	17.9 ± 4.5
12.5	14.2 ± 6.4
25	13.4 ± 8.4
50	13.6 ± 4.7
100	6.4 ± 4.6 *

7 day IC10 (reproduction) = 9.1%**
7 day IC50 (reproduction) = 81.7%***
NOEC = 50%
LOEC = 100%

*Significantly lower number of young compared with the DMW Control (Dunnett's Test, 1-tailed, P=0.05)
**95% confidence limits are not reliable
***95% confidence limits are not available

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean % survival	≥80.0%	100%	Yes
Control mean number of young	≥15.0	18.0	Yes
Reference Toxicant within cusum chart limits	151.8-396.6mg KCl/L	288.5mg KCl/L	Yes

Toxicity Test Report: TR1128/7

Test Report Authorised by: Dr Rick Krassoi, Director on 27 May 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

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Citations:

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000) Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. *Environmental Toxicology and Chemistry* 19:88-93.

ESA (2013) ESA SOP 102 – *Acute Toxicity Test Using Ceriodaphnia dubia.* Issue No 9. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

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Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 30 April 2009

Sample Receipt Notification

Attention : Stuart Gray

Client : GHD Pty Ltd
Level 3, 24 Honeysuckle Drive
Newcastle NSW 2300

Email : stuart.gray@ghd.com
Telephone : (02) 4979 9017
Facsimile :

Date : 15/05/2014

Re : Receipt of Samples **Pages : 2**

ESA Project : PR1128 ☑ For Review ☐ Additional Documentation Required - Please Respond

Sample Delivery Details

Completed Chain of Custody accompanied samples: **YES**
Samples received in apparent good condition and correctly bottled: **YES**
Security seals on sample bottles and esky intact: **YES**

Date samples received : 15/05/2014
Time samples received : 8:30
No. of samples received : 1
Sample matrix : Aqueous
Sample temperature : 6°C

Comments : Includes 4x2.5L LDP001 (ESA ID# 6634).

Contact Details

Customer Services Officer : Tina Micevska
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : tmicevska@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

Note that the chain-of-custody provides definitive information on the tests to be performed

Ecotox Services Australia
ABN 45 094 714 904
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

Chain-of-Custody / Service Request Form

ecotox SERVICES AUSTRALASIA

Datasheet ID: 601.1
Last Revised: 22 January 2013

Customer: GHD NEWCASTLE
Ship To:
Contact Name: Stuart Gray
Attention: Tina Micevska
Phone: 4979 9017 Email: stuart.gray@ghd.com (please provide an email address for sample receipt notification)
Sampled by: Dan Collins - 0423 221 875

Sample Date (day/month /year)	Sample Time	Sample Name (exactly as written on the sample vessel)	Sample Method (eg. Grab, composite etc.)	Number and Volume of Containers (eg 2 x 1L)	Tests Requested (See reverse for guidance)	Comments / Instructions
					Chronic Ceriod	**Note that testing will be delayed if an incomplete chain of custody is received** • Additional treatment of samples (i.e. spiking) • Sub-contracted services (i.e. chemical analyses) • Dilutions required (if different than 100% down to 6.25%) • Sample holding time restriction (if applicable) • Sample used for litigation (if applicable) *Note: An MSDS must be attached if Available* PR 1128 **ESA Project Number: PR** 2216681
14.5.14	13:00	LDP001	Composite	4 x 2.5L amber glass	X	Dilutions: 100%, 50%, 25%, 12.5%, 6.25%, 3.125%, 0%

6634 @6°C

1) Released By:	Date:	2) Received By:	Date:	3) Released By:	Date:	4) Received By:	Date:
Dan Collins	14.5.14	KS	15/5/14				
Of: GHD	Time: 14:45	Of: ESA	Time: 830	Of:	Time:	Of:	Time:

Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.

Ecotox Services Australasia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

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Statistical Printouts for the 7-d Chronic Test with *Ceriodaphnia dubia*

Ceriodaphnia Partial Life-Cycle Test-7 Day Survival

Start Date:	16/05/2014 13:00	Test ID:	PR1128/02	Sample ID:	LDP001
End Date:	23/05/2014 10:30	Lab ID:	6634	Sample Type:	KCL-Potassium chloride
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

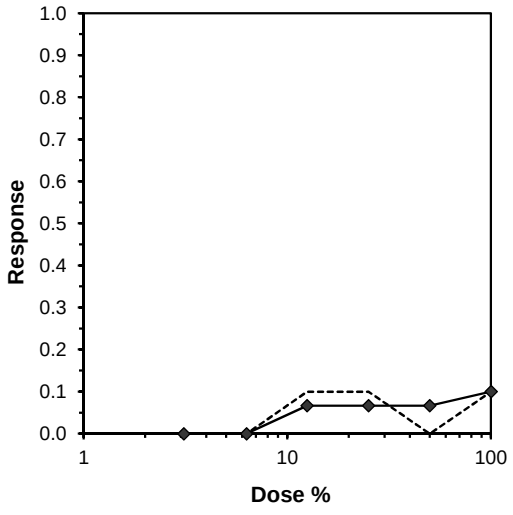
Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3.1	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	1.0000

Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Isotonic Mean	Isotonic N-Mean
DMW Control	1.0000	1.0000	0	10	10	10			1.0000	1.0000
3.1	1.0000	1.0000	0	10	10	10	1.0000	0.0500	1.0000	1.0000
6.3	1.0000	1.0000	0	10	10	10	1.0000	0.0500	1.0000	1.0000
12.5	0.9000	0.9000	1	9	10	10	0.5000	0.0500	0.9333	0.9333
25	0.9000	0.9000	1	9	10	10	0.5000	0.0500	0.9333	0.9333
50	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0.9333	0.9333
100	0.9000	0.9000	1	9	10	10	0.5000	0.0500	0.9000	0.9000

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

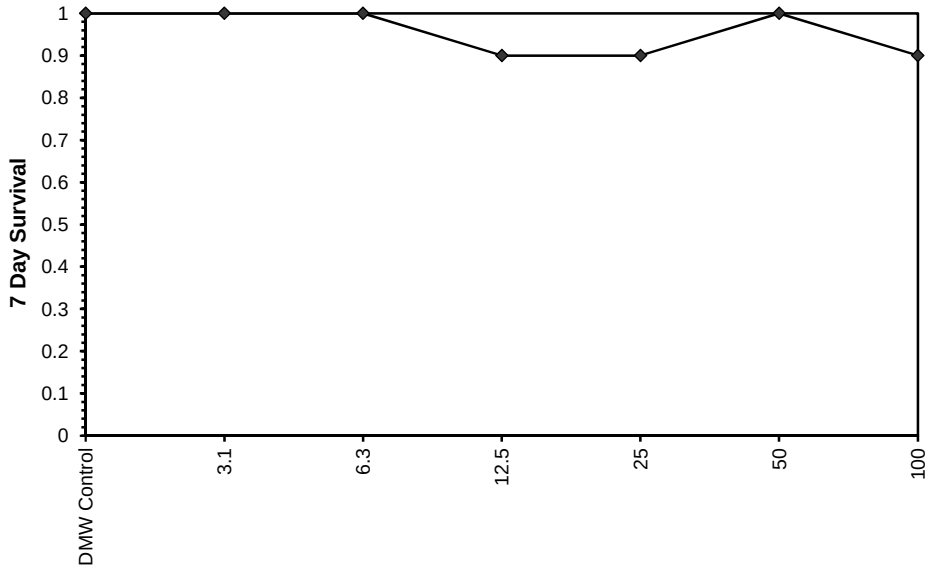
Point	%	SD	95% CL	Skew
IC05	12.120			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Ceriodaphnia Partial Life-Cycle Test-7 Day Survival

Start Date:	16/05/2014 13:00	Test ID:	PR1128/02	Sample ID:	LDP001
End Date:	23/05/2014 10:30	Lab ID:	6634	Sample Type:	KCL-Potassium chloride
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-7 Day Survival

Start Date:	16/05/2014 13:00	Test ID:	PR1128/02	Sample ID:	LDP001
End Date:	23/05/2014 10:30	Lab ID:	6634	Sample Type:	KCL-Potassium chloride
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	18.00	10.00	23.00	4.50	11.78	10
3.1		17.70	9.00	23.00	4.99	12.62	10
6.3		17.90	9.00	23.00	4.53	11.89	10
12.5		14.20	0.00	21.00	6.41	17.83	10
25		13.40	0.00	26.00	8.38	21.61	10
50		13.60	8.00	22.00	4.70	15.93	10
100		6.40	3.00	16.00	4.58	33.42	10
DMW Control	% survival	100.00	100.00	100.00	0.00	0.00	10
3.1		100.00	100.00	100.00	0.00	0.00	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		90.00	0.00	100.00	31.62	6.25	10
25		90.00	0.00	100.00	31.62	6.25	10
50		100.00	100.00	100.00	0.00	0.00	10
100		90.00	0.00	100.00	31.62	6.25	10
DMW Control	pH	7.80	7.80	7.80	0.00	0.00	1
3.1		7.20	7.20	7.20	0.00	0.00	1
6.3		7.50	7.50	7.50	0.00	0.00	1
12.5		7.80	7.80	7.80	0.00	0.00	1
25		8.00	8.00	8.00	0.00	0.00	1
50		8.10	8.10	8.10	0.00	0.00	1
100		8.10	8.10	8.10	0.00	0.00	1
DMW Control	DO %	100.00	100.00	100.00	0.00	0.00	1
3.1		98.50	98.50	98.50	0.00	0.00	1
6.3		98.80	98.80	98.80	0.00	0.00	1
12.5		98.10	98.10	98.10	0.00	0.00	1
25		98.30	98.30	98.30	0.00	0.00	1
50		98.50	98.50	98.50	0.00	0.00	1
100		100.30	100.30	100.30	0.00	0.00	1
DMW Control	Cond uS/cm	184.30	184.30	184.30	0.00	0.00	1
3.1		256.00	256.00	256.00	0.00	0.00	1
6.3		323.00	323.00	323.00	0.00	0.00	1
12.5		455.00	455.00	455.00	0.00	0.00	1
25		709.00	709.00	709.00	0.00	0.00	1
50		1210.00	1210.00	1210.00	0.00	0.00	1
100		2200.00	2200.00	2200.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	16/05/2014 13:00	Test ID:	PR1128/02	Sample ID:	LDP001
End Date:	23/05/2014 10:30	Lab ID:	6634	Sample Type:	KCL-Potassium chloride
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	23.000	15.000	20.000	20.000	19.000	11.000	19.000	10.000	21.000	22.000
3.1	14.000	19.000	23.000	23.000	17.000	11.000	23.000	19.000	19.000	9.000
6.3	16.000	20.000	17.000	18.000	21.000	21.000	12.000	22.000	23.000	9.000
12.5	13.000	21.000	21.000	19.000	11.000	0.000	14.000	10.000	19.000	14.000
25	21.000	0.000	16.000	26.000	5.000	13.000	8.000	24.000	11.000	10.000
50	12.000	10.000	22.000	13.000	8.000	11.000	21.000	13.000	10.000	16.000
100	3.000	12.000	4.000	10.000	3.000	4.000	16.000	4.000	4.000	4.000

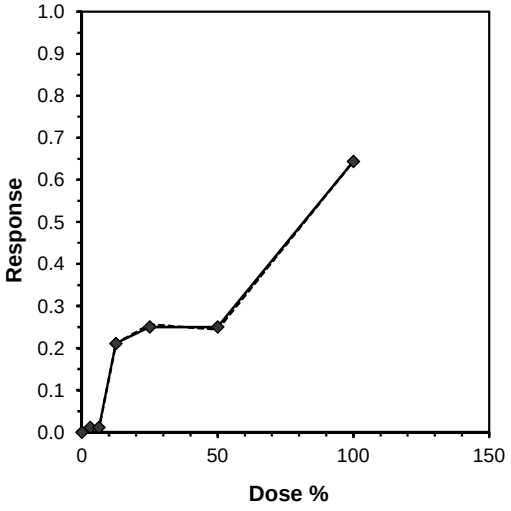
			Transform: Untransformed					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
DMW Control	18.000	1.0000	18.000	10.000	23.000	24.983	10				18.000	1.0000
3.1	17.700	0.9833	17.700	9.000	23.000	28.192	10	0.120	2.347	5.884	17.800	0.9889
6.3	17.900	0.9944	17.900	9.000	23.000	25.322	10	0.040	2.347	5.884	17.800	0.9889
12.5	14.200	0.7889	14.200	0.000	21.000	45.129	10	1.516	2.347	5.884	14.200	0.7889
25	13.400	0.7444	13.400	0.000	26.000	62.556	10	1.835	2.347	5.884	13.500	0.7500
50	13.600	0.7556	13.600	8.000	22.000	34.523	10	1.755	2.347	5.884	13.500	0.7500
*100	6.400	0.3556	6.400	3.000	16.000	71.489	10	4.627	2.347	5.884	6.400	0.3556

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates normal distribution (p > 0.05)	0.62113	0.895	-0.18015	0.165483
Bartlett's Test indicates equal variances (p = 0.34)	6.796889	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	50	100	70.71068	2	5.884302	0.326906	169.5952	31.4254	1.5E-04	6, 63
Treatments vs DMW Control										

Linear Interpolation (200 Resamples)

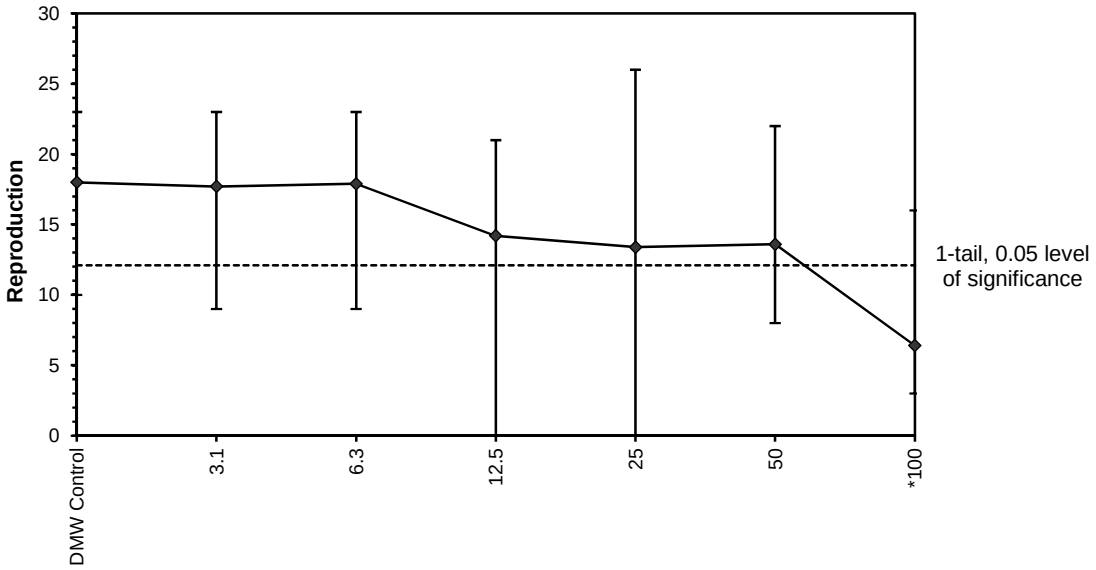
Point	%	SD	95% CL		Skew
IC05	7.506	3.550	0.941	14.257	1.0954
IC10	9.056	4.852	1.882	23.619	1.5858
IC15	10.606	8.565	2.823	35.762	2.7272
IC20	12.156	13.178	6.125	54.429	1.7287
IC25	50.000	17.571	9.268	60.002	0.5853
IC40	69.014				
IC50	81.690				



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	16/05/2014 13:00	Test ID:	PR1128/02	Sample ID:	LDP001
End Date:	23/05/2014 10:30	Lab ID:	6634	Sample Type:	KCL-Potassium chloride
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	16/05/2014 13:00	Test ID:	PR1128/02	Sample ID:	LDP001
End Date:	23/05/2014 10:30	Lab ID:	6634	Sample Type:	KCL-Potassium chloride
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	18.00	10.00	23.00	4.50	11.78	10
3.1		17.70	9.00	23.00	4.99	12.62	10
6.3		17.90	9.00	23.00	4.53	11.89	10
12.5		14.20	0.00	21.00	6.41	17.83	10
25		13.40	0.00	26.00	8.38	21.61	10
50		13.60	8.00	22.00	4.70	15.93	10
100		6.40	3.00	16.00	4.58	33.42	10
DMW Control	% survival	100.00	100.00	100.00	0.00	0.00	10
3.1		100.00	100.00	100.00	0.00	0.00	10
6.3		100.00	100.00	100.00	0.00	0.00	10
12.5		90.00	0.00	100.00	31.62	6.25	10
25		90.00	0.00	100.00	31.62	6.25	10
50		100.00	100.00	100.00	0.00	0.00	10
100		90.00	0.00	100.00	31.62	6.25	10
DMW Control	pH	7.80	7.80	7.80	0.00	0.00	1
3.1		7.20	7.20	7.20	0.00	0.00	1
6.3		7.50	7.50	7.50	0.00	0.00	1
12.5		7.80	7.80	7.80	0.00	0.00	1
25		8.00	8.00	8.00	0.00	0.00	1
50		8.10	8.10	8.10	0.00	0.00	1
100		8.10	8.10	8.10	0.00	0.00	1
DMW Control	DO %	100.00	100.00	100.00	0.00	0.00	1
3.1		98.50	98.50	98.50	0.00	0.00	1
6.3		98.80	98.80	98.80	0.00	0.00	1
12.5		98.10	98.10	98.10	0.00	0.00	1
25		98.30	98.30	98.30	0.00	0.00	1
50		98.50	98.50	98.50	0.00	0.00	1
100		100.30	100.30	100.30	0.00	0.00	1
DMW Control	Cond uS/cm	184.30	184.30	184.30	0.00	0.00	1
3.1		256.00	256.00	256.00	0.00	0.00	1
6.3		323.00	323.00	323.00	0.00	0.00	1
12.5		455.00	455.00	455.00	0.00	0.00	1
25		709.00	709.00	709.00	0.00	0.00	1
50		1210.00	1210.00	1210.00	0.00	0.00	1
100		2200.00	2200.00	2200.00	0.00	0.00	1

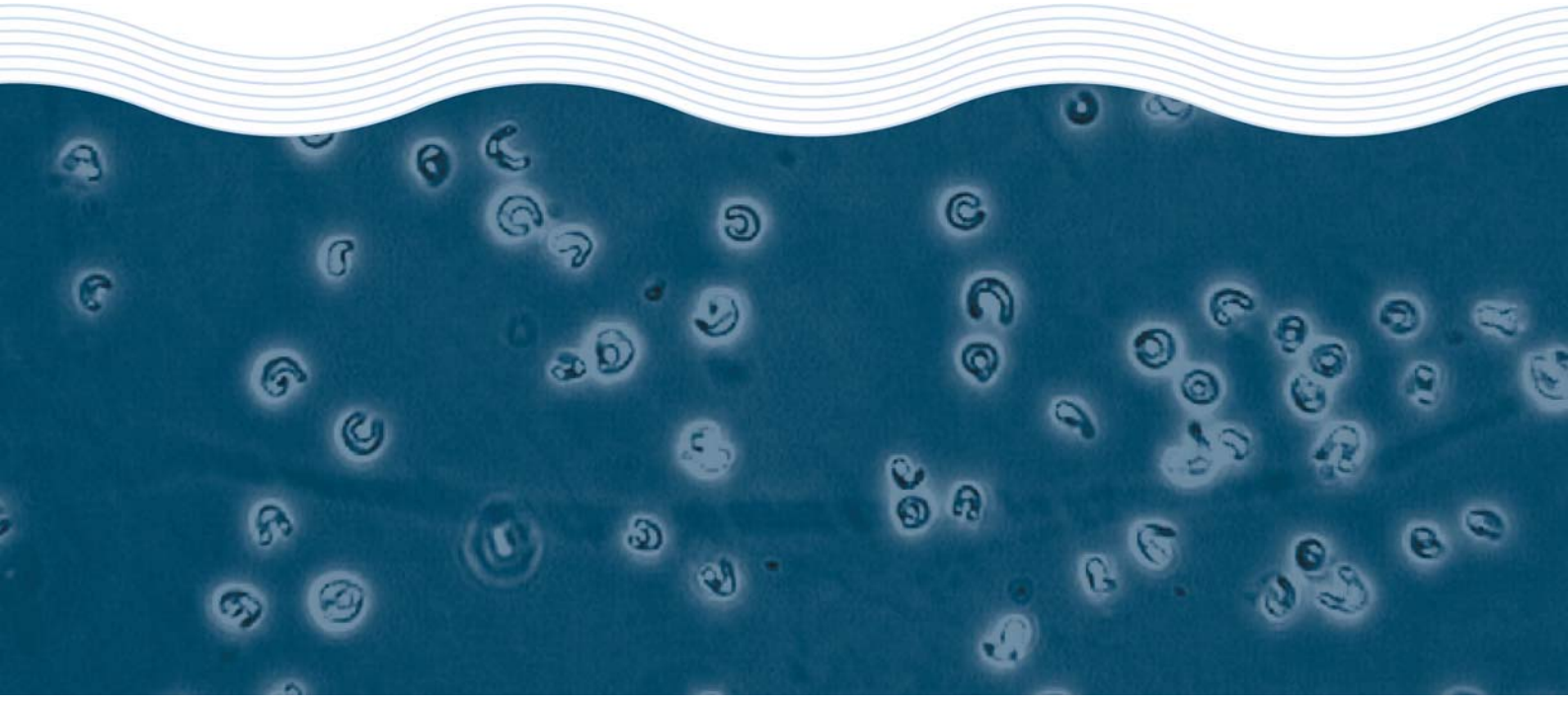
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SERVICES AUSTRALASIA

Toxicity Assessment of a Freshwater Sample

GHD Pty Ltd

Test Report

November 2014



Toxicity Assessment of a Freshwater Sample

GHD Pty Ltd

Test Report

November 2014

ECOTOX Services Australasia Pty Ltd ABN>45 094 714 904
unit 27/2 chaplin drive lane cove nsw 2066 T>61 2 9420 9481 F>61 2 9420 9484 W>www.ecotox.com.au

Toxicity Test Report: TR1249/1

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd Level 3, 24 Honeysuckle Drive Newcastle NSW 2300	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1249 12 November 2014 13 November 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1249_q01

Lab ID No.:	Sample Name:	Sample Description:
6922	LDP001-A	Aqueous sample, pH 7.8*, conductivity 2530µS/cm*, total ammonia <2.0mg/L*. Sample received at 15ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Partial life-cycle toxicity test using the freshwater cladoceran *Ceriodaphnia cf dubia*
Test Protocol:	ESA SOP 102 (ESA 2013), based on USEPA (2002) and Bailey *et al*. (2000)
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was serially diluted with Dilute Mineral Water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	14 November 2014 at 1400h

Sample 6922: *LDP001-A*

Concentration (%)	% Survival at 7 days (Mean ± SD)
DMW Control	100 ± 0.0
3.1	90.0 ± 31.6
6.3	80.0 ± 42.2
12.5	100 ± 0.0
25	100 ± 0.0
50	90.0 ± 31.6
100	100 ± 0.0

7 day EC10 (survival) = >100%
7 day EC50 (survival) = >100%
NOEC = 100%
LOEC = >100%

Sample 6922: *LDP001-A*

Concentration (%)	Number of Young (Mean ± SD)
DMW Control	15.1 ± 5.1
3.1	11.9 ± 5.4
6.3	11.3 ± 5.3
12.5	13.0 ± 5.3
25	14.1 ± 4.2
50	10.6 ± 6.4
100	9.5 ± 4.7

7 day IC10 (reproduction) = Not reliable*
7 day IC50 (reproduction) = >100%
NOEC = 50%
LOEC = 100%

*IC10 is not reliable due to an interrupted dose response in the sample

QA/QC Parameter	Criterion	This Test	Criterion met?
Control mean % survival	≥80.0%	100%	Yes
Control mean number of young	≥15.0	15.1	Yes
Reference Toxicant within cusum chart limits	144.8-419.7mg KCl/L	226.0mg KCl/L	Yes

Toxicity Test Report: TR1249/1

Test Report Authorised by:  Dr Rick Krassoi, Director on 4 December 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

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Citations:

Bailey, H.C., Krassoi, R., Elphick, J.R., Mulhall, A., Hunt, P., Tedmanson, L. and Lovell, A. (2000) Application of *Ceriodaphnia cf. dubia* for whole effluent toxicity tests in the Hawkesbury-Nepean watershed, New South Wales, Australia: method development and validation. *Environmental Toxicology and Chemistry* 19:88-93.

ESA (2013) ESA SOP 102 – *Acute Toxicity Test Using Ceriodaphnia dubia.* Issue No 9. Ecotox Services Australasia, Sydney, NSW.

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

Toxicity Test Report: TR1249/2

Accredited for compliance with ISO/IEC 17025

Client:	GHD Pty Ltd	**ESA Job #:**	PR1249
	Level 3, 24 Honeysuckle Drive	**Date Sampled:**	12 November 2014
	Newcastle NSW 2300	**Date Received:**	13 November 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1249_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6922	LDP001-A	Aqueous sample, pH 7.8*, conductivity 2530µS/cm*, total ammonia <2.0mg/L*. Sample received at 15ºC* in apparent good condition.

*NATA accreditation does not cover the performance of this service

Test Performed:	Rainbowfish embryo hatching test using *Melanotaenia splendida splendida*
Test Protocol:	ESA SOP 126 (2013), based on USEPA (2002), but adapted for use with native rainbowfish
Test Temperature:	The test was performed at 25±1°C.
Deviations from Protocol:	Nil
Comments on Solution Preparation:	The sample was serially diluted with dilute mineral water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	ESA Laboratory culture
Test Initiated:	14 November 2014 at 1400h

Sample 6922: *LDP001-A* **Concentration (%)**	**% Un-affected (Mean ± SD)**	*Vacant*	*Vacant*
DMW Control	95.0 ± 10.0		
3.1	75.0 ± 10.0		
6.3	95.0 ± 10.0		
12.5	85.0 ± 19.2		
25	85.0 ± 10.0		
50	55.0 ± 19.2 *		
100	85.0 ± 19.2		

13-d EC10 = Not reliable**
13-d EC50 = >100%
NOEC = 100%
LOEC = >100%

*Significantly lower percent unaffected compared with the DMW Control (Dunnett's Test, 1-tailed, P=0.05)
**IC10 is not reliable due to an interrupted dose response in the sample

QA/QC Parameter	**Criterion**	**This Test**	**Criterion met?**
Control mean % survival	≥80.0%	95.0%	Yes
Reference Toxicant within cusum chart limit	12.0-61.3µg Cu/L	29.1µg Cu/L	Yes

Toxicity Test Report: TR1249/2

Test Report Authorised by: Dr Rick Krassoi, Director on 4 December 2014

Results are based on the samples in the condition as received by ESA.

NATA Accredited Laboratory Number: 14709

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Citations:

ESA (2013) *SOP 126- Rainbowfish Embryo Hatching Test*. Issue N°3. Ecotox Services Australasia, Sydney NSW

USEPA (2002) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms.4th Ed.* United States Environmental Protection Agency, Office of Water, Washington DC.

Toxicity Test Report: TR1249/3

Client:	GHD Pty Ltd Level 3, 24 Honeysuckle Drive Newcastle NSW 2300	**ESA Job #:** **Date Sampled:** **Date Received:**	PR1249 13 November 2014 14 November 2014
Attention:	Stuart Gray	**Sampled By:**	Client
Client Ref:	Not supplied	**ESA Quote #:**	PL1249_q01

Lab ID No.:	**Sample Name:**	**Sample Description:**
6928	LDP001-B	Aqueous sample, pH 7.9, conductivity 2560µS/cm, total ammonia <2.0mg/L. Sample received at 15ºC in apparent good condition.

Test Performed:	10-day acute survival test using the freshwater shrimp *Paratya australiensis*
Test Protocol:	ESA SOP 123 (ESA 2012), based on USEPA (1996)
Test Temperature:	The test was performed at 20±1°C.
Deviations from Protocol:	The test was extended to 10 days, as per client's request. The test solutions were renewed every 48 hours, with the organisms fed 3 hours prior to solution renewal.
Comments on Solution Preparation:	The sample was serially diluted with dilute mineral water (DMW) to achieve the test concentrations. A DMW control was tested concurrently with the sample.
Source of Test Organisms:	Hatchery reared, QLD
Test Initiated:	20 November 2014 at 1200h

Sample 6928: *LDP001-B* **Concentration (%)**	**% Unaffected (Mean ± SD)**	*Vacant*	*Vacant*
DMW Control	80.0 ± 16.3		
3.1	95.0 ± 10.0		
6.3	100 ± 0.0		
12.5	100 ± 0.0		
25	100 ± 0.0		
50	100 ± 0.0		
100	100 ± 0.0		
10-day EC10 = >100% **10-day EC50 = >100%** **NOEC = 100%** **LOEC = >100%**			

QA/QC Parameter	**Criterion**	**This Test**	**Criterion met?**
10-day control mean % unaffected	≥80.0%	80.0%	Yes
Control mean % unaffected	≥90.0%	100%	Yes
Reference Toxicant within cusum chart limits	37.8-744.9µg Cu/L	89.1µg Cu/L	Yes

Toxicity Test Report: TR1249/3

Test Report Authorised by: Dr Rick Krassoi, Director on 4 December 2014

Results are based on the samples in the condition as received by ESA. This document shall not be reproduced except in full.

Citations:

ESA (2012) SOP 123 –*Acute Toxicity Test Using Freshwater Shrimp.* Issue No 2. Ecotox Services Australasia, Sydney, NSW

USEPA (1996) Ecological Effects Test Guidelines: OPPTS 850.1035 Mysid Acute Toxicity Test. Public Draft. United States Environmental Protection Agency, Washington DC, USA.

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Chain-of-Custody Documentation

Datasheet ID: 601.2
Last Revised: 30 April 2009

Sample Receipt Notification

Attention : Tess Davies

Client : GHD Pty Ltd
GHD Tower, Level 3, 24 Honeysuckle Dr
Newcastle NSW 2300

Email : tess.davies@ghd.com
Telephone : 02 49799993
Facsimile :

Date : 13/11/2014

Re : Receipt of Samples **Pages : 2**

ESA Project : PR1249 ☑ For Review ☐ Additional Documentation Required - Please Respond

Sample Delivery Details

Completed Chain of Custody accompanied samples: YES
Samples received in apparent good condition and correctly bottled: YES
Security seals on sample bottles and esky intact: YES

Date samples received : 13/11/2014
Time samples received : 9:30
No. of samples received : 1
Sample matrix : Aqueous
Sample temperature : 15°C

Comments : Includes 3x5L LDP001-A (ESA ID# 6922)

Contact Details

Customer Services Officer : Tina Micevska
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : tmicevska@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

Note that the chain-of-custody provides definitive information on the tests to be performed

Ecotox Services Australia
ABN 45 094 714 904
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

Chain-of-Custody / Service Request Form

ecotox SERVICES AUSTRALASIA

Datasheet ID: 601.1
Last Revised: 15 July 2014

Customer: GHD
Contact Name: Tess Davies
Phone: 0404941556 Email: tess.davies@ghd.com (please provide an email address for sample receipt notification)
Sampled by: TD

Ship To:
Attention:

Sample Date (day/month /year)	Sample Time	Sample Name (exactly as written on the sample vessel)	Sample Method (eg. Grab, composite etc.)	Number and Volume of Containers (eg 2 x 1L)	Tests Requested (See reverse for guidance)	Comments / Instructions
12/11/14	1pm	LDP001-A	Composite	3x5L	See email	

6922 ~15

Note that testing will be delayed if an incomplete chain of custody is received

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

Note: An MSDS must be attached if Available

ESA Project Number: PR 1249

1) Released By:	Date:	2) Received By:	Date:	3) Released By:	Date:	4) Received By:	Date:
TD	12/11	Tina	13/11/14				
Of: GHD	Time: 3:20pm	Of: ESA	Time: 9:30	Of:	Time:	Of:	Time:

Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.

Ecotox Services Australasia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

Datasheet ID: 601.2
Last Revised: 30 April 2009

Sample Receipt Notification

Attention : Tess Davies

Client : GHD Pty Ltd
GHD Tower, Level 3, 24 Honeysuckle Dr
Newcastle NSW 2300

Email : tess.davies@ghd.com
Telephone : 02 49799993
Facsimile :

Date : 14/11/2014

Re : Receipt of Samples **Pages : 2**

ESA Project : PR1249 ☑ For Review ☐ Additional Documentation Required - Please Respond

Sample Delivery Details

Completed Chain of Custody accompanied samples: YES
Samples received in apparent good condition and correctly bottled: YES
Security seals on sample bottles and esky intact: YES

Date samples received : 14/11/2014
Time samples received : 9:40
No. of samples received : 1
Sample matrix : Aqueous
Sample temperature : 15°C

Comments : Includes 4x5L LDP001-B (ESA ID# 6928)

Contact Details

Customer Services Officer : Tina Micevska
Telephone : 61 2 9420 9481
Facsimile : 61 2 9420 9484
Email : tmicevska@ecotox.com.au

Please contact customer services officer for all queries or issues regarding samples

Note that the chain-of-custody provides definitive information on the tests to be performed

Ecotox Services Australia
ABN 45 094 714 904
Unit 27, 2 Chaplin Drive
Lane Cove NSW 2066 Australia

Phone : 61 2 9420 9481
Fax : 61 2 9420 9484
Email : info@ecotox.com.au

Chain-of-Custody / Service Request Form

Datasheet ID: 601.1
Last Revised: 15 July 2014

ecotox SERVICES AUSTRALASIA

Customer: GHD
Contact Name: Tess Davies
Phone: 0404941556 Email: tess.davies@ghd.com (please provide an email address for sample receipt notification)
Sampled by: TD

Ship To:
Attention:

Sample Date (day/month /year)	Sample Time	Sample Name (exactly as written on the sample vessel)	Sample Method (eg. Grab, composite etc.)	Number and Volume of Containers (eg 2 x 1L)	Tests Requested (See reverse for guidance)	Comments / Instructions
13/11/14	1:30	LDP001-B	Composite	4x5L		

Note that testing will be delayed if an incomplete chain of custody is received

- Additional treatment of samples (i.e. spiking)
- Sub-contracted services (i.e. chemical analyses)
- Dilutions required (if different than 100% down to 6.25%)
- Sample holding time restriction (if applicable)
- Sample used for litigation (if applicable)

Note: An MSDS must be attached if Available

ESA Project Number: PR 1249

928
15°C

1) Released By:	Date:	2) Received By:	Date:	3) Released By:	Date:	4) Received By:	Date:
TD	13/11/14	Tina	14/11/14				
Of: GHD	Time:	Of: ESA	Time: 9:40	Of:	Time:	Of:	Time:

Note that the chain-of-custody documentation will provide definitive information on the tests to be performed.

Ecotox Services Australasia . Unit 27, 2 Chaplin Drive, Lane Cove NSW 2066 AUSTRALIA
Phone: 61 2 9420-9481 Fax 61 2 9420-9484 info@ecotox.com.au

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Statistical Printouts for the 7-d Chronic Test with *Ceriodaphnia dubia*

Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	14/11/2014 14:00	Test ID:	PR1249/02	Sample ID:	LDP001
End Date:	21/11/2014 14:15	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	17.000	18.000	18.000	17.000	9.000	20.000	21.000	13.000	5.000	13.000
3.1	17.000	3.000	9.000	16.000	21.000	9.000	16.000	10.000	8.000	10.000
6.3	15.000	19.000	14.000	8.000	10.000	14.000	9.000	15.000	9.000	0.000
12.5	12.000	24.000	21.000	8.000	10.000	11.000	10.000	14.000	10.000	10.000
25	18.000	19.000	12.000	15.000	12.000	12.000	10.000	11.000	22.000	10.000
50	0.000	17.000	18.000	13.000	17.000	16.000	5.000	5.000	6.000	9.000
100	2.000	11.000	5.000	9.000	13.000	18.000	10.000	5.000	9.000	13.000

			Transform: Untransformed					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	15.100	1.0000	15.100	5.000	21.000	33.544	10			15.100	1.0000
3.1	11.900	0.7881	11.900	3.000	21.000	45.245	10	85.50	74.00	12.575	0.8328
6.3	11.300	0.7483	11.300	0.000	19.000	46.837	10	85.00	74.00	12.575	0.8328
12.5	13.000	0.8609	13.000	8.000	24.000	40.704	10	91.50	74.00	12.575	0.8328
25	14.100	0.9338	14.100	10.000	22.000	29.800	10	96.00	74.00	12.575	0.8328
50	10.600	0.7020	10.600	0.000	18.000	60.521	10	82.50	74.00	10.600	0.7020
100	9.500	0.6291	9.500	2.000	18.000	49.185	10	76.00	74.00	9.500	0.6291

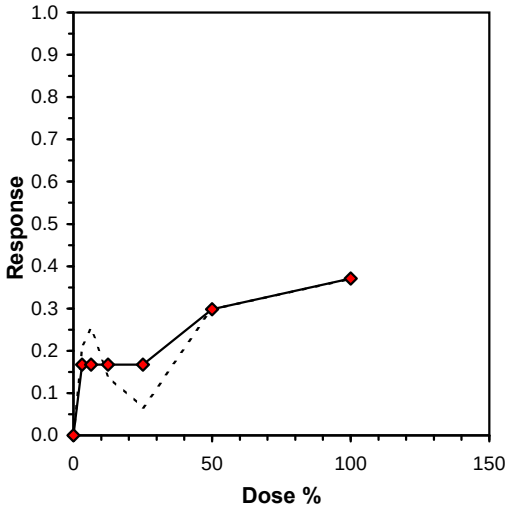
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Kolmogorov D Test indicates non-normal distribution (p <= 0.05)	1.011523	0.895	0.003864	-0.44458
Bartlett's Test indicates equal variances (p = 0.94)	1.789101	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs DMW Control				

Linear Interpolation (200 Resamples)

Point	%	SD	95% CL		Skew
IC05*	0.927	11.388	0.487	38.626	3.4267
IC10*	1.854				
IC15*	2.781				
IC20	31.266				
IC25	40.823				
IC40	>100				
IC50	>100				

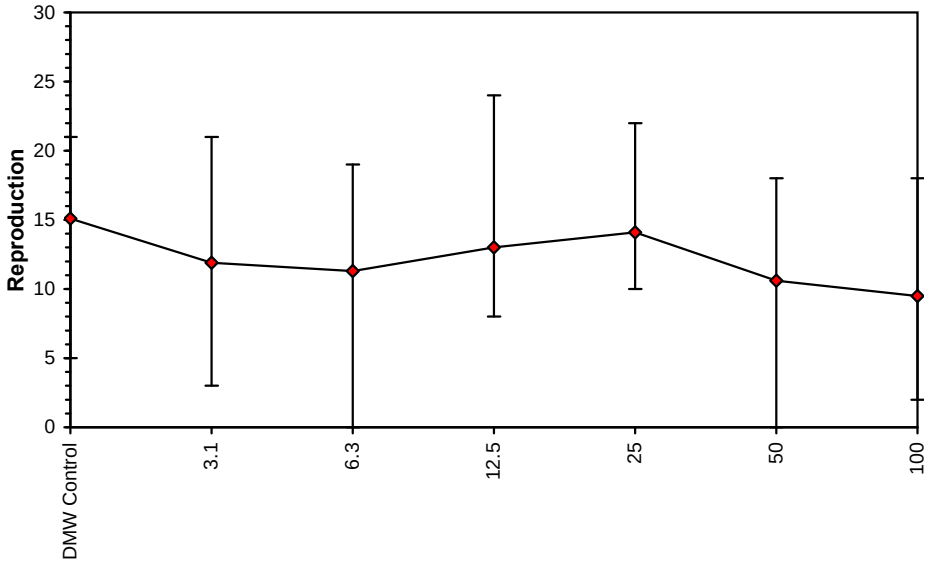
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	14/11/2014 14:00	Test ID:	PR1249/02	Sample ID:	LDP001
End Date:	21/11/2014 14:15	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-Reproduction

Start Date:	14/11/2014 14:00	Test ID:	PR1249/02	Sample ID:	LDP001
End Date:	21/11/2014 14:15	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	15.10	5.00	21.00	5.07	14.90	10
3.1		11.90	3.00	21.00	5.38	19.50	10
6.3		11.30	0.00	19.00	5.29	20.36	10
12.5		13.00	8.00	24.00	5.29	17.69	10
25		14.10	10.00	22.00	4.20	14.54	10
50		10.60	0.00	18.00	6.42	23.89	10
100		9.50	2.00	18.00	4.67	22.75	10
DMW Control	% unaffected	100.00	100.00	100.00	0.00	0.00	10
3.1		90.00	0.00	100.00	31.62	6.25	10
6.3		80.00	0.00	100.00	42.16	8.12	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		100.00	100.00	100.00	0.00	0.00	10
50		90.00	0.00	100.00	31.62	6.25	10
100		100.00	100.00	100.00	0.00	0.00	10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.30	8.30	8.30	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.40	8.40	8.40	0.00	0.00	1
100		8.30	8.30	8.30	0.00	0.00	1
DMW Control	DO %	101.80	101.80	101.80	0.00	0.00	1
3.1		101.10	101.10	101.10	0.00	0.00	1
6.3		101.90	101.90	101.90	0.00	0.00	1
12.5		102.70	102.70	102.70	0.00	0.00	1
25		103.00	103.00	103.00	0.00	0.00	1
50		103.70	103.70	103.70	0.00	0.00	1
100		105.00	105.00	105.00	0.00	0.00	1
DMW Control	Cond uS/cm	191.00	191.00	191.00	0.00	0.00	1
3.1		270.00	270.00	270.00	0.00	0.00	1
6.3		352.00	352.00	352.00	0.00	0.00	1
12.5		513.00	513.00	513.00	0.00	0.00	1
25		817.00	817.00	817.00	0.00	0.00	1
50		1424.00	1424.00	1424.00	0.00	0.00	1
100		2610.00	2610.00	2610.00	0.00	0.00	1

Ceriodaphnia Partial Life-Cycle Test-7 Day Unaffected

Start Date:	14/11/2014 14:00	Test ID:	PR1249/02	Sample ID:	LDP001
End Date:	21/11/2014 14:15	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Conc-%	1	2	3	4	5	6	7	8	9	10
DMW Control	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3.1	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6.3	1.0000	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000
12.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
50	0.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

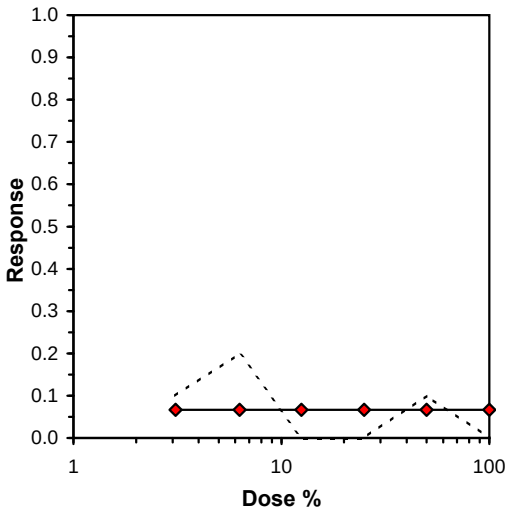
Conc-%	Mean	N-Mean	Resp	Not Resp	Total	N	Fisher's Exact P	1-Tailed Critical	Isotonic Mean	Isotonic N-Mean
DMW Control	1.0000	1.0000	0	10	10	10			1.0000	1.0000
3.1	0.9000	0.9000	1	9	10	10	0.5000	0.0500	0.9333	0.9333
6.3	0.8000	0.8000	2	8	10	10	0.2368	0.0500	0.9333	0.9333
12.5	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0.9333	0.9333
25	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0.9333	0.9333
50	0.9000	0.9000	1	9	10	10	0.5000	0.0500	0.9333	0.9333
100	1.0000	1.0000	0	10	10	10	1.0000	0.0500	0.9333	0.9333

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Fisher's Exact Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

Point	%	SD	95% CL	Skew
IC05*	2.8398			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			

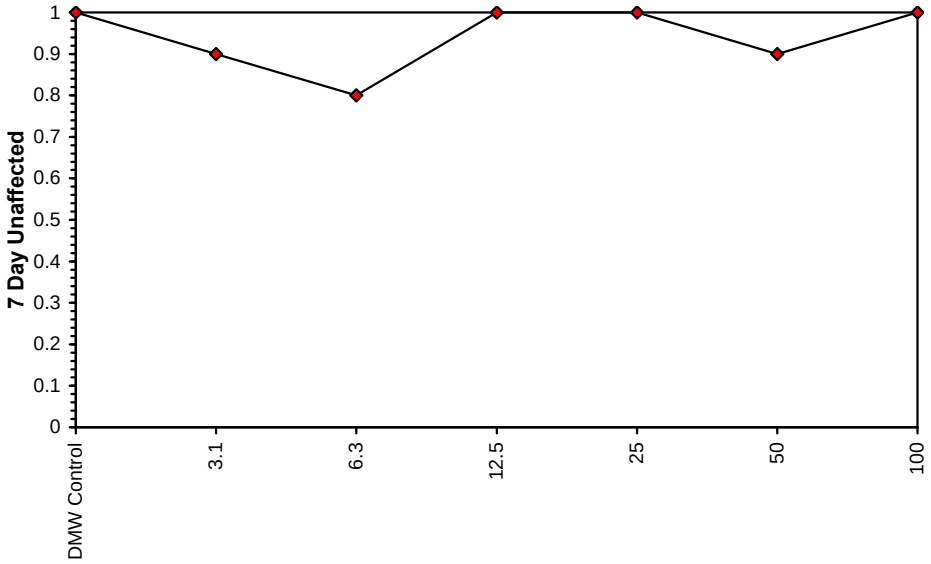
* indicates IC estimate less than the lowest concentration



Ceriodaphnia Partial Life-Cycle Test-7 Day Unaffected

Start Date:	14/11/2014 14:00	Test ID:	PR1249/02	Sample ID:	LDP001
End Date:	21/11/2014 14:15	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Dose-Response Plot



Ceriodaphnia Partial Life-Cycle Test-7 Day Unaffected

Start Date:	14/11/2014 14:00	Test ID:	PR1249/02	Sample ID:	LDP001
End Date:	21/11/2014 14:15	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 102	Test Species:	CD-Ceriodaphnia dubia
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	No of Young	15.10	5.00	21.00	5.07	14.90	10
3.1		11.90	3.00	21.00	5.38	19.50	10
6.3		11.30	0.00	19.00	5.29	20.36	10
12.5		13.00	8.00	24.00	5.29	17.69	10
25		14.10	10.00	22.00	4.20	14.54	10
50		10.60	0.00	18.00	6.42	23.89	10
100		9.50	2.00	18.00	4.67	22.75	10
DMW Control	% unaffected	100.00	100.00	100.00	0.00	0.00	10
3.1		90.00	0.00	100.00	31.62	6.25	10
6.3		80.00	0.00	100.00	42.16	8.12	10
12.5		100.00	100.00	100.00	0.00	0.00	10
25		100.00	100.00	100.00	0.00	0.00	10
50		90.00	0.00	100.00	31.62	6.25	10
100		100.00	100.00	100.00	0.00	0.00	10
DMW Control	pH	8.10	8.10	8.10	0.00	0.00	1
3.1		8.20	8.20	8.20	0.00	0.00	1
6.3		8.20	8.20	8.20	0.00	0.00	1
12.5		8.30	8.30	8.30	0.00	0.00	1
25		8.30	8.30	8.30	0.00	0.00	1
50		8.40	8.40	8.40	0.00	0.00	1
100		8.30	8.30	8.30	0.00	0.00	1
DMW Control	DO %	101.80	101.80	101.80	0.00	0.00	1
3.1		101.10	101.10	101.10	0.00	0.00	1
6.3		101.90	101.90	101.90	0.00	0.00	1
12.5		102.70	102.70	102.70	0.00	0.00	1
25		103.00	103.00	103.00	0.00	0.00	1
50		103.70	103.70	103.70	0.00	0.00	1
100		105.00	105.00	105.00	0.00	0.00	1
DMW Control	Cond uS/cm	191.00	191.00	191.00	0.00	0.00	1
3.1		270.00	270.00	270.00	0.00	0.00	1
6.3		352.00	352.00	352.00	0.00	0.00	1
12.5		513.00	513.00	513.00	0.00	0.00	1
25		817.00	817.00	817.00	0.00	0.00	1
50		1424.00	1424.00	1424.00	0.00	0.00	1
100		2610.00	2610.00	2610.00	0.00	0.00	1

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Statistical Printouts for the Fish Embryonic Development and Post-hatch Survival Tests

Fish Embryonic Development-% Unaffected

Start Date:	14/11/2014 14:00	Test ID:	PR1249/03	Sample ID:	LDP001-A
End Date:	27/11/2014 13:30	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Conc-%	1	2	3	4
DMW Control	1.0000	1.0000	0.8000	1.0000
3.1	0.8000	0.8000	0.8000	0.6000
6.3	1.0000	0.8000	1.0000	1.0000
12.5	1.0000	1.0000	0.8000	0.6000
25	1.0000	0.8000	0.8000	0.8000
50	0.8000	0.6000	0.4000	0.4000
100	0.6000	0.8000	1.0000	1.0000

			Transform: Arcsin Square Root					1-Tailed			Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	t-Stat	Critical	MSD	Mean	N-Mean
DMW Control	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4				0.9500	1.0000
3.1	0.7500	0.7895	1.0519	0.8861	1.1071	10.508	4	1.994	2.451	0.2876	0.8500	0.8947
6.3	0.9500	1.0000	1.2857	1.1071	1.3453	9.261	4	0.000	2.451	0.2876	0.8500	0.8947
12.5	0.8500	0.8947	1.1709	0.8861	1.3453	18.840	4	0.979	2.451	0.2876	0.8500	0.8947
25	0.8500	0.8947	1.1667	1.1071	1.3453	10.206	4	1.015	2.451	0.2876	0.8500	0.8947
*50	0.5500	0.5789	0.8407	0.6847	1.1071	23.960	4	3.794	2.451	0.2876	0.7000	0.7368
100	0.8500	0.8947	1.1709	0.8861	1.3453	18.840	4	0.979	2.451	0.2876	0.7000	0.7368

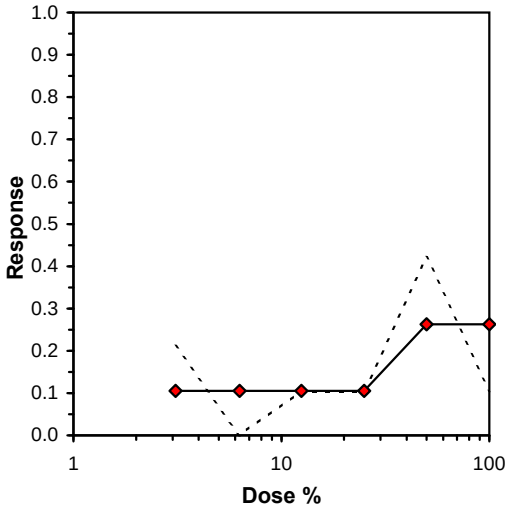
Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates normal distribution (p > 0.05)	0.935499	0.924	-0.29601	-0.63055
Bartlett's Test indicates equal variances (p = 0.76)	3.391709	16.81189		

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU	MSDu	MSDp	MSB	MSE	F-Prob	df
Dunnett's Test	100	>100		1	0.214512	0.232931	0.094981	0.027523	0.015681	6, 21
Treatments vs DMW Control										

Log-Logit Interpolation (200 Resamples)

Point	%	SD	95% CL(Exp)		Skew
IC05*	1.313	7.967	0.925	44.135	1.9964
IC10*	2.914				
IC15	31.670				
IC20	39.445				
IC25	47.719				
IC40	>100				
IC50	>100				

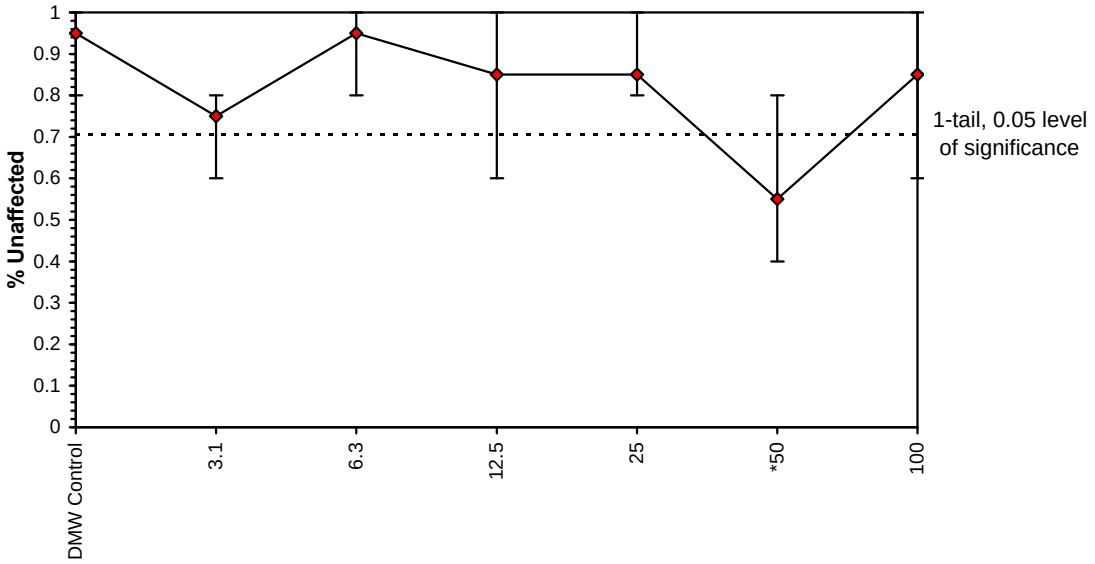
* indicates IC estimate less than the lowest concentration



Fish Embryonic Development-% Unaffected

Start Date:	14/11/2014 14:00	Test ID:	PR1249/03	Sample ID:	LDP001-A
End Date:	27/11/2014 13:30	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Dose-Response Plot



Fish Embryonic Development-% Unaffected

Start Date:	14/11/2014 14:00	Test ID:	PR1249/03	Sample ID:	LDP001-A
End Date:	27/11/2014 13:30	Lab ID:	6922	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 126	Test Species:	MS-Melanotaenia splendida
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Unaffected	95.00	80.00	100.00	10.00	3.33	4
3.1		75.00	60.00	80.00	10.00	4.22	4
6.3		95.00	80.00	100.00	10.00	3.33	4
12.5		85.00	60.00	100.00	19.15	5.15	4
25		85.00	80.00	100.00	10.00	3.72	4
50		55.00	40.00	80.00	19.15	7.96	4
100		85.00	60.00	100.00	19.15	5.15	4
DMW Control	pH	8.00	8.00	8.00	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		8.00	8.00	8.00	0.00	0.00	1
12.5		8.00	8.00	8.00	0.00	0.00	1
25		8.00	8.00	8.00	0.00	0.00	1
50		8.00	8.00	8.00	0.00	0.00	1
100		7.80	7.80	7.80	0.00	0.00	1
DMW Control	Conductivity (uS/cm)	171.20	171.20	171.20	0.00	0.00	1
3.1		253.00	253.00	253.00	0.00	0.00	1
6.3		332.00	332.00	332.00	0.00	0.00	1
12.5		488.00	488.00	488.00	0.00	0.00	1
25		793.00	793.00	793.00	0.00	0.00	1
50		1383.00	1383.00	1383.00	0.00	0.00	1
100		2530.00	2530.00	2530.00	0.00	0.00	1
DMW Control	DO (% sat)	98.20	98.20	98.20	0.00	0.00	1
3.1		98.50	98.50	98.50	0.00	0.00	1
6.3		99.30	99.30	99.30	0.00	0.00	1
12.5		99.40	99.40	99.40	0.00	0.00	1
25		100.70	100.70	100.70	0.00	0.00	1
50		103.30	103.30	103.30	0.00	0.00	1
100		107.80	107.80	107.80	0.00	0.00	1

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Statistical Printouts for the Freshwater Shrimp Tests

Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	20/11/2014 12:00	Test ID:	PR1249/06	Sample ID:	LDP001-B
End Date:	30/11/2014 13:00	Lab ID:	6928	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Conc-%	1	2	3	4
DMW Control	0.8000	0.6000	1.0000	0.8000
3.1	0.8000	1.0000	1.0000	1.0000
6.3	1.0000	1.0000	1.0000	1.0000
12.5	1.0000	1.0000	1.0000	1.0000
25	1.0000	1.0000	1.0000	1.0000
50	1.0000	1.0000	1.0000	1.0000
100	1.0000	1.0000	1.0000	1.0000

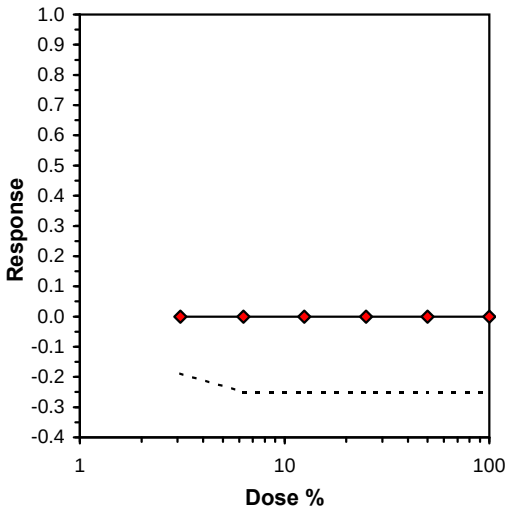
			Transform: Arcsin Square Root					Rank	1-Tailed	Isotonic	
Conc-%	Mean	N-Mean	Mean	Min	Max	CV%	N	Sum	Critical	Mean	N-Mean
DMW Control	0.8000	1.0000	1.1114	0.8861	1.3453	16.874	4			0.9643	1.0000
3.1	0.9500	1.1875	1.2857	1.1071	1.3453	9.261	4	22.50	10.00	0.9643	1.0000
6.3	1.0000	1.2500	1.3453	1.3453	1.3453	0.000	4	24.00	10.00	0.9643	1.0000
12.5	1.0000	1.2500	1.3453	1.3453	1.3453	0.000	4	24.00	10.00	0.9643	1.0000
25	1.0000	1.2500	1.3453	1.3453	1.3453	0.000	4	24.00	10.00	0.9643	1.0000
50	1.0000	1.2500	1.3453	1.3453	1.3453	0.000	4	24.00	10.00	0.9643	1.0000
100	1.0000	1.2500	1.3453	1.3453	1.3453	0.000	4	24.00	10.00	0.9643	1.0000

Auxiliary Tests	Statistic	Critical	Skew	Kurt
Shapiro-Wilk's Test indicates non-normal distribution (p <= 0.05)	0.606859	0.924	-0.36495	6.831605
Equality of variance cannot be confirmed				

Hypothesis Test (1-tail, 0.05)	NOEC	LOEC	ChV	TU
Steel's Many-One Rank Test	100	>100		1
Treatments vs DMW Control				

Log-Logit Interpolation (200 Resamples)

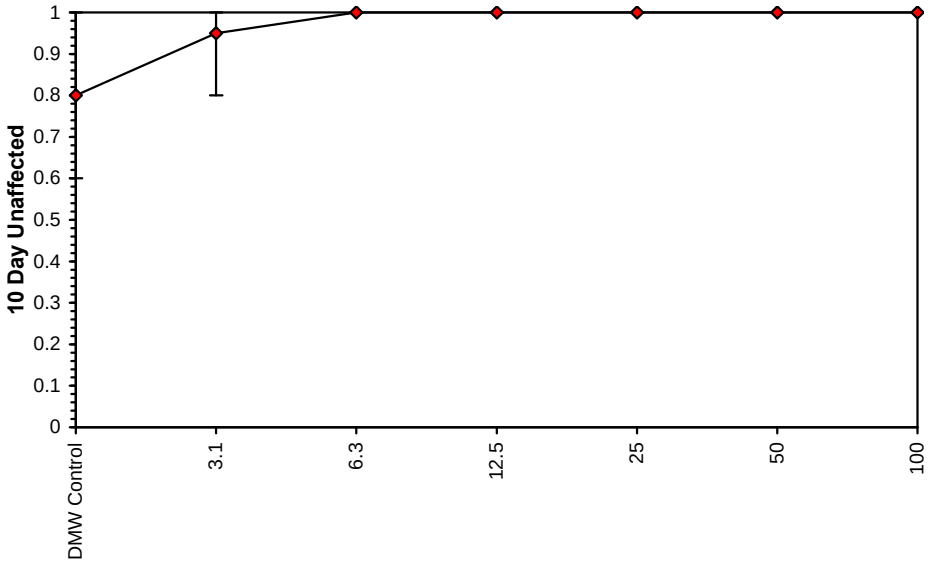
Point	%	SD	95% CL(Exp)	Skew
IC05	>100			
IC10	>100			
IC15	>100			
IC20	>100			
IC25	>100			
IC40	>100			
IC50	>100			



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	20/11/2014 12:00	Test ID:	PR1249/06	Sample ID:	LDP001-B
End Date:	30/11/2014 13:00	Lab ID:	6928	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Dose-Response Plot



Freshwater Shrimp Acute Toxicity Test-10 Day Unaffected

Start Date:	20/11/2014 12:00	Test ID:	PR1249/06	Sample ID:	LDP001-B
End Date:	30/11/2014 13:00	Lab ID:	6928	Sample Type:	AQ-Aqueous
Sample Date:		Protocol:	ESA 123	Test Species:	PSP-Paratya australiensis
Comments:					

Auxiliary Data Summary

Conc-%	Parameter	Mean	Min	Max	SD	CV%	N
DMW Control	% Survival	80.00	60.00	100.00	16.33	5.05	4
3.1		95.00	80.00	100.00	10.00	3.33	4
6.3		100.00	100.00	100.00	0.00	0.00	4
12.5		100.00	100.00	100.00	0.00	0.00	4
25		100.00	100.00	100.00	0.00	0.00	4
50		100.00	100.00	100.00	0.00	0.00	4
100		100.00	100.00	100.00	0.00	0.00	4
DMW Control	pH	7.90	7.90	7.90	0.00	0.00	1
3.1		8.00	8.00	8.00	0.00	0.00	1
6.3		8.00	8.00	8.00	0.00	0.00	1
12.5		8.00	8.00	8.00	0.00	0.00	1
25		8.00	8.00	8.00	0.00	0.00	1
50		8.00	8.00	8.00	0.00	0.00	1
100		7.90	7.90	7.90	0.00	0.00	1
DMW Control	Cond uS/cm	165.60	165.60	165.60	0.00	0.00	1
3.1		246.00	246.00	246.00	0.00	0.00	1
6.3		326.00	326.00	326.00	0.00	0.00	1
12.5		482.00	482.00	482.00	0.00	0.00	1
25		786.00	786.00	786.00	0.00	0.00	1
50		1389.00	1389.00	1389.00	0.00	0.00	1
100		2560.00	2560.00	2560.00	0.00	0.00	1
DMW Control	DO %	101.30	101.30	101.30	0.00	0.00	1
3.1		101.20	101.20	101.20	0.00	0.00	1
6.3		101.30	101.30	101.30	0.00	0.00	1
12.5		101.20	101.20	101.20	0.00	0.00	1
25		101.80	101.80	101.80	0.00	0.00	1
50		102.20	102.20	102.20	0.00	0.00	1
100		112.30	112.30	112.30	0.00	0.00	1

Appendix B – Water Quality Reports

CERTIFICATE OF ANALYSIS

Work Order	: **ES1410641**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR STUART GRAY	Contact	: Client Services
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: stuart.gray@ghd.com	E-mail	: sydney@alsglobal.com
Telephone	: +61 4979 9999	Telephone	: +61-2-8784 8555
Facsimile	: ----	Facsimile	: +61-2-8784 8500
Project	: NEWSTAN	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: 2216681		
C-O-C number	: ----	Date Samples Received	: 14-MAY-2014
Sampler	: DC	Issue Date	: 20-MAY-2014
Site	: ----		
		No. of samples received	: 1
Quote number	: EN/005/13	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LDP001	----	----	----	----
				Client sampling date / time	14-MAY-2014 13:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1410641-001	----	----	----	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**1220**	----	----	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		**8**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**534**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**534**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**114**	----	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**313**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**18**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**7**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**427**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.109**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.003**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		**0.003**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.010**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LDP001	----	----	----	----
				Client sampling date / time	14-MAY-2014 13:00	----	----	----	----
Compound	CAS Number	LOR	Unit		ES1410641-001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser - Continued									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.22**	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		**0.2**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ **Total Nitrogen as N**	----	0.1	mg/L		**0.4**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.02**	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**21.9**	----	----	----	----
Total Cations	----	0.01	meq/L		**20.1**	----	----	----	----
Ionic Balance	----	0.01	%		**4.20**	----	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **ES1424877**	Page	: 1 of 5
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR STUART GRAY	Contact	: Barbara Hanna
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: stuart.gray@ghd.com	E-mail	: Barbara.Hanna@alsglobal.com
Telephone	: +61 4979 9999	Telephone	: +61 2 8784 8555
Facsimile	: ----	Facsimile	: +61 2 8784 8555
Project	: 22 17586	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 13-NOV-2014
Sampler	: TD	Issue Date	: 20-NOV-2014
Site	: ----		
		No. of samples received	: 2
Quote number	: EN/005/14	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics

General Comments

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Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.**
- **EG020: It is recognised that total concentration is less than dissolved for some analytes. However, the difference is within experimental variation of the methods.**
- **EG035: Poor matrix spike recovery was obtained for Mercury on sample ES1424424 # 1 due to high matrix interference.Confirmed by reanalysis.**
- **EG035T: Positive Mercury results have been confirmed by re-digestion and re-analysis.**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LDP001-A	LDP001-B	----	----	----
				Client sampling date / time	12-NOV-2014 15:00	[13-NOV-2014]	----	----	----
Compound	CAS Number	LOR	Unit		ES1424877-001	ES1424877-002	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		8.06	8.06	----	----	----
EA006: Sodium Adsorption Ratio (SAR)									
Sodium Adsorption Ratio	----	0.01	-		23.1	22.4	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		2600	2610	----	----	----
EA016: Non Marine - Estimated TDS Salinity									
Total Dissolved Solids (Calc.)	----	1	mg/L		1690	1700	----	----	----
EA025: Suspended Solids									
Suspended Solids (SS)	----	5	mg/L		<5	<5	----	----	----
EA065: Total Hardness as CaCO3									
Total Hardness as CaCO3	----	1	mg/L		117	126	----	----	----
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		0.767	0.838	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		575	582	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		575	582	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		137	133	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		454	455	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		32	34	----	----	----
Magnesium	7439-95-4	1	mg/L		9	10	----	----	----
Sodium	7440-23-5	1	mg/L		575	578	----	----	----
Potassium	7440-09-7	1	mg/L		4	4	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		0.106	0.108	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LDP001-A	LDP001-B	----	----	----
				Client sampling date / time	12-NOV-2014 15:00	[13-NOV-2014]	----	----	----
Compound	CAS Number	LOR	Unit		ES1424877-001	ES1424877-002	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.002**	----	----	----
Lead	7439-92-1	0.001	mg/L		**0.005**	**0.005**	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.138**	**0.134**	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.015**	**0.016**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.009**	**0.009**	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L		**1.97**	**1.95**	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.006**	<0.005	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.21**	**0.21**	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	----	----	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.117**	**0.107**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.003**	----	----	----
Lead	7439-92-1	0.001	mg/L		**0.006**	**0.005**	----	----	----
Lithium	7439-93-2	0.001	mg/L		**0.150**	**0.137**	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	----	----	----
Molybdenum	7439-98-7	0.001	mg/L		**0.018**	**0.017**	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.009**	**0.009**	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	LDP001-A	LDP001-B	----	----	----
				Client sampling date / time	12-NOV-2014 15:00	[13-NOV-2014]	----	----	----
Compound	CAS Number	LOR	Unit		ES1424877-001	ES1424877-002	----	----	----
EG020T: Total Metals by ICP-MS - Continued									
Silver	7440-22-4	0.001	mg/L		<0.001	<0.001	----	----	----
Strontium	7440-24-6	0.001	mg/L		**2.16**	**2.00**	----	----	----
Tin	7440-31-5	0.001	mg/L		<0.001	<0.001	----	----	----
Titanium	7440-32-6	0.01	mg/L		<0.01	<0.01	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.006**	**0.022**	----	----	----
Boron	7440-42-8	0.05	mg/L		**0.22**	**0.21**	----	----	----
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	**0.0003**	----	----	----
EG052F: Dissolved Silica by ICPAES									
Silicon as SiO2	14464-46-1	0.1	mg/L		**11.8**	**12.0**	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.4**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.21**	**0.22**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	0.1	mg/L		<0.1	**0.1**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser									
^ Total Nitrogen as N	----	0.1	mg/L		**0.2**	**0.3**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	<0.01	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**27.2**	**27.2**	----	----	----
Total Cations	----	0.01	meq/L		**27.4**	**27.8**	----	----	----
Ionic Balance	----	0.01	%		**0.52**	**0.93**	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	----	----	----

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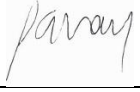
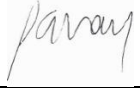
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Centennial Coal
Environment Matters

Appendix 4 - Aquatic Monitoring and Ecotoxicology Assessment Summary Report

Centennial Coal

Northern Coal Logistics Project

Aquatic Ecology Monitoring and Ecotoxicology Assessment Summary Report

January 2015

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Glossary

Alkalinity	A measure of the ability of an aqueous solution to neutralise acids. Alkalinity of natural waters is due primarily to the presence of hydroxides, bicarbonates and carbonates. It is expressed in units of calcium carbonate ($CaCO_3$).
Analysis of similarity	A method of multivariate analysis used to statistically test whether there is a significant difference between one or more groups of sampling units.
Aquifer	An underground layer of permeable material from which groundwater can be usefully extracted.
Baseflow	The component of flow in a watercourse that is driven from the discharge of underground water.
Bioavailability	The fraction of the total of a substance in the surrounding environment that is available to be taken up by living organisms.
Biota	All of the living organisms found in a given area.
Canopy cover	The above-ground portion of a plant community.
Cluster analysis	A method of multivariate analysis which classifies a sample of subjects into a number of different groups such that similar subjects are placed in the same group.
Community	An assemblage of organisms occupying a specified location and time, usually interacting with one another.
Community composition	All of the taxa present in a community.
Contaminant	Any physical, chemical, biological or radiological substance capable of producing an adverse effect in a biological system or the natural environment.
Control	The part of an experimental procedure which is like the treated part in every respect except that it is not subjected to the test conditions. The control is used as a standard of comparison, to check that the outcome of the experiment is a reflection of the test conditions and not of some unknown factor.
Cryptic animal	An animal that avoids observation or detection.
Depauperate	Lacking in numbers or variety of species.
Detritus	Matter composed of leaves and other plant parts, animal remains, waste products and other organic debris that falls onto the soil or into bodies of water from surrounding terrestrial communities.
Discharge	The quantity of water per unit of time flowing in a stream, for example cubic metres per second or megalitres per day.
Dissolved oxygen	A measure of the amount of oxygen that is dissolved in water.

Ecosystem	A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.
Electrical conductivity	A measure of the concentration of dissolved salts or ions in water.
Emergent vegetation	A plant or plants rooted underwater that grows above the water surface.
Endemism	Ecologically unique to a defined geographic area.
Ephemeroptera, Plecoptera, Trichoptera richness index	An index based on the number of taxa of the environmentally sensitive orders Ephemeroptera, Plecoptera and Trichoptera identified in a sample.
Estuarine	A partly enclosed coastal body of brackish water with one or more rivers flowing into it and with a free connection to the open sea.
Geomorphology	Scientific study of landforms, their evolution and the processes that shape them. In this report relates to the form and structure of waterways.
Groundwater	Water occurring naturally below ground level.
Guideline	A numerical concentration or narrative statement that provides appropriate guidance for a designated water use or impact.
Hyporheic	Any physical, chemical, biological or radiological substance capable of producing an adverse effect in a biological system or the natural environment.
Index	Composite value that can give a quick ranking to an ecosystem feature (e.g. a water body), derived via a formula that combines measurements of important ecosystem characteristics; typically used to rank ‘health’ or naturalness.
Karst	Any physical, chemical, biological or radiological substance capable of producing an adverse effect in a biological system or the natural environment.
Licensed discharge point	A location where the premises discharge water in accordance with conditions stipulated within the site Environmental Protection License.
Macroinvertebrate	An animal species that does not develop a vertebral column that is large enough to be seen without the use of a microscope. These animals generally include insects, crustaceans, molluscs, arachnids and annelids.
Macrophyte	A member of the macroscopic plant life of an area, especially of a large body of water.
Multivariate analysis	Statistical analysis concerned with data collected on multiple dimensions of the same subject.

Non-metric multi-dimensional scaling analysis	A method of multivariate analysis used to express the similarities between different objects in a small number of dimensions. This allows a complex set of inter-relationships to be summarised in a simple figure.
Organic carbon	Generally carbon which is chemically bonded to other carbon atoms, although methane (one carbon atom only) and its derivatives are considered organic.
Organic matter	Matter composed of organic compounds that has come from the remains of once-living organisms such as plants and animals and their waste products.
pH	The value taken to represent the acidity or alkalinity of an aqueous solution. It is defined as the negative logarithm of the hydrogen ion concentration of the solution.
Phreatic	Relating to or denoting underground water in the zone of saturation (beneath the water table)
Percentile	The value of a variable below which a certain percent of observations fall. For example, the 80th percentile is the value below which 80 percent of values are found.
Principal component analysis	A method of multivariate analysis used to reduce the number of variables so that data can be represented as a smaller number of artificial variables (called principal components).
Rapid bioassessment	A form of biological assessment that uses standardised, cost-effective protocols to provide rapid sample processing, data analysis, reporting and management response. The results from such assessments are likely to be reliable to detect large impacts but not small or minor impacts.
Reach	A defined section of a stream with a uniform character and behaviour.
Richness	The number of species or taxa present (generally applied to a sample or community).
Riparian	Pertaining to, or situated on, the bank of a river or other water body.
Salinity	The dissolved salt content of a body of water or soil.
Sediment	Soil or other particles that settle to the bottom of lakes, rivers, oceans and other waters.
Slightly disturbed ecosystems	A classification used by ANZECC (2000) guidelines applied to ecosystems where there has been a relatively small adverse effect to biodiversity due to anthropogenic activity with largely intact habitats and biological communities.
Similarity percentages analysis	A simple method of multivariate analysis used to assess which taxa are primarily responsible for an observed difference between groups of samples.

Taxa	Any group of organisms considered to be sufficiently distinct from other groups to be treated as a separate unit (e.g. species, genera, families).
Taxonomic	An organism's location in the biological classification system used to identify and group organisms with similar physical, chemical and/or structural composition.
Toxicity	The inherent potential or capacity of a substance to cause adverse effects in a living organism.
Tributary	A stream or river that flows into a main river or lake.
Trigger value	The concentration or load of physico-chemical characteristics of an aquatic ecosystem, below which there exists a low risk that adverse ecological effects will occur. They indicate a risk of impact if exceeded and should 'trigger' action to conduct further investigations or to implement management or remedial processes.
Turbidity	A measure of clarity (turbidity) of water. Turbidity in excess of 5 NTU is just noticeable to the average person.
Univariate analysis	Statistical analysis concerned with data collected on one dimension of the same subject.

Abbreviations

ANOSIM	Analysis of similarity
ANOVA	Analysis of variance
AUSRIVAS	Australian Rivers Assessment System
Centennial	Centennial Coal Company Pty Limited
Centennial Mandalong	Centennial Mandalong Pty Limited
Centennial Newstan	Centennial Newstan Pty Limited
CHP	Coal handling plant
CPP	Coal preparation plant
CWP	Clean Water Plant
DO	Dissolved oxygen
DTA	Direct toxicity assessment
DTV	Default trigger value
EC	Effect concentration
EPL	Environment Protection Licence
EPT	Ephemeroptera, Plecoptera, Trichoptera
ESA	Ecotox Services Australasia
ESMW	Ecotoxicological, sediment, macroinvertebrate and water
GHD	GHD Pty Ltd
GLM	Generalised linear model
ISQG	Interim sediment quality guideline
km	Kilometre
LDP	Licensed discharge point
m	Metre
mg/L	Milligram per litre
ML	Megalitre
ML/day	Megalitre per day
mm	Millimetre
NATA	National Association of Testing Authorities
NOEC	No observable effect concentration

Northern Coal Services	Centennial Northern Coal Services Pty Limited
NTU	Nephelometric turbidity unit
PCA	Principle component analysis
RBA	Rapid bioassessment
ROM	Run of mine
SIGNAL 2	Stream Invertebrate Grade Number Average Level – Version 2
SIMPER	Similarity percentages
SSTV	Site-specific trigger value
TDS	Total dissolved solids
TKN	Total Kjeldahl nitrogen
TOC	Total organic carbon
TSS	Total suspended solids
µm	Micrometre
µS/cm	Microsiemens per centimetre
°C	Degree Celsius

1. Introduction

GHD Pty Ltd (GHD) was commissioned by Centennial Northern Coal Services Pty Limited (Northern Coal Services) to prepare a summary report of all aquatic ecology monitoring and ecotoxicology assessments undertaken at the Cooranbong Services Site and Newstan Colliery Surface Site. This report is to form part of the Response to Submissions for an application for the Northern Coal Logistics Project (the Project) under Part 4 of the *Environmental Planning and Assessment Act 1979* seeking development consent for the Project. The locality of the Project is presented in Figure 1-1 with respect to the Central Coast and lower Hunter Valley regions.

1.1 Background

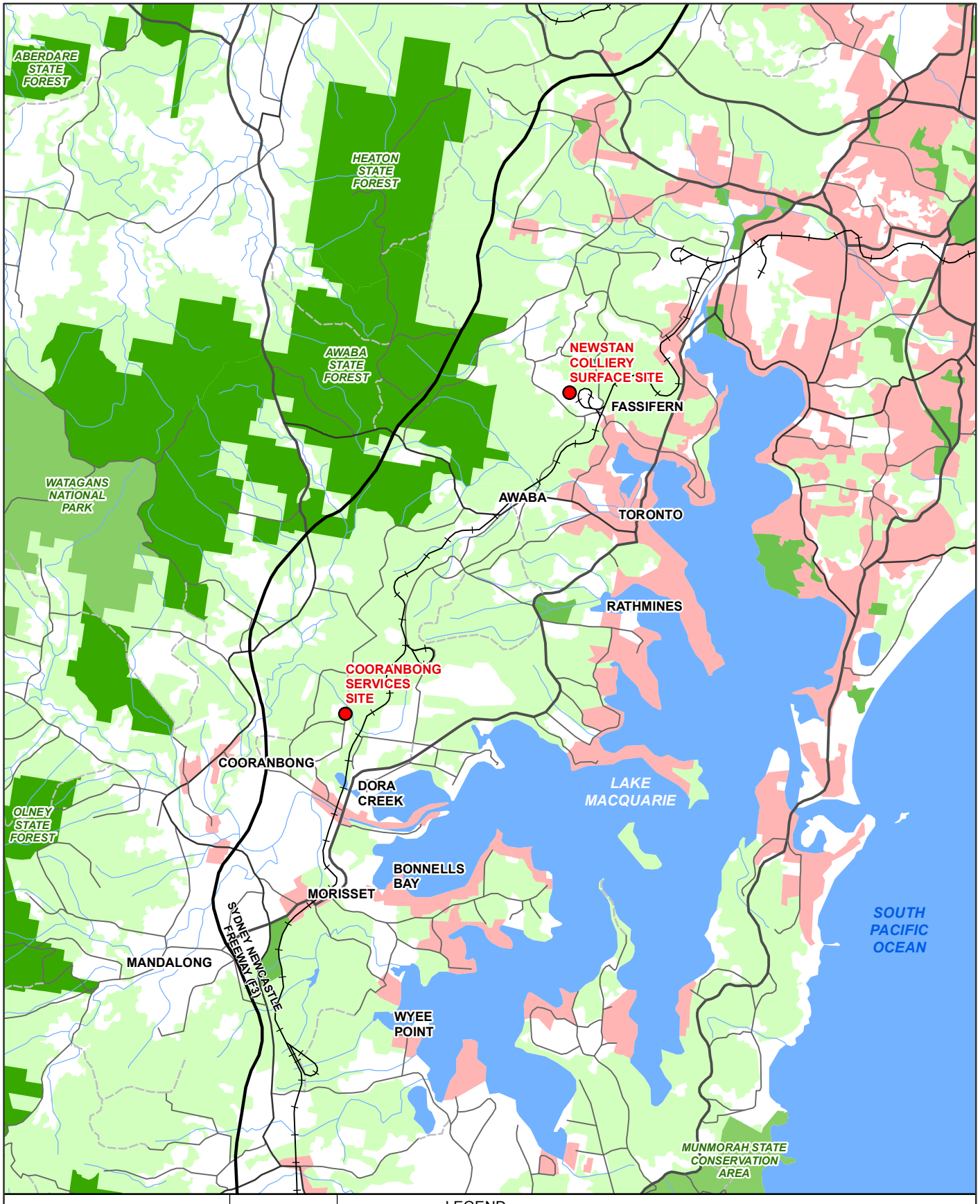
Centennial Coal Company Pty Limited (Centennial) is a coal mining company that supplies thermal and coking coal to the domestic and export markets. Centennial's northern operations include Awaba Colliery, Mandalong Mine, Mannering Colliery, Myuna Colliery and Newstan Colliery located around Lake Macquarie. The Cooranbong Services Site and Newstan Colliery Surface Site are integral to the ongoing processing, handling and transport of coal from the Mandalong Mine and Newstan Colliery operations (including the proposed Mandalong Southern Extension Project and Newstan Extension of Mining Project) into the domestic and export markets. These services are managed by the Northern Coal Services business unit within Centennial.

The Cooranbong Services Site is an existing coal handling facility owned and operated by Centennial Mandalong Pty Limited (Centennial Mandalong). It is also located on the western side of Lake Macquarie approximately 130 km north of Sydney and 2 km north of the township of Dora Creek.

Newstan Colliery is an existing underground coal mine owned and operated by Centennial Newstan Pty Limited (Centennial Newstan). It is located on the western side of Lake Macquarie approximately 25 km south-west of Newcastle and approximately 140 km north of Sydney within the Lake Macquarie Local Government Area. The Newstan Colliery Surface Site is located approximately 4 km north of the township of Toronto and in close proximity to the townships of Fassifern and Wakefield.

The Cooranbong Services Site and Newstan Colliery Surface Site are linked by the Cooranbong Private Haul Road owned by Centennial Mandalong and the Newstan-Eraring Private Haul Road owned by Eraring Energy, as shown on Figure 1-1.

The Project, in conjunction with Centennial's Mandalong Southern Extension Project and Newstan Extension of Mining Project, stems from the long-term strategy Centennial has developed for its future operations in the Newcastle Coalfield to provide the infrastructure and flexibility required to meet future opportunities in both the domestic and export coal markets. The Project includes the continuation of existing operations and upgrade to the existing surface coal handling and processing infrastructure at Newstan Colliery Surface Site and Cooranbong Services Site, along with the existing private haul roads and rail loading infrastructure.



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0 500 1,000 2,000 3,000 4,000

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Watercourse
- Watercourse Area
- Nature Conservation Reserve
- State Forest
- Built Up Areas
- Forest Or Shrub
- Freeway
- Principal Road
- Secondary Road
- Minor Road
- Track

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Aquatic Ecology Monitoring and Ecotoxicology Assessment Summary Report

Locality plan

Centennial Coal

DATE 19/01/2015

Figure 1-1

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© Commonwealth of Australia (Geoscience Asutralia): 250K Topographic Data Series 3, 2006. Centennial: Locations

1.2 Overview of site operations

1.2.1 Cooranbong Services Site

The Cooranbong Services Site is currently used to receive, handle and transfer coal extracted from the Mandalong Mine underground workings. Mined coal is transferred from the Mandalong Mine underground workings via conveyor systems to the Cooranbong Services Site. Run of mine (ROM) coal is processed in a coal handling plant (CHP) at the site prior to being transferred by overland conveyor to Eraring Power Station or by private haul road to the Newstan Colliery Surface Site for further processing and delivery to the domestic and export markets.

1.2.2 Newstan Colliery Surface Site

The Newstan Colliery Surface Site is currently used to receive, handle, process and transfer coal and waste material from Newstan Colliery, Awaba Colliery and Mandalong Mine. Mined coal from the Newstan Colliery underground workings (currently under care and maintenance) is transferred to the Newstan Colliery Surface Site via conveyor systems. ROM coal is processed in the coal preparation plant (CPP) prior to being transported by private haul road to Eraring Power Station and by rail to Vales Point Power Station for domestic power generation and by rail to the Port of Newcastle and/or Port Kembla for export.

1.2.3 Environment Protection Licences

Under the *Protection of the Environment Operations Act 1997*, an Environment Protection Licence (EPL) is required for premises at which a 'scheduled activity' is conducted. Licence conditions relate to pollution prevention and monitoring and can control the waste, water, air and noise impacts of an activity.

Mandalong Mine currently holds EPL 365, which also includes requirements to monitor dust, water quality and water quantity and quality of discharges. Water is currently licensed to be discharged from Cooranbong Services Site under EPL 365 through the following two licensed discharge points (LDPs):

- Cooranbong LDP001 – Discharges from the Borehole Dam into an unnamed tributary of Muddy Lake. Licensed to discharge up to 5 ML/day.
- Cooranbong LDP002 – Discharges from the 5 ML Dam into an unnamed tributary of Muddy Lake.

Newstan Colliery currently holds EPL 395, which includes requirements to monitor dust, water quality and water quantity and quality of discharges. Water is currently licensed to be discharged from Newstan Colliery Surface Site under EPL 395 through the following three LDPs:

- Newstan LDP001 – Discharges from the Clean Water Plant and overflows from Graunch's Dam into the upper reaches of the northern arm of LT Creek. Licensed to discharge up to 11 ML/day.
- Newstan LDP002 – Discharges from the Final Pollution Control Dam into the upper reaches of the northern arm of LT Creek.
- Newstan LDP017 – Discharges from the Fassifern Underground Storage into Stony Creek.

1.3 Surface water management

The objective of the water management systems at Cooranbong Services Site and Newstan Colliery Surface Site is to separate clean and dirty water in order to manage impacts to water quality and to manage transfers between the respective underground workings and surface storages.

The management of surface water at both sites include both clean and dirty water management systems. Clean water is defined as water from vegetated catchments and hardstand areas that do not involve processing and preparation of coal. Dirty water is defined as water from hardstand areas devoted to the processing and preparation of coal and coal stockpile areas.

1.3.1 Cooranbong Services Site

Cooranbong Services Site is located within the upper reaches of an unnamed tributary of Muddy Lake, which flows into Lake Macquarie. Clean water is diverted around the Cooranbong Services Site with diversions in place around the ROM Coal Stockpile, through the western sector of the site and around the north-east boundary. Clean catchment runoff is collected by the Rehabilitation Dams and the Construction Dam to the south of the site. The Rehabilitation Dams discharge to the Construction Dam via a discharge pipe. Overflows from the Construction Dam occur via a weir and contribute to the existing waterway flowing into Muddy Lake.

Runoff from disturbed and workshop areas is collected by a number of dirty water control structures. These structures enable suspended solids to settle out of the water column and also allow for dirty water to be reused in site processes, thereby minimising the potential for dirty water discharges into the surrounding environment.

The Borehole Dam is located upslope of the main Cooranbong Services Site and is part of the Mandalong Southern Extension Project. The dam receives mine water extracted from the Cooranbong Underground Storage via a dewatering bore.

A pipeline is currently operational directing water from the Borehole Dam directly to Cooranbong LDP001 into an unnamed tributary of Muddy Lake. In the event that water quality from the Borehole Dam is not considered acceptable for discharge, water can be transferred back to the Cooranbong Underground Storage for additional filtration and settlement prior to being returned to the Borehole Dam.

Prior to April 2013, the average rate of discharge through Cooranbong LDP001 was approximately 1.5 ML/day. Since June 2013, the average rate has increased to approximately 2 ML/day in order to manage underground water levels. Between February and September 2014, there was no discharge through Cooranbong LDP001 due to replacement of the dewatering pump.

Discharge from the 5 ML Dam via an overflow culvert occurs through Cooranbong LDP002 into an unnamed tributary of Muddy Lake. A dewatering pump established on the 5 ML Dam allows low water levels to be maintained by pumping water to other storages or directly to the Cooranbong Underground Storage.

1.3.2 Newstan Colliery Surface Site

Newstan Colliery Surface Site is located within the upper reaches of the LT Creek catchment. The collection of surface water from undisturbed areas is minimised by the diversion of clean water around the site. Dirty water diversions have been constructed to convey runoff from disturbed areas to treatment facilities.

Clean catchment runoff is captured and managed by the Main By-Wash Dam, which is a wetland system that has low flow discharges via a pipe and overflows via a weir into the northern arm of LT Creek. Newstan Colliery is currently licensed to pump water from the Main By-Wash Dam to supplement the water supply to the CPP and other water demands. Extraction from the dam occurs occasionally during dry periods or when other supplies are compromised due to infrastructure failures.

Runoff from disturbed and workshop areas is collected by a number of dirty water control structures. These structures enable suspended solids to settle out of the water column and also allow for dirty water to be reused in site processes, thereby minimising the potential for dirty water discharges into the surrounding environment. Dirty water management at Newstan Colliery Surface Site is a complex and largely manually-operated system.

Water in the dirty water management storages is generally maintained such that water in storages further down the catchment is pumped to Connolly's Dam or the Tailings Storage Facility (TSF) for reuse in the CPP or transfer to the Fassifern Underground Storage. The TSF consists of an embankment that has been constructed across the upper reaches of the southern arm of LT Creek. The TSF receives tailings from the CPP, with water decanted to the Fassifern Underground Storage. Water is also transferred from other surface water storages to prevent overflows.

A Clean Water Plant (CWP) commenced operations at Newstan Colliery Surface Site in late 2013. The CWP employs coagulation, flocculation, sedimentation, filtration and ultra-violet treatment to reduce the concentrations of total suspended solids (TSS) and total (unfiltered) metals. Water treated by the CWP is used to supply mining processes and the CPP or is discharged through Newstan LDP001 into the northern arm of LT Creek. Discharge through Newstan LDP001 increased from approximately 7 ML/day to 11 ML/day following approval to increase the volumetric limit in October 2012.

Water is transferred from surface storages to the Fassifern Underground Storage and this water is drawn from during dry periods to supply the CPP. The storage also receives inflows as a result of infiltration from the surface catchment and groundwater inflows. Water levels in the Fassifern Underground Storage are managed by transferring water to the CWP for treatment and discharge through Newstan LDP001.

Discharge from the Final Pollution Control Dam occurs via overflow to Newstan LDP002 into the northern arm of LT Creek. The volume of water contained in the dam is maintained low by dewatering to the Pollution Transfer Tanks and various other storages on site.

Discharge into Stony Creek via Newstan LDP017 occurs during wet periods when water within the Fassifern Underground Storage rises above 16.6 m below ground level. Discharge occurs from the storage through two 600 mm diameter pipes to a water management and monitoring station that was commissioned in 2013 which allows for the control of discharges. No discharges have occurred via Newstan LDP017 since August 2012.

1.4 Scope of work

This report has been developed to summarise the results of aquatic ecology monitoring and ecotoxicology assessments conducted for the unnamed tributary of Muddy Lake at Cooranbong Services Site and LT Creek and Stony Creek at Newstan Colliery Surface Site from 2011 to 2014.

Data collected during aquatic ecology monitoring will be analysed in order to identify seasonal and spatial trends in macroinvertebrate communities and physicochemical properties of the assessed waterways. The results of ecotoxicology assessments conducted at the two sites will also be analysed to assess the toxicity and chemical constituents of mine water discharges.

2. Methodology

2.1 Aquatic ecology monitoring

2.1.1 Monitoring program

Routine aquatic ecology monitoring has been undertaken at Cooranbong Services Site and Newstan Colliery Surface Site to determine the potential impacts of mine water discharge from both sites into receiving waterways. The purpose of the aquatic ecology monitoring programs at both Cooranbong Services Site and Newstan Colliery Surface Site is to obtain chemical, biological and physical system attributes that allow sample results to be analysed for:

- Identification and fate of contaminants.
- Assessment of water quality against discharge limits specified by EPL 395 and derived site-specific trigger values (SSTVs), using defined guidelines and standards such as ANZECC (2000) water quality guidelines for ecosystem protection for water and sediment quality.
- Assessment of biological impacts using the Australian River Assessment Systems (AUSRIVAS) methodology on downstream populations.
- Development and refinement of water management plans, site water balances and rehabilitation strategies.
- Demonstration of environmental due diligence.

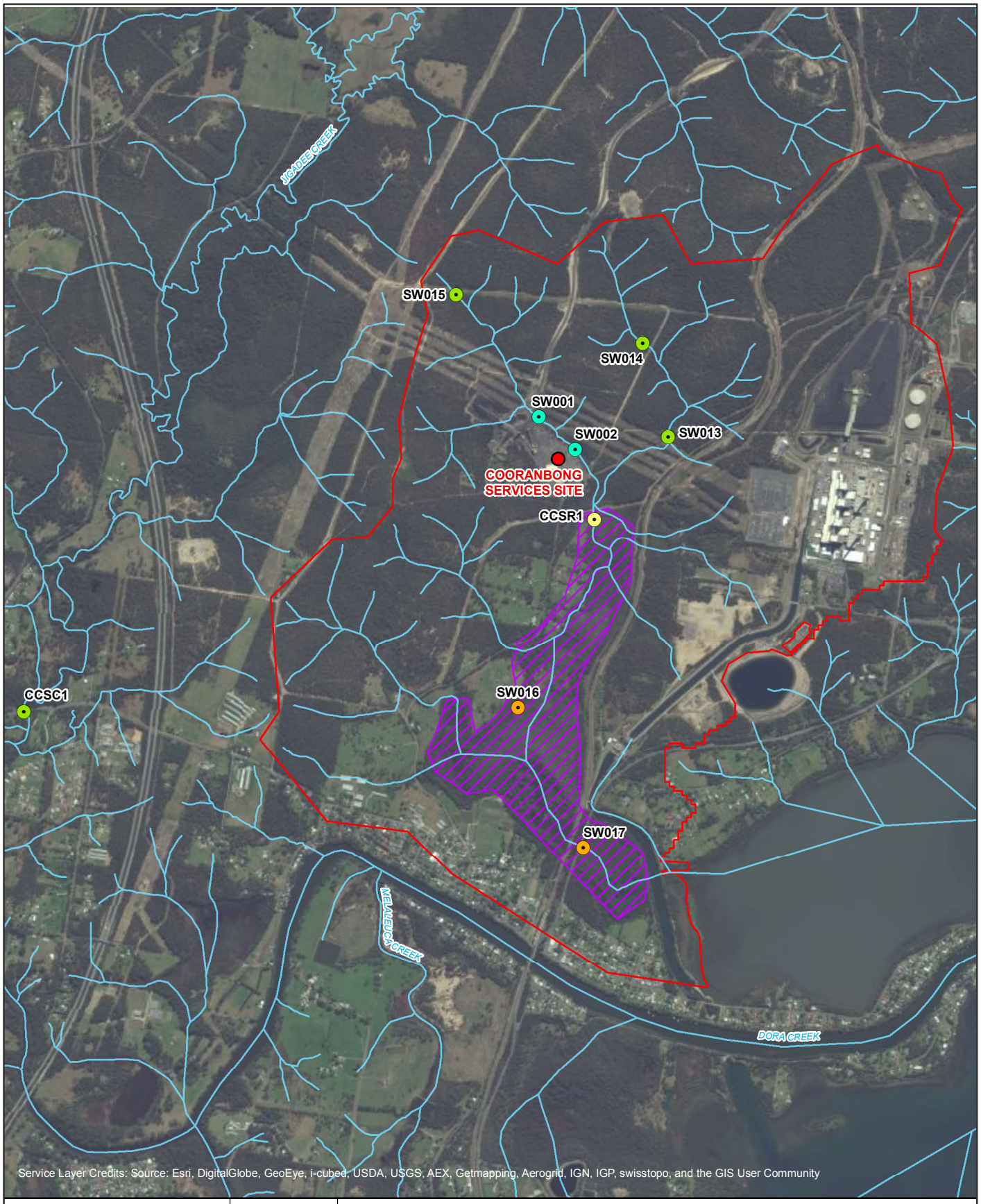
Cooranbong Services Site

Aquatic ecology monitoring at Cooranbong Services Site has occurred at nine locations, as shown in Figure 2-1. The locations have been categorised into reference sites, which are not influenced by mine water discharge, on-site impact sites, downstream impact sites and downstream recovery sites. All sites are considered to be freshwater, however Muddy Lake exhibits estuarine influences with salinity varying spatially in the lake due to rainfall and tides. A summary of each of the monitoring locations is provided in Appendix A.

Aquatic ecology monitoring has been undertaken at Cooranbong Services Site in:

- Winter 2012.
- Spring 2013.
- Autumn 2014.
- Spring 2014.

Table 2-1 provides the details of locations assessed during aquatic ecology monitoring at Cooranbong Services Site. Not all sites were monitored for all sampling events. Sites were not monitored due to site and operational conditions which prevented appropriate monitoring.



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0 110 220 440 660 880

Metres

Map Projection: Universal Transverse Mercator
Horizontal Datum: Geodetic Datum of Australia 1994
Grid: Map Grid of Australia, Zone 56

N

LEGEND

- Downstream impact
- Downstream recovery
- On-site impact
- Reference
- Waterway
- Muddy Lake
- Unnamed creek catchment

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SCALE	Refer to scalebar

Aquatic Ecology Monitoring and Ecotoxicology Assessment Summary Report

Cooranbong Services Site
Aquatic ecology monitoring locations

Centennial Coal

DATE 19/01/2015

Figure 2-1

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LPI:DTDB, 2012. ESRI: Aerial Imagery, 2014. Centennial: Monitoring, 2014

Table 2-1 Cooranbong Services Site – Locations assessed during aquatic ecology monitoring

Location	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Reference sites				
SW013	✓	✓		
SW014			✓	✓
SW015			✓	
CCSC1	✓	✓		✓
On-site impact sites				
SW001	✓	✓	✓	✓
SW002	✓	✓		
Downstream impact site				
CCSR1	✓	✓	✓	✓
Downstream recovery sites				
SW016			✓	✓
SW017	✓	✓	✓	✓

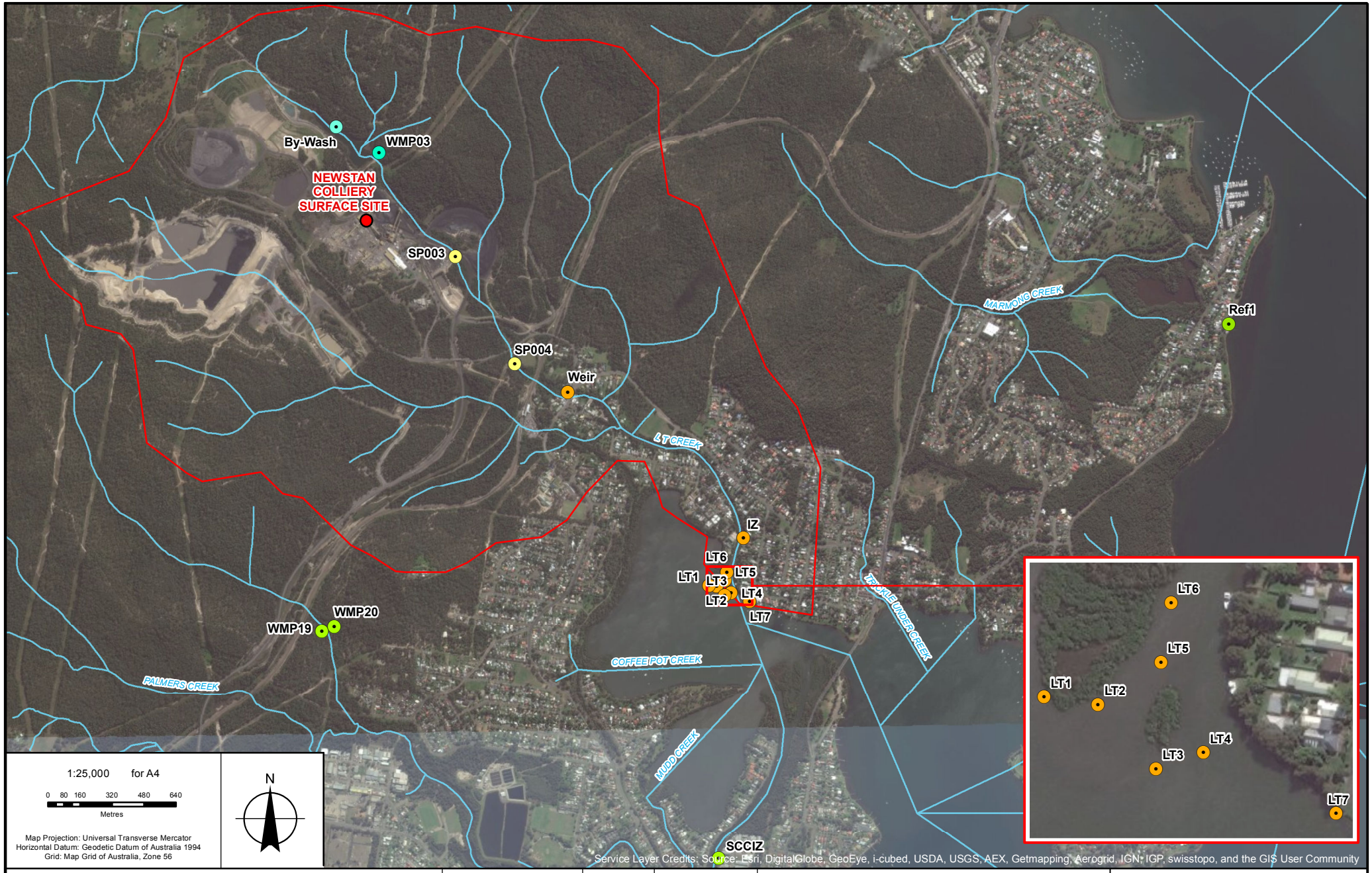
Newstan Colliery Surface Site

Monitoring at Newstan Colliery Surface Site is undertaken in accordance with the Ecotoxicological, Sediment, Macroinvertebrate and Water (ESMW) Monitoring Program (GHD, 2012a). This procedure details sample collection and analysis, quality, documentation and reporting to meet the requirements of EPL 395.

Aquatic ecology monitoring at Newstan Colliery Services Site has occurred at 18 locations, as shown in Figure 2-2. As above, locations have been categorised into reference sites, on-site impact sites, downstream impact sites and downstream recovery sites. The majority of sites assessed are freshwater, with two estuarine reference sites and eight estuarine downstream recovery sites. A summary of each of the monitoring locations is provided in Appendix A.

Aquatic ecology monitoring has been undertaken at Newstan Colliery Surface Site in:

- Autumn 2011.
- Summer 2012.
- Summer 2013.
- Autumn 2013.
- Winter 2013 (sediment sampling only).
- Spring 2013.
- Summer 2014 (sediment and water sampling only).
- Autumn 2014.
- Spring 2014.



LEGEND

- Downstream impact site
- Downstream recovery site
- On-site impact site
- Reference site
- Waterway
- LT Creek catchment area

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Aquatic Ecology Monitoring and Ecotoxicology Assessment Summary Report

Newstan Colliery Surface Site
Aquatic ecology monitoring locations

Centennial Coal

DATE 19/01/2015

Figure 2-2

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© Commonwealth of Australia (Geoscience Asutralia): 250K Topographic Data Series 3, 2006. LPI:DTDB, 2012. ESRI: Aerial Imagery, 2014. Centennial: Monitoring, 2014

Table 2-2 provides the details of locations assessed during aquatic ecology monitoring at Newstan Colliery Surface Site. Not all sites were monitored for all sampling events, with sites not monitored due to site and operational conditions which prevented appropriate monitoring. Estuarine sites LT1–LT7 were sampled as an initial investigation in 2011 into metal accumulation in the tidal extent of LT Creek. Subsequent sampling events monitored site IZ, which is located in the vicinity of the previous estuarine sites sampled.

2.1.2 Habitat assessment

Information about site habitat condition was documented in accordance with AUSRIVAS protocols (Turak *et al.*, 2004). Information about habitat condition was recorded in a systematic and comparable way using the First National Assessment of River Health field data sheet.

Observations were made over a 100 m reach at each site. Field data were recorded by professionally qualified and experienced aquatic ecologists. A range of physical habitat measurements were recorded, including the following:

- Information about the site location, including coordinates and access details.
- General attributes of the site, including information on topography, flow, stream size and riparian vegetation.
- Physical attributes of the instream habitat, including substrate composition, presence of discrete habitats (e.g. detritus, bank overhanging vegetation, trailing bank vegetation and macrophytes).
- A visual assessment of human disturbance to the water quality, instream habitat and riparian zone.

Photographs of each site were taken as a further record of habitat conditions observed at the time of assessment.

2.1.3 Water quality sampling

In situ water quality

In situ physicochemical water quality parameters were measured at each of the sites using water quality meters that were calibrated in accordance with quality assurance/quality control requirements and the manufacturer's specifications prior to its use in the field. Alkalinity was measured in the field using a CHEMetrics Titrets hand-held titration cell.

In situ physicochemical measurements included:

- Temperature (°C).
- pH (pH unit).
- Electrical conductivity (µS/cm).
- Dissolved oxygen (DO) (% saturation and mg/L).
- Turbidity (NTU).
- Alkalinity (mg/L $CaCO_3$).

Table 2-2 Newstan Colliery Surface Site – Locations assessed during aquatic ecology monitoring

Site	Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Winter 2013*	Spring 2013	Summer 2014#	Autumn 2014	Spring 2014
Reference sites									
WMP19-US~			✓						
WMP20	✓#							✓	✓
SSCIZ^								✓	✓
Ref1^		✓							
On-site impact sites									
By-Wash	✓	✓	✓	✓	✓	✓	✓	✓	✓
WMP03	✓	✓	✓	✓	✓	✓	✓	✓	✓
Downstream impact sites									
SP003	✓	✓							
SP004		✓	✓	✓	✓	✓	✓	✓	✓
WMP19-DS~			✓						
Downstream recovery sites									
Weir		✓	✓	✓	✓	✓	✓	✓	✓
IZ^			✓	✓	✓	✓	✓	✓	✓
LT1^		✓							

Site	Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Winter 2013*	Spring 2013	Summer 2014#	Autumn 2014	Spring 2014
LT2^		✓							
LT3^		✓							
LT4^		✓							
LT5^		✓							
LT6^		✓							
LT7^		✓							

~ Water and macroinvertebrate sampling only.

* Sediment sampling only.

Sediment and water sampling only.

^ Estuarine site.

Laboratory analysed water quality

At each monitoring location, samples of water were collected and tested for the parameters listed in Table 2-3 at a National Association of Testing Authorities (NATA) accredited laboratory.

Table 2-3 Water quality parameters

Category	Parameter
Physicochemical parameters	Total dissolved solids (TDS), TSS.
Nutrients	Nitrate, nitrite, nitrate + nitrite, total Kjeldahl nitrogen (TKN), total nitrogen, total phosphorus.
Anions	Alkalinity (bicarbonate and total), chloride, sulfate.
Cations	Calcium, magnesium, potassium, sodium.
Metals (dissolved and total)	Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, tin, titanium, vanadium, zinc.
Other	Ammonia, silica, total hardness, total organic carbon (TOC).

2.1.4 Sediment quality sampling

Sediment samples were collected at each monitoring located following water sampling and prior to macroinvertebrate sampling. The sediment samples were tested for the parameters listed in Table 2-4 at a NATA accredited laboratory.

Table 2-4 Sediment quality parameters

Category	Parameter
Metals (acid extractable and total)	Aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, tin, vanadium, zinc.
Other	Moisture content, organic matter, pH, TOC.

2.1.5 Macroinvertebrate sampling

Freshwater

Field sampling

Field sampling following rapid bioassessment (RBA) protocols was undertaken in accordance with the NSW AUSRIVAS sampling and processing manual (Turak *et al.*, 2004). The AUSRIVAS program is a nationally recognised, standardised sampling method used to assess the health of Australian rivers and developed for Australia's National River Health Program.

Sampling was conducted using a standard ISO 7828 (1983) design sweep-net with 250 µm mesh. Nets were washed thoroughly between sampling sites to remove any invertebrates retained on them.

At each site, the littoral or edge habitat was sampled by sweeping the collecting net along the edge of the stream in areas of little or no current. The net was swept around overhanging terrestrial vegetation, against snags if present, in backwaters and through beds of macrophytes. This process was continued, working upstream against the flow, over approximately 10 m of edge.

For each RBA sample, the collected material was placed into a sorting tray and macroinvertebrates picked for a minimum of 40 minutes by professionally qualified and experienced aquatic biologists using forceps and pipettes. If new taxa were found between 30 and 40 minutes, sorting continued for a further 10 minutes. The processing cycle was continued up to a total maximum sorting time of one hour.

The objective of the RBA sorting protocol was to obtain a sample containing as diverse a fauna as possible (and hence provide a useful measure of taxonomic richness). Attempts were made to avoid bias towards abundant taxa and to collect all taxa present in the sample, including rare or cryptic animals. Samples were preserved in 70% ethanol and clearly labelled with information including site, habitat, sampling method, date and sampler.

Laboratory processing and identification

Macroinvertebrates were examined using Leica MZ 9.5 stereo-dissection microscopes with planachromat objectives and a zoom capability between 6.3x and 60x. Freshwater macroinvertebrates were identified using published taxonomic keys, unpublished working keys and an extensive specimen reference collection maintained by GHD following protocols identified by Hawking (2000).

Most macroinvertebrates were identified to family level with some exceptions following standard conventions of the NSW AUSRIVAS sampling and processing manual (Turak *et al*., 2004). Chironomidae (Diptera) were identified to sub-family (e.g. Orthocladiinae, Chironominae and Tanypodinae). Groups such as Nematoda, Oligochaeta and Acarina were identified to class or order level in accordance with accepted convention. Microcrustacea, Ostracoda, Copepoda and Cladocera were also identified to the order level. Data is stored on a specialised aquatic ecology database maintained by GHD.

Upon completion of identification all samples were returned to 100% ethanol for long-term archiving. This process allows samples to be re-examined at a later date if required. This may be important, particularly if the taxonomy changes significantly in the future under a long-term monitoring program. GHD will ensure that archived samples are retained for the life of the Project. Reference specimens remain the property of GHD and are available upon request.

Estuarine

Field sampling

At estuarine sites, benthic invertebrates were sampled using a 100 mm diameter sediment corer. The corer was pushed 200 mm deep into the sediment. The samples were sifted through a 250 µm mesh sieve to remove the fine silt, mud and clay. The remaining sample was preserved in methylated spirits and labelled for later identification.

Laboratory processing and identification

The estuarine macroinvertebrate samples were sorted by GHD staff using a Leica MZ 9.5 stereo-dissection microscope with planachromat objectives and a zoom capability between 6.3x and 60x. Processed samples were then submitted to professional taxonomist Shona Marks of Benthic Australia for identification to family level or below.

Samples collected at Newstan Colliery Surface Site in 2012 were only identified to order level and the data has not been presented in this report as it is not comparable.

Permits and licences

GHD holds a current NSW Department of Primary Industries Scientific Collection Permit (P07/042-4.0, expiry 27/08/18) to conduct aquatic ecology surveys including macroinvertebrate sampling in NSW rivers and streams. Sampling conducted for this Project was conducted in accordance with this permit and the requirements of the GHD Animal Ethics Committee.

2.1.6 Data analysis

Water quality

Comparison to trigger values

The results of the water quality analysis were compared to the trigger values presented in Table 2-5.

For the freshwater sites monitored, the results of the water quality analysis were compared to SSTVs derived for discharge from Cooranbong LDP001 and Newstan LDP001. The SSTVs adopted are based on a review of default trigger values (DTVs) recommended by ANZECC (2000) and water quality observed at reference sites at upstream sites.

For the estuarine sites monitored at Newstan Colliery Surface Site, results for physicochemical parameters were compared to the ANZECC (2000) DTVs for slightly disturbed estuarine ecosystems of south-eastern Australia. Results for metals were compared to the ANZECC (2000) trigger values for marine water and 95% species protection.

Table 2-5 Trigger values for assessment of water quality

Parameter	Units	Freshwater sites		Estuarine sites
		Cooranbong LDP001 (GHD, 2013a)	Newstan LDP001 (GHD, 2011)	
Physicochemical parameters				
Electrical conductivity	µS/cm	2,200	2,200	–
DO	% sat.	85–110	85–110	80–110
pH	pH unit	6.5–9.0	6.5–8.5	7.0–8.5
TSS	mg/L	50	50	–
Turbidity	NTU	56	50	0.5–10
Nutrients				
Ammonia	mg/L	0.9	0.9	0.91
Total nitrogen	mg/L	1.3	0.5	0.3
Total phosphorus	mg/L	0.1	0.05	0.03
Dissolved metals				
Aluminium	mg/L	1.97	0.68	–

Parameter	Units	Freshwater sites		Estuarine sites
		Cooranbong LDP001 (GHD, 2013a)	Newstan LDP001 (GHD, 2011)	
Arsenic	mg/L	0.024	0.024	–
Barium	mg/L	0.02	N/A	–
Boron	mg/L	0.37	0.37	–
Cadmium	mg/L	0.0008	0.00054	0.0055
Chromium	mg/L	0.0037	0.0025	0.0274
Cobalt	mg/L	0.001	N/A	0.001
Copper	mg/L	0.00546	0.0035	0.0013
Iron	mg/L	2.58	0.3	–
Lead	mg/L	0.02584	0.0136	0.0044
Manganese	mg/L	1.9	1.9	–
Mercury	mg/L	0.0006	0.0006	0.0004
Nickel	mg/L	0.0429	0.0275	0.07
Selenium	mg/L	0.011	0.03	–
Silver	mg/L	0.001	0.00005	0.0014
Vanadium	mg/L	–	–	0.1
Zinc	mg/L	0.0312	0.02	0.015

Statistical analysis

Multivariate analyses were performed on the water quality results using PRIMER Version 6.1.13. Water quality results were normalised prior to statistical analysis, which involved principal component analysis (PCA).

PCA is a multivariate analysis technique that is commonly used on environmental data as an exploratory procedure. It compresses a set of variables, in this case water quality, into a smaller number of derived variables, called components. These components are linear combinations of the original variables that help explain as much of the variation in the data matrix as possible (Quinn and Keough, 2002). PCA is very useful for identifying key variables from a large data set.

The output from the PCA includes a two or three dimensional plot similar to those produced by non-metric multidimensional scaling and a list of eigenvalues and eigenvectors. The eigenvalues represent the amount of the original variance explained by each new component and the eigenvectors are coefficients or weights that show how much each original variable contributes to each new, derived variable or component.

Sediment quality

Sediment quality results were compared to ANZECC (2000) interim sediment quality guidelines (ISQGs).

Freshwater macroinvertebrate communities

In order to explain spatial trends in the data and determine underlying environmental factors responsible for observed trends (where possible), a range of univariate and multivariate analyses were performed. Both forms of analysis provide different levels of information, with univariate analysis used primarily to assess the condition or 'health' of sites, while multivariate analysis allows comparisons between sites based on community structure to determine if relationships exist between relevant environmental variables and macroinvertebrate communities. The various univariate and multivariate analysis methods used are discussed in more detail below.

Data preparation

Generally, cryptic taxa such as microcrustacea (Copepoda, Ostracoda and Cladocera) and Collembola were removed from the dataset. Additionally, if taxa were too small or damaged to identify to the family level and order level identification was the lowest resolution obtained, these taxa were retained in the dataset only if no other representatives from that group were found in that sample. Otherwise, the taxa were removed from the dataset.

Univariate analysis

Univariate analysis was based on the following macroinvertebrate biotic indices:

- Relative richness.
- Taxonomic richness.
- Ephemeroptera, Plecoptera, Trichoptera (EPT) richness.
- Stream Invertebrate Grade Number Average Level – Version 2 (SIGNAL 2) biotic index.
- AUSRIVAS model.
- Generalised linear model (GLM).

It should be noted that where two edge samples were collected at a site, the first replicate was selected for inclusion. All data including replicates was included in the GLM and multivariate analysis.

Taxonomic richness refers to the number of different taxa contained in a sample. A high number of taxa present at a monitoring location can indicate that the site is in good condition and/or has a diverse range of habitats and an abundant food supply. However, in some cases, higher taxonomic richness can occur at impacted sites due to the provision or enhancement of habitats or food resources that may not occur naturally (e.g. enhanced riffle habitat availability due to altered flow conditions, enhanced periphyton food resource for macroinvertebrate grazing taxa due to increased nutrient levels). Consequently, results for taxonomic richness must be assessed on a case-by case-basis and in relation to habitat conditions.

Relative richness is the percentage of the major taxonomic orders found and has been derived from the presence/absence data for each sample. This measure provides an estimate of the percentage contribution of the major macroinvertebrate orders and allows for a visual representation of the macroinvertebrate community at each monitoring site and a pooled total representing the macroinvertebrate community across all sites.

EPT richness refers to the number of families of EPT taxa contained in a sample. Some groups of aquatic macroinvertebrates are more sensitive to changes in the aquatic environment than others and it is possible to refine the assessment of river health based on the presence or absence of sensitive taxa. It is generally accepted that three orders of aquatic insects, the Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies), are among the most sensitive taxa to altered water quality and habitat conditions. The total number of families of EPT taxa can be used to assess degradation of habitat and water quality (Plafkin *et al.*, 1989). The use of this index is based on the premise that undisturbed sites will have relatively greater numbers of EPT taxa than sites in a degraded condition.

SIGNAL 2 biotic index (Chessman, 2003) is a simple scoring system for macroinvertebrates of Australian rivers. SIGNAL 2 is a biotic index based on pollution sensitivity values (grade numbers) assigned to aquatic macroinvertebrate families that have been derived from published and unpublished information on tolerance to pollutants, such as sewage and nitrification (Chessman, 1995).

Macroinvertebrate families are assigned a grade from 1 (most tolerant) to 10 (most sensitive) based on ecotoxicity assessment data. Families in a sample that have not been assigned a grade are excluded from the analysis. The overall SIGNAL 2 score for each site is calculated by the determining the average of the SIGNAL 2 grades for each taxon contained in a sample.

The **AUSRIVAS model** provides a river health assessment based on predictive models of macroinvertebrate distribution. Physical and chemical data collected at each site is used to determine the predicted composition of macroinvertebrate fauna if the site is in an undisturbed or reference condition. The AUSRIVAS model compares the macroinvertebrates collected at the site (observed) to the macroinvertebrates predicted to occur (expected) at undisturbed reference sites with similar environmental characteristics. An OE50 score was generated, which is a probability score based on the predicted occurrence of macroinvertebrate species which ranges from 0 to 1. A score close to 0 indicates an impoverished assemblage and a score close to 1 indicates similarity to the reference site. Five bands are derived from OE50 scores which indicate the level of impact at a site. A summary of the AUSRIVAS bandings is provided in Table 2-6.

On occasion, results were found to be outside of the experience of the model (OEM). This occurs when there is no appropriate reference group for comparison to the test sites.

Rainfall data was required for the AUSRIVAS model and was obtained for the Bureau of Meteorology stations at Toronto WWTP (station number 61322) and Cooranbong (Avondale) (station number 61012).

Table 2-6 AUSRIVAS band summary

Band label	Band name	Band description
Band X	More biologically diverse than reference sites.	More taxa found than expected. Potential biodiversity hot-spot. Possible mild organic enrichment.
Band A	Reference condition.	Most/all of the expected families found. Water quality and/or habitat condition approximately equivalent to reference sites. Impact on water quality and habitat condition does not result in a loss of macroinvertebrate diversity.

Band label	Band name	Band description
Band B	Significantly impaired.	Fewer families than expected. Potential impact either on water quality or habitat quality or both, resulting in loss of taxa.
Band C	Severely impaired.	Many fewer families than expected. Loss of macroinvertebrate biodiversity due to substantial impacts on water and/or habitat quality.
Band D	Extremely impaired.	Few of the expected families remain. Extremely poor water and/or habitat quality. Highly degraded.

GLMs were performed as an analysis of variance (ANOVA) approximation to test the main effects of site type and sampling event on taxonomic richness, EPT richness, SIGNAL 2 score and AUSRIVAS OE50 score. GLMs were used in place of a traditional ANOVA as there was unequal replication across the sites and sampling events and interaction effects of incomplete factorial ANOVA cannot be accurately assessed based on traditional least squares formulae.

Tests were performed on the edge habitat data collected in 2013 and 2014 for Newstan and data collected from 2012 to 2014 for Cooranbong. Data from other years were excluded due to small sample size. Additionally, the reference site type was omitted from the Newstan data as no reference sites were sampled prior to 2014.

GLMs were performed using STATISTICA Version 12. Tests were performed using Type VI sum of squares as this method provides an adjustment to the calculation to compensate for the unequal sample size between cells.

Multivariate analysis

The use of multivariate analysis techniques allows exploration of the patterns of macroinvertebrate communities which univariate analysis techniques cannot. All multivariate analyses were performed using the statistical package PRIMER Version 6.1.13.

RBA sampling does not provide a quantitative estimate of the abundance of each taxon in a sample. As such, all macroinvertebrate data were converted to binary form (i.e. presence/absence data) prior to macroinvertebrate analysis. For all multivariate analyses, taxa that were considered rare (present in less than 5% of samples) were removed from the dataset as their occurrence at a given site could be more related with chance than habitat conditions at the site. Such taxa often create 'noise' within the data that masks actual patterns that relate to treatment effects (Clarke and Warwick, 2001).

Multivariate analysis was based on the following methods:

- Cluster.
- ANOSIM.
- Similarity percentages (SIMPER).

Classification or **cluster analysis** is a mathematical method of grouping entities according to the relative similarity of their attributes. In an ecological setting these techniques can be used to group sites according to how similar their macroinvertebrate community is. Cluster analysis was used to help identify any differences (or similarities) in the macroinvertebrate communities between reference and impact sites or between sampling events.

The key to this technique is the Bray-Curtis similarity matrix which is constructed from the individual similarities between all possible pairs of sites (Bray and Curtis, 1957; Clifford and Stephenson, 1975). From this matrix, a classification using hierarchical agglomerative clustering is obtained and represented visually as a dendrogram or tree diagram. The dendrogram displays sites in groups of varying size according to the similarities between them. In other words, sites which are similar in macroinvertebrate assemblage will be grouped together on the dendrogram.

ANOSIM was used to investigate the significance of any similarity between and within site groupings. ANOSIM, fully described by Clarke and Gorley (2006), compares the similarity of samples within groups to the similarity of samples between groups. The test uses a randomisation procedure to test the hypothesis that there is no community structure between site/sample groups. Each randomisation compares the R test statistic generated from a randomly sorted dataset with the R value calculated from the original dataset. One thousand randomisations of the data were undertaken for each comparison. An R value can vary between -1 and 1. The greater the R value, the greater the separation between groups. A probability estimate is also generated as part of ANOSIM and can be used as formal evidence of whether or not particular sample groupings are significantly different from one another in terms of taxonomic composition.

SIMPER was used to investigate the taxa responsible for any observed significant differences in macroinvertebrate community structure between sample groups (e.g. reference and impact sites). SIMPER computes the average dissimilarity (Bray-Curtis) between all pairs of inter-group samples (every sample in group one with every sample in group two etc.) and then breaks this average down into the separate contributions from each taxon. In addition to calculating the average dissimilarity between groups, SIMPER also calculates the average similarity within a group.

Estuarine macroinvertebrate communities

Estuarine samples were analysed using both abundance and taxonomic richness techniques. Further analyses were limited due to there being only a single estuarine downstream recovery site (IZ) sampled more than once and as there are no relevant biotic indices on which to assess estuarine benthic fauna community condition.

Univariate analysis was based on the following methods:

- Taxonomic richness.
- Abundance.
- Composition.

Taxonomic richness refers to the number of different taxa contained in a sample identified to family level or below. Rare and common taxa are considered equally, as richness does not take into account abundance.

Abundance refers to the number of each taxa recorded in the samples collected.

Composition refers to the range of taxa recorded in the samples collected.

2.2 Ecotoxicology assessments

2.2.1 Sample collection

One ecotoxicology assessment has been conducted on Cooranbong LDP001 discharge, in September 2012 (GHD, 2013b).

The following four ecotoxicology assessments have been performed on Newstan LDP001 discharge:

- Untreated discharge in May 2011 (GHD, 2011).
- Laboratory treated discharge representative of the proposed discharge from the CWP in April 2012 (GHD, 2012b).
- Discharge treated by the CWP in May 2014 (GHD, 2014).
- Discharge treated by the CWP in November 2014 (GHD, 2014).

Samples from the CWP at Newstan Colliery Surface Site in May and November 2014 were collected from the composite sampler. The composite sampler provides 24 samples of water over the space of 24 hours (one sample per hour), which were mixed on site to provide a batch sample of Newstan LDP001 discharge.

Two batch samples were collected from the CWP composite sampler in November 2014, due to the large volume of water required for toxicity testing. These samples are specified in this report as LDP001-A, which was collected on 12 November 2014, and LDP001-B, which was collected on 13 November 2014.

Samples of mine water discharge for all ecotoxicology assessments at Cooranbong Services Site and Newstan Colliery Surface Site were transferred to the Ecotox Services Australasia (ESA) laboratory in Sydney for toxicity testing. Samples were also collected for water quality analysis.

2.2.2 Direct toxicity assessment

Direct toxicity assessment (DTA) is a common method used to determine the toxicity of mixtures of compounds in ambient waters. The method provides an integrated measure of effects and accounts for interactions (synergistic, additive and ameliorative) within a mixture, therefore closely simulating the effects in the receiving waterway. To ensure a close simulation of the toxic effects of the discharge, site-specific testing was undertaken using species indigenous to, or representative of, the receiving ecosystem.

DTA was undertaken for the mine water discharge samples collected from Cooranbong LDP001 and Newstan LDP001. The DTA methodology followed Section 8.3.6 of the ANZECC (2000) guidelines, which provides an increased level of confidence that the derived targets will not cause adverse environmental effects to receiving ecosystems.

Toxicity testing involves exposing laboratory test species to a range of concentrations of sampled water for a specified exposure period. At the end of the exposure period, specific points are assessed, such as species survival, reproduction or growth. Statistical analysis of the results provide the effect concentration of the sample where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibit the specific end point and the no observable effect concentration (NOEC), which represents the highest concentration that has no effect upon the test species.

2.2.3 Species tested

Toxicity testing of sampled water was performed using the ANZECC (2000) protocol with species endemic to, or representative of, the receiving environment. Where possible, chronic bioassays were performed using NATA accredited tests.

Cooranbong Services Site

The following freshwater species and test protocols were used to test the sample collected from Cooranbong LDP001 in September 2012:

- Seven day partial life-cycle (chronic) test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) protocol.
- 72 hour microalgal growth inhibition (chronic) test using the green alga *Selanastrum capricornutum*, based on the USEPA (2002) protocol.
- 96 hour survival (acute) test using the freshwater shrimp *Paratya australiensis*, based on the USEPA (1996) protocol.
- Seven day growth inhibition (chronic) test using the freshwater aquatic duckweed *Lemna disperma*, based on the OECD (2006) protocol.
- 10 day fish embryonic development and post-hatch survival (chronic) test using the eastern rainbowfish *Melanotaenia spendida splendida*, based on the USEPA (2002) protocols.

Newstan Colliery Surface Site

May 2011

The following freshwater species and test protocols were used to test the sample of untreated discharge collected from Newstan LDP001 in May 2011:

- Eight day partial life-cycle (chronic) test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) protocol.
- 72 hour microalgal growth inhibition (chronic) test using the green alga *Selanastrum capricornutum*, based on the USEPA (2002) protocol.
- 96 hour survival (acute) test using the freshwater shrimp *Paratya australiensis*, based on the USEPA (1996) protocol.
- Seven day growth inhibition (chronic) test using the freshwater aquatic duckweed *Lemna disperma*, based on the OECD (2006) protocol.
- 12 day fish embryonic development and post-hatch survival (chronic) test using the eastern rainbowfish *Melanotaenia spendida splendida*, based on the USEPA (2002) protocols.

April 2012

The following freshwater species and test protocols were used to test the sample of laboratory treated discharge collected from Newstan LDP001 in April 2012:

- Seven day partial life-cycle (chronic) test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) protocol.
- 72 hour microalgal growth inhibition (chronic) test using the green alga *Selanastrum capricornutum*, based on the USEPA (2002) protocol.
- 96 hour survival (acute) test using the freshwater shrimp *Paratya australiensis*, based on the USEPA (1996) protocol.

- Seven day growth inhibition (chronic) test using the freshwater aquatic duckweed *Lemna disperma*, based on the OECD (2006) protocol.
- 48 hour survival (acute) test using the chironomid *Chironomus tepperi*, based on in-house test methods.

May 2014

The seven day partial life-cycle (chronic) test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) protocol, was performed on the sample of treated Newstan LDP001 discharge collected from the CWP in May 2014.

November 2014

The following freshwater species and test protocols were used to test the sample of treated Newstan LDP001 discharge collected from the CWP in November 2014:

- Eight day partial life-cycle (chronic) test using the freshwater cladoceran *Ceriodaphnia cf. dubia*, based on the USEPA (2002) protocol.
- 10 day fish embryonic development and post-hatch survival (chronic) test using the eastern rainbowfish *Melanotaenia spendida splendida*, based on the USEPA (2002) protocols.
- 10 day survival (chronic) test using the freshwater shrimp *Paratya australiensis*, based on the USEPA (1996) protocol. Note this bioassay is not NATA accredited.

The cladoceran and eastern rainbowfish bioassays were performed using the Newstan LDP001-A sample and the freshwater shrimp bioassay was performed using the Newstan LDP001-B sample.

2.2.4 Concentrations tested

ESA recommended the use of laboratory dilution water to provide a more accurate indication of the toxicity of the samples. ESA used in-house diluents for all dilutions and controls to ensure the toxicity observed can be attributed directly to the sample tested. All samples were serially diluted with the appropriate diluent to achieve the test concentration. Concentrations and diluents differed between bioassays due to the methodologies used. A summary of the concentrations of mine water discharge used in the toxicity testing is provided in Appendix B.

2.2.5 Water quality analysis

Water samples were tested for the parameters listed in Table 2-7 at NATA accredited facilities at the ALS Environmental Division Laboratory for all samples, with the exception of the laboratory treated Newstan LDP001 discharge, which was analysed at the NATA accredited Hunter Water Australia Laboratory.

The results of the water quality analysis were compared to SSTVs derived for discharge from Cooranbong LDP001 and Newstan LDP001, as shown in Table 2-5.

Table 2-7 Summary of water quality parameters analysed for ecotoxicology assessments

Category	Parameter
Physicochemical parameters	Electrical conductivity, pH, TDS, TSS.
Nutrients	Nitrite + nitrate, TKN, total nitrogen, total phosphorus.
Anions	Alkalinity, chloride, sulfate.

Category	Parameter
Cations	Calcium, magnesium, potassium, sodium.
Dissolved metals	Aluminium, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc.
Other	Ammonia, oil and grease, silica.

2.2.6 Dilution factor

The BurrliOZ statistical analytical program (Campbell *et al.*, 2000) uses the EC_{10} results from the toxicity testing to calculate the concentration of mine water discharge to protect 99%, 95%, 90% and 80% of species in the receiving environment from a 10% reduction in growth or reproduction. Dilution factors are then calculated for each species protection level, which can be used to assist in deriving site-specific concentrations of contaminants that will not adversely impact organisms within the receiving environment. Concentrations of individual contaminants cannot be extrapolated from toxicity testing results for use as trigger values. However, concentrations can be used for monitoring purposes to ensure that the dilution factors are met at the appropriate monitoring site.

It should be noted that the future version of the ANZECC (2000) guidelines will require the use of a log-logistic distribution for data sets of small samples sizes. The BurrliOZ program requires a minimum of eight data sets to obtain an accurate species sensitivity distribution and results using less data sets must be interpreted with caution.

3. Aquatic ecology monitoring

3.1 Cooranbong Services Site

3.1.1 Aquatic habitat assessment

A total of ten sites have been monitored in the vicinity of Cooranbong Services Site from 2012 to 2014, with all monitoring sites located in a lowland coastal catchment. Aquatic habitat at the majority of sites is considered to be a modified stream, with the exception of SW016 and SW017, which are located within a fairly undisturbed 'swampy' environment. Riparian vegetation was observed at SW017 characteristic of an estuarine environment. This site supported a healthy mangrove forest dominated by grey mangroves (*Avicennia marina)* indicating that this site is subject to tidal inundation. Riparian vegetation at all other sites was characteristic coastal freshwater creeks and included various eucalypt and melaleuca species. There was considerable variation between sites, with the site classification ranging between lowland broad valley and upland floodplain.

Assessment of aquatic habitat indicated that the majority of sites monitored at Cooranbong Services Site are considered to be in a slightly to moderately disturbed condition. The catchment areas of these monitoring sites are small, which was reflected in the small shallow creeks of low flow dominated by pool habitat. The exception is the downstream sites located on Muddy Lake, SW016 and SW017, which are located on large deep pools which are more permanently inundated.

The land use influences observed for the impacts sites SW001, SW002 and CCSR1 have caused some degree of change from the natural condition, particularly concerning riparian vegetation condition and increased erosion. The highest degree of disturbance was observed at the impact sites due to the construction of water management infrastructure which has likely contributed to historical changes in the macroinvertebrate community as well as water quality over time. Land clearing was also observed at other monitoring sites, however the primary land use for most reference and recovery sites was native vegetation, indicating urban impacts on these sites would be minimal. Power easements are also prevalent surrounding the site area which has significant cleared dense strips of vegetation.

Instream habitat complexity was found to be moderate at most monitoring sites with at least some macrophyte presence, overhanging habitat, flow through the site or accumulated detrital matter observed along edges. Macrophyte growth, predominantly *Typha* and *Phragmites*, was found to be prevalent at some sites, particularly at impact sites SW001 and CCSR1. Due to the relatively low nutrient levels of discharge from Cooranbong LDP001, it is not likely that the macrophyte growth is being exacerbated by discharges through nutrient enrichment. It is more likely that macrophytes are taking advantage of the permanent water sources at these sites due to the discharge.

Sediment composition can be highly influential on aquatic communities and may have contributed to differences observed between monitoring sites. The substrate at some sites, including SW001, SW013, SW014 and SW017, was found to be largely dominated by silt with little variation. Sediments at other sites contained a larger proportion of gravel or sand. Sediment particle size can influence many aspects of aquatic communities including type of macrophyte growth, length of water retention, type and diversity of macroinvertebrates as well as water and sediment quality.

Recovery site SW017 on Muddy Lake is clearly influenced by estuarine waters with healthy mangrove pneumatophores and estuarine riparian vegetation dominated by grey mangroves (*A. marina*) observed at this site. Review of available aerial imagery and 2 m contours of Muddy Lake provide evidence that SW017 is likely within the tidal limit with tidal waters able to enter this area from Lake Eraring via the Dora Creek aquaduct. It also suggests that tidal waters may have the potential to reach site SW016 during king tides, however it is unknown whether the tidal limit reaches this far into Muddy Lake.

A brief description of aquatic habitat conditions observed at each of the monitoring sites has been provided below.

SW013 – Reference site

SW013 is located on a tributary of the unnamed creek upstream of Cooranbong LDP001 within a broad valley, as shown in Figure 2-1. This site has been monitored in winter 2012 and spring 2013. Table 3-1 provides photographs of the site from both monitoring rounds.

The unnamed creek at SW013 is approximately 4 m wide and approximately 0.5 m deep. On both monitoring occasions, the creek was found to be dominated by low flow pool habitat with some run habitat in isolated areas; however no habitat typical of a riffle zone was observed.

The substrate within the area sampled for macroinvertebrates was found to be dominated by silt, with approximately 60% detritus covered the habitat sampled within the reach.

Aquatic macrophytes were present within the assessed reach and a variety of coarse particulate matter including logs and branches were observed in both 2012 and 2013, which increased instream habitat complexity. In the immediate riparian zone, there was a dense groundcover of common saw sedge (*Gahnia clarkei*), dense *Melaleuca* shrubs and mature eucalypts observed, which provided moderate shading across the assessed reach. The majority of vegetation at this site is considered native as few exotics were observed. Aquatic habitats included pool, large woody debris, instream macrophytes and trailing vegetation.

The dominant land use in the catchment area upstream of this site was native vegetation. Downstream of the site, native vegetation has been cleared for access tracks and a coal conveyor. There was little evidence of human disturbance, other than this clearing for access tracks.

No major differences, in terms of instream habitat, were observed at the monitoring sites between 2012 and 2013. There were marked changes to water quality between 2012 and 2013, discussed further in Section 3.1.2. Despite being classified as a reference site, the water quality results at SW013 in October 2013 indicate potential anthropogenic influences at this site and, thus, it was recommended that this site be replaced with a more suitable control site.

Table 3-1 Photographs of SW013 at Cooranbong Services Site during winter 2012 and spring 2013 surveys

Sampling event	Description	Photograph
Winter 2012 (24/07/2012)	Facing upstream at SW013	
Spring 2013 (23/10/2013)	Facing upstream at SW013	

SW014 – Reference site

SW014 replaced SW013 as a reference site following the October 2013 survey and has been monitored in autumn and spring 2014. Table 3-2 provides photographs of the site from both monitoring rounds.

SW014 is a broad valley site on an unnamed creek, north-east of Cooranbong Services Site and upstream of SW013, as shown in Figure 2-1. This site was dry during the October 2013 monitoring event, however in April 2014 a number of small isolated pools, approximately 2 m in width and a maximum of 5 m in length, were present. In October 2014, the creek was found to be approximately 1 m wide and approximately 30 cm deep.

The substrate within the area sampled for macroinvertebrates was found to be dominated by silt with only a small proportion of sand. Approximately 40% detritus covered the habitat sampled within the reach during both autumn and spring 2014 surveys.

In the immediate riparian zone, the common saw sedge (*G. clarkei*) and common reed (*Phragmites australis*) were observed to dominate. Shrubs and small to large eucalypts extended in the vegetation beyond the stream banks which provided moderate shading across the assessed reach. The majority of vegetation at SW014 is considered native as few exotic species were observed.

The dominant land use in the catchment area upstream of this site was native vegetation and there was moderate to low evidence of human disturbance, other than some clearing for access tracks.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events in 2014.

Table 3-2 Photographs of SW014 at Cooranbong Services Site during autumn and spring 2014 surveys

Sampling event	Description	Photograph
Autumn 2014 (10/04/2014)	Facing upstream at SW014	
Spring 2014 (01/10/2014)	Facing upstream at SW014	

SW015 – Reference site

SW015 is located on the unnamed creek, upstream of the discharge location LDP001, as shown in Figure 2-1, and has been monitored once in autumn 2014. Table 3-3 provides a photograph of the site. SW015 is classified as an upland floodplain, with the aquatic habitat present in autumn 2014 not considered ideal for macroinvertebrate sampling due to the limited extent and ephemeral nature of the habitat.

A small, shallow, turbid pool, approximately 1 m wide, was present in autumn 2014 and aquatic habitat appeared to be temporary and was likely only to be present following recent rainfall. There was no active channel evident downstream of a track which crosses the creek and was a small barrier to the flow and may be the reason water was pooling at this location. Exotic grasses dominated the area that was cleared for the track, while there were scattered sedges observed in the riparian area and terrestrial plant species appeared to dominate. The area beyond the cleared vegetation was dominated by generally native shrubs and small to medium eucalypts.

Within the sampled habitat, substrate was dominated by silt with some sand and gravel content. Approximately 25% of the substrate was covered with detritus. There were few macrophytes observed within the sampled area however overhanging habitat, predominantly grasses, extended along approximately 90% of the sampled edge.

In the area that was not cleared for the access track, dominant land use was native vegetation on both sides of the pool. Apart from the access track, little other evidence of human disturbance could be observed in the catchment upstream of the site.

Table 3-3 Photograph of SW015 at Cooranbong Services Site in autumn 2014 survey

Sampling event	Description	Photograph
Autumn 2014 (11/04/2014)	Facing upstream at SW015	

CCSC1 – Reference site

CCSC1 is a reference site located on Jigadee Creek at the bridge crossing on Newport Road, as shown in Figure 2-1. This site is the catchment adjacent and to the west of the unnamed creek and is not influenced by discharge from Cooranbong Services Site. CCSC1 has been monitored in winter 2012, spring 2013 and spring 2014. Table 3-4 provides photographs of the site from each monitoring round.

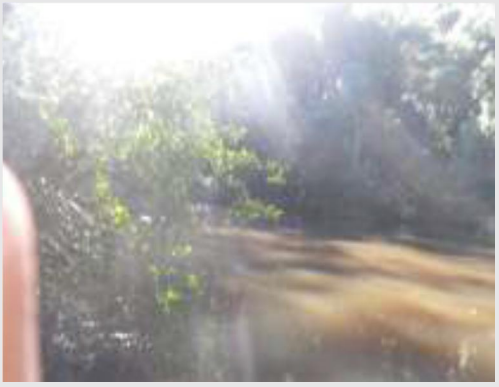
In spring 2014, the creek had a width of approximately 10 m with a number of instream barriers including large bridge pylons and a downstream weir. The site is classified as a broad valley, with riparian vegetation generally limited to a narrow band of eucalypt forest with a dense shrub layer of the exotic small leaf privet (*Ligustrum sinense)*.

Within the sampled habitat substrate was dominated by silt with some sand and gravel content and approximately 25% of the substrate was covered with detritus. There were few macrophytes observed within the sampled area. However, overhanging habitat, predominantly grasses and sedges, extended along approximately 70% of the sampled edge in spring 2014.

The catchment land use was found to be dominated by native forest, with some rural and urban residential and well as agriculture.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events between 2012 and 2014.

Table 3-4 Photographs of CCSC1 at Cooranbong Services Site in winter 2012, spring 2013 and spring 2014 surveys

Sampling event	Description	Photograph
Winter 2012 (25/07/2012)	Facing upstream at CCSC1	

Sampling event	Description	Photograph
Spring 2013 (23/10/2013)	Facing upstream at CCSC1	
Spring 2014 (01/10/2014)	Facing upstream at CCSC1	

SW001– On-site impact site

SW001 is located on the unnamed creek at Cooranbong LDP001 and has been monitored in winter 2012, spring 2013 and autumn and spring 2014. Table 3-5 provides photographs of the site from each monitoring round.

SW001 was found to be limited to a densely vegetated pool predominantly covered by common reed (*P. australis*). This dense macrophyte bed reduces the flow through this site and limits the diversity and extent of aquatic habitat with the majority of the reach being a standing or slow flowing pool. This macrophyte bed may act as a filter which may be beneficial for limiting dispersal of mine site discharge waters downstream and could reduce potential impact of pollutants on the aquatic ecosystem. However, the extent of growth of the macrophyte beds limits the habitat variability for macroinvertebrate taxa which is likely to influence the macroinvertebrate community at the site. The density of the macrophyte beds also makes it extremely difficult to collect an adequate macroinvertebrate sample, especially during low flow periods.

Strong odours were omitted from sediment during all rounds of sampling, suggesting anaerobic conditions with fine black silt and organic matter evident in the plume when sampling disturbed the substrate. Substrate composition was 100% silt and clay which also contributed to the limited habitat variability across the stream reach.

Land use was found to be dominated by native vegetation on the left bank while industrial influences were present on the right bank. The discharge at Cooranbong LDP001 is a potential point source of pollution and the mining facilities in the catchment upstream are a potential non-point source of pollution. Riparian vegetation on the stream banks was limited to mown grasses on the right bank with some mature shrubs and only a few trees in the immediate riparian area on the left bank generally providing little shading over the stream channel.

There was a marked difference in the density of instream macrophytes between 2012 and 2013. The density of macrophytes was similar between 2013 and 2014, as shown in Table 3-5.

Table 3-5 Photographs of SW001 at Cooranbong Services Site in winter 2012, spring 2013 and autumn and spring 2014 surveys

Sampling event	Description	Photograph
Winter 2012 (25/07/2012)	Facing upstream at SW001	
Spring 2013 (22/10/2013)	Facing upstream at SW001	
Autumn 2014 (10/04/2014)	Facing upstream at SW001	
Spring 2014 (30/09/2014)	Facing upstream at SW001	

SW002 – On-site impact site

SW002 is located on the unnamed creek adjacent to the 5 ML Dam at Cooranbong Services site and downstream of Cooranbong LDP001 and LDP002. This site has been monitored in winter 2012. Table 3-6 provides a photograph of the site.

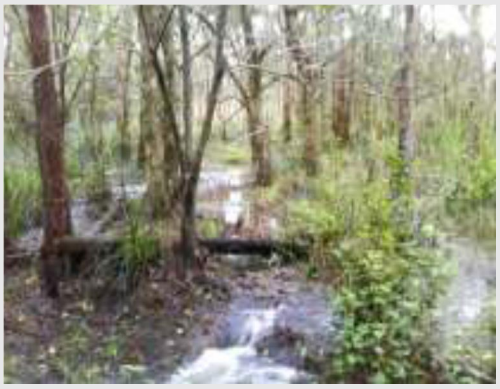
SW002 is located within a small stand of native trees which was observed to shade the creek considerably and limit instream macrophyte growth. The flow types observed in winter 2012 included riffle and run, however the site was dominated by pool habitat with riffle habitat insufficient to provide an adequate riffle macroinvertebrate sample.

Sediment substrate was dominated by clay/silt with some sand and a little gravel in isolated areas across the assessed reach. The riparian vegetation was a mixture of native overstory trees and exotic shrubs. Groundcover included large areas of lantana mixed with other exotic weed species.

In spring 2013, SW002 was sampled at the discharge point of the 5 ML Dam via Cooranbong LDP002. Noticeable coal sediment was observed within the system in this monitoring round. The site resembled a pool habitat with no flow observed due to the dam. The sediment was estimated to be 100% silt/clay. Algal coverage was fairly high, which is to be expected as there was little shading or overhanging habitat observed. There was only a small coverage of macrophyte at this site and little detritus.

Apart from the coal mining operations, surrounding land use in the immediate area was mostly native forest. Riparian vegetation was dominated by grasses with some eucalypts and she-oak as well as lantana noted on both sides of the bank.

Table 3-6 Photograph of SW002 at Cooranbong Services Site in winter 2012 and spring 2013 surveys

Sampling event	Description	Photograph
Winter 2012 (24/07/2012)	Facing upstream at SW002	
Spring 2013 (22/10/2013)	View of 5 ML Dam (SW002 at outlet) facing upstream	

CCSR1 – Downstream impact site

CCSR1 is located on the unnamed creek downstream of Cooranbong Services Site, as shown in Figure 2-1, and has been monitored in winter 2012, spring 2013 and autumn and spring 2014. Table 3-7 provides photographs of the site from each monitoring round.

CCSR1 is located downstream of a small swamp and upstream of Muddy Lake, in an area where access is possible as the majority of riparian vegetation had been cleared for high tension power lines. The assessed reach was a pool containing a moderate coverage of macrophytes dominated by common reed (*P. australis*) with rushes (*Juncus sp.*) observed in the reach downstream of the road culvert. Overhanging riparian vegetation was limited to some native shrubs and grasses in the downstream habitat and the flow level at the time of sampling was assessed to be slightly below the normal flow level.

Substrate at this site was found to be a mix of gravel and clay and silt, with some cobble and boulder added around the culvert for stabilisation. Deposition of fine black sediment was observed in the upstream reach habitats above the macrophyte bed which shows that the macrophytes are acting as a filter for fine sediments and possibly limiting the deposition downstream.

Native vegetation was observed to be the main land use on both stream banks, with the exception of the cleared areas around the power lines.

There was a marked difference in the density of instream macrophytes between 2012 and 2013. The density of macrophytes was similar between 2013 and 2014, as shown in Table 3-7.

Table 3-7 Photographs of CCSR1 at Cooranbong Services Site in winter 2012, spring 2013 and autumn and spring 2014 surveys

Sampling event	Description	Photograph
Winter 2012 (24/07/2012)	Facing upstream at CCSR1	
Spring 2013 (22/10/2013)	Facing upstream at CCSR1	

Sampling event	Description	Photograph
Autumn 2014 (10/04/2014)	Facing upstream at CCSR1	
Spring 2014 (30/09/2014)	Facing upstream at CCSR1	

SW016 – Downstream recovery site

SW016 is located in Muddy Lake downstream of Cooranbong Services Site, as shown in Figure 2-1, and has been monitored in autumn and spring 2014. Table 3-8 provides photographs of the site from 2014. Muddy Lake is a lowland coastal swamp and is a large but relatively shallow water body approximately 40 m wide.

The main land use in the vicinity was native vegetation and agriculture. SW016 and the wider area were observed to be coastal swamp with low vegetation dominated by grasses, sedges and juvenile swamp oak (*Casuarina glauca*) trees. On the right bank there were some taller swamp oak trees which provided limited shading of the water body. Review of available aerial imagery and the 2 m contours of Muddy Lake suggests that tidal waters may have the potential to reach this site during king tides, however it is unknown whether the tidal limit reaches this far into Muddy Lake.

A strong smell was emitted during sampling in both monitoring rounds which was indicative of breakdown of organic matter and anaerobic conditions, which could be considered as normal for this type of coastal swamp habitat. Substrate in the area sampled for macroinvertebrates was found to be chiefly comprised of silt with some gravel. There was approximately 30% macrophyte coverage in the sampled reach and this was comprised of some submerged and emergent taxa while approximately 30% of the sample was taken where overhanging habitat, mainly grasses and swamp oak roots, were present.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events in 2014.

Table 3-8 Photographs of SW016 at Cooranbong Services Site in autumn and spring 2014 surveys

Sampling event	Description	Photograph
Autumn 2014 (11/04/2014)	Facing upstream at SW016	
Spring 2014 (29/09/2014)	Facing upstream at SW016	

SW017 – Downstream recovery site

SW017 is located in Muddy Lake downstream of monitoring site SW016, as shown in Figure 2-1, and has been monitored winter 2012, spring 2013 and autumn and spring 2014. Table 3-9 provides photographs of the site from each monitoring round.

SW017 was at a large pool, approximately 50 m wide. The riparian vegetation was dominated by common reed (*P. australis)* and grey mangroves (*A. marina)* around the edge of the pool, and grasses, swamp oak and weeds (including lantana) in the habitat beyond the riparian edge. While this site recorded relatively fresh electrical conductivity, this site clearly is influenced by estuarine waters with healthy mangrove pneumatophores and estuarine riparian vegetation grey mangroves observed. Review of available aerial imagery also provides evidence that this area is within the tidal limit and tidal waters can enter this area via the Dora Creek aquaduct.

Substrate was dominated by clay and silt with organic debris and detritus, leading to anoxic substrate, prevalent in the area sampled. In the area sampled for macroinvertebrates, there was approximately 30% shading provided by the swamp oak and grey mangroves and approximately 25% of the sample was collected where overhanging vegetation was present.

Apart from the mining facilities upstream, local land use within the area included rural and urban residential, road and rail infrastructure, agriculture and Eraring Power Station.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events from 2012 to 2014, with the exception of the presence of a large algae bloom during the 2013 survey, as shown in Table 3-9.

Table 3-9 Photographs of SW017 at Cooranbong Services Site in winter 2012, spring 2013 and autumn and spring 2014 surveys

Sampling event	Description	Photograph
Winter 2012 (25/07/2012)	Facing upstream at SW017	
Spring 2013 (21/10/2013)	Facing upstream at SW017	
Autumn 2014 (11/04/2014)	Facing upstream at SW017	
Spring 2014 (29/09/2014)	Facing upstream at SW017	

3.1.2 Water quality

In situ water quality

Results of *in situ* water quality monitoring are presented in Appendix C for reference sites SW013, SW014, SW015 and CCSC1, on-site and downstream impact monitoring sites SW001, SW002, LDP002 and CCSR1 and downstream recovery sites SW016 and SW017. The SSTVs calculated for Cooranbong LDP001 (GHD, 2013a) are also included for comparison in each table.

Results for reference site SW013 in 2013 were significantly different to results recorded in 2012, with an increase in electrical conductivity and decrease in pH and turbidity. This indicates potential anthropogenic influences at the site and as a result, this site was recommended to be replaced with a more suitable control site in subsequent monitoring surveys.

Electrical conductivity levels were observed to be above SSTV of 2,200 µS/cm at SW001 and immediately downstream of this site. A decreasing trend in electrical conductivity is evident with increasing distance downstream of the discharge at Cooranbong LDP001.

Results for pH were found to be below the lower SSTV on several occasions at reference monitoring sites and once at LDP002 in spring 2013.

Dissolved oxygen (DO) results were below the lower SSTV at the majority of sites; however there is no trend evident with regards to location or site type (i.e. reference, downstream impact and downstream recovery sites). This indicates that it is unlikely that the lower DO values reported throughout the catchment are the result mine water discharge from Cooranbong Services Site and are likely to be associated with natural fluctuation. It should be noted that DO recorded as part of aquatic ecology monitoring does not represent the full diurnal range of potential DO levels.

Laboratory analysed water quality

Results of laboratory analysed water quality monitoring are presented in Appendix C for reference sites SW013, SW014, SW015 and CCSC1, on-site and downstream impact monitoring sites SW001, SW002, LDP002 and CCSR1 and downstream recovery sites SW016 and SW017. The SSTVs calculated for Cooranbong LDP001 (GHD, 2013a) are also included for comparison in each table.

Reference monitoring site SW013 presented poor water quality results in spring 2013 compared to winter 2012. SSTVs for dissolved aluminium, barium, cobalt, iron, manganese, nickel and zinc were all exceeded in addition to the elevated electrical conductivity and low pH noted in the *in situ* monitoring results. Given the potential anthropogenic influences at the reference site, it was recommended to be replaced with a more suitable control site in subsequent monitoring surveys.

SSTVs for TSS, total nitrogen and dissolved barium, cobalt and iron were exceeded at sites SW015 and CCSC1. As these reference sites are not affected by mine water discharge from Cooranbong Services Site, it is considered that these exceedences are a result of other sources within the wider catchments of the respective waterways.

Muddy Lake, represented by downstream recovery monitoring sites SW016 and SW017, was generally found to have elevated concentrations of nutrients. It is expected that the lake acts as a form of sedimentation basin and hence some accumulation of nutrients is likely to be occurring. Elevated total nitrogen and total phosphorus levels above SSTVs at these monitoring sites was reported.

Concentrations of dissolved barium, cobalt and nickel were found to exceed SSTVs at the on-site and downstream impact sites. These parameters were generally found to be elevated compared to concentrations observed at upstream reference sites, suggesting the source was mine water discharges from Cooranbong Services Site. This is likely due to the chemistry of the underground water present within the Cooranbong Underground Storage. Dissolved cobalt and nickel concentrations were found to decrease to below the relevant SSTVs at the downstream recovery monitoring sites within Muddy Lake.

Multivariate analysis

A PCA was conducted to evaluate the overall trends in water quality between site type and sampling event. The autumn 2014 data was not included in this analysis as only results for total metals were available and it could not be compared directly to the other events. The following variables were included in this analysis:

- Aluminium
- Arsenic
- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- DO
- Electrical conductivity
- Iron
- Lead
- Magnesium
- Manganese
- Nickel
- Nitrate + nitrite
- pH
- Potassium
- Sodium
- Sulfate
- Total alkalinity
- TKN
- TOC
- Total phosphorus
- Turbidity
- Zinc

Arrangement of the samples in the two dimensional PCA plot explains approximately 69.5% of the variation in the water quality data, as shown in Figure 3-1. Samples further to the right of the plot are those with higher levels of potassium, sodium, chloride, electrical conductivity, alkalinity, sulfate, calcium and magnesium and lower levels of TOC. Samples towards the top of the plot are those with higher levels of TKN and turbidity and lower levels of total phosphorus and nitrate + nitrite. Thus, this plot indicates that water quality downstream of the discharge is generally characterised by increased levels of anions and cations, increased electrical conductivity and increased alkalinity and lower levels of TOC. The recovery sites are still influenced by the discharge water to some degree but levels of these substances are less when compared to impact sites. Water at the recovery sites also tends to be higher in TKN and turbidity and lower in nitrate + nitrite and total phosphorus compared to the reference sites.

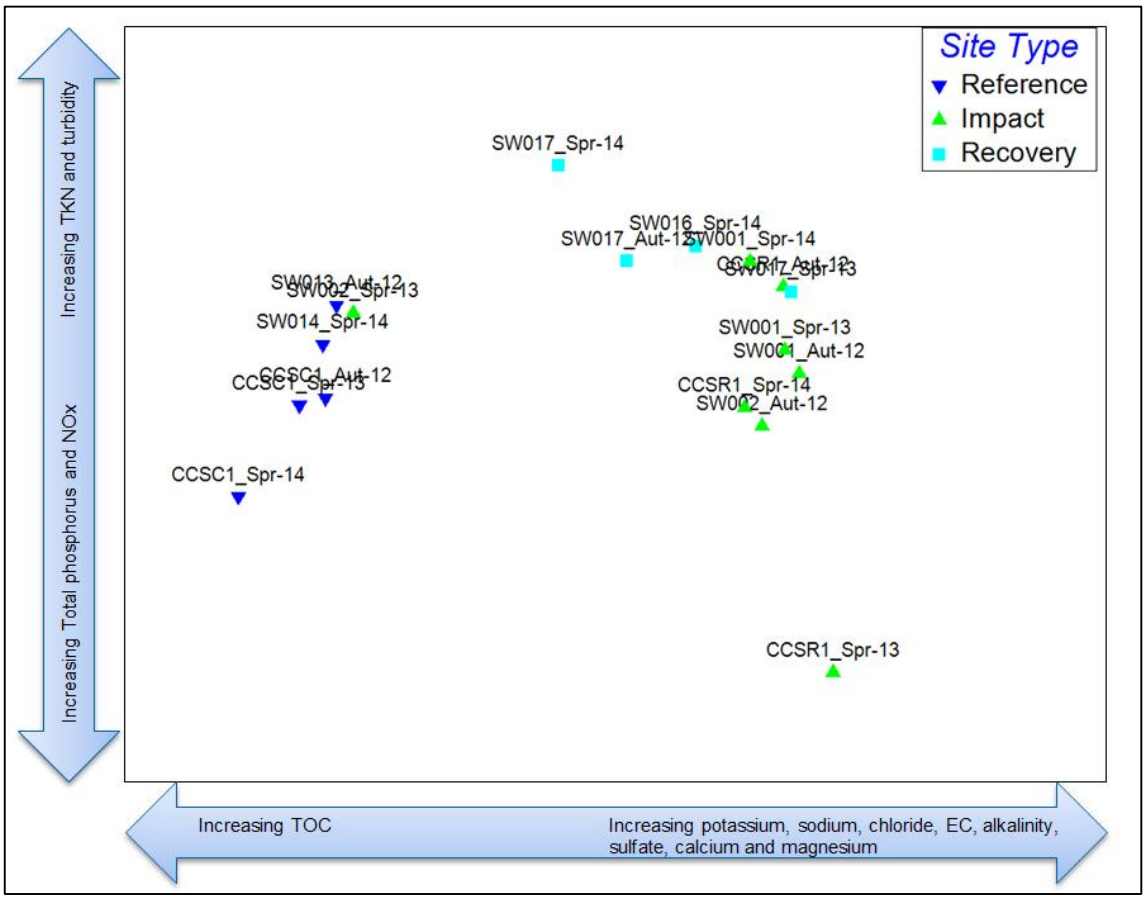


Figure 3-1 Principal component analysis showing overall trends in water quality at Cooranbong Services Site

3.1.3 Sediment quality

Laboratory analysed sediment quality

Results of laboratory analysed sediment quality monitoring are presented in Appendix D for reference sites SW013, SW014, SW015 and CCSC1, on-site and downstream impact monitoring sites SW001, SW002, LDP002 and CCSR1 and downstream recovery sites SW016 and SW017. The low and high ISQG values recommended by ANZECC (2000) are also included for comparison in each table. It is important to note that results are presented for total metals, which do not necessarily represent bioavailable concentrations.

Sediment sampling results indicate that total metal concentrations are generally higher at the on-site and downstream impact sites compared to the reference and downstream recovery sites. This result indicates that the majority of metals are associated with operations at Cooranbong Services Site. A trend of decreasing metal concentrations with increasing distance downstream of discharges is evident from the sediment quality monitoring results. All sites monitored in the most recent survey in spring 2014 were found to be below the recommended ISQG values (ANZECC, 2000).

The nickel concentrations at monitoring sites SW001 and CCSR1 were reported to exceed the ISQG value (ANZECC, 2000) in spring 2013. The concentrations of cadmium, mercury and nickel and zinc at on-site impact monitoring site SW002 were also found to exceed the ISQG values (ANZECC, 2000) in winter 2012. At all sites, sampling in subsequent monitoring rounds has found concentrations below the low ISQG values (ANZECC, 2000), indicating exceedences were isolated incidents.

Elevated metal concentrations reported for site SW002 are likely to be associated with historical discharges from the 5 ML Dam via Cooranbong LDP002. Water management at Cooranbong Services Site was revised to reduce the risk of discharge from the 5 ML Dam.

Lead concentrations at the downstream recovery monitoring site SW017 were found to exceed the low ISQG value in monitoring rounds undertaken in winter 2012, spring 2013 and autumn 2014. However in the most recent round of monitoring (spring 2014), the lead concentration reported was below the low ISQG value.

3.1.4 Macroinvertebrate results

Community composition

A total of 58 macroinvertebrate taxa were collected from the monitored sites at Cooranbong Services Site over the four sampling events carried out between 2012 and 2014. The macroinvertebrate community was largely made up of insects, dominated by groups of Coleoptera (beetles), Diptera (flies), Hemiptera (true bugs), Odonata (dragonflies and damselflies) and Trichoptera (caddisflies).

The most abundant families/sub-families collected were stick caddisfly larvae (Leptoceridae), non-biting midge larvae (Tanypodinae/Chironominae), diving beetles (Dytiscidae) and narrow-winged damselflies (Coenagrionidae). Leptoceridae, Tanypodinae, Chironominae, Dytiscidae and Coenagrionidae were collected in over half of the samples.

Leptoceridae have a SIGNAL 2 score of six and are one of the most common families of Trichoptera (caddisflies) in temperate Australia. This family occurs in a diverse range of habitats where organic matter is present and are tolerant of high electrical conductivity. Chironominae and Tanypodinae have a SIGNAL 2 score of three and four respectively and are typical of organically polluted waters due to their ability to survive in environments with low DO. However, the presence of these families does not necessarily imply poor water quality. These animals are very common across Australian waterways. Dytiscidae are likewise tolerant of poor water quality (SIGNAL 2 score of two) and, particularly, poor oxygen environments since they breath atmospheric air. Consequently, Dytiscidae are often found in small pools and other temporary water sources such as drains and ditches. With a SIGNAL 2 score of two, Coenagrionidae are also very pollution tolerant and widespread in Australia. These macroinvertebrates are usually found in and around submerged vegetation to which they cling.

The relative richness for sites surveyed at Cooranbong Services Site is presented in Figure 3-2. The relative proportion of the community made up of the main groups Diptera, Hemiptera, Trichoptera, Coleoptera and Odonata were fairly similar across the four sampling events. Individual relative richness plots for each site and sampling event are presented in Appendix E.

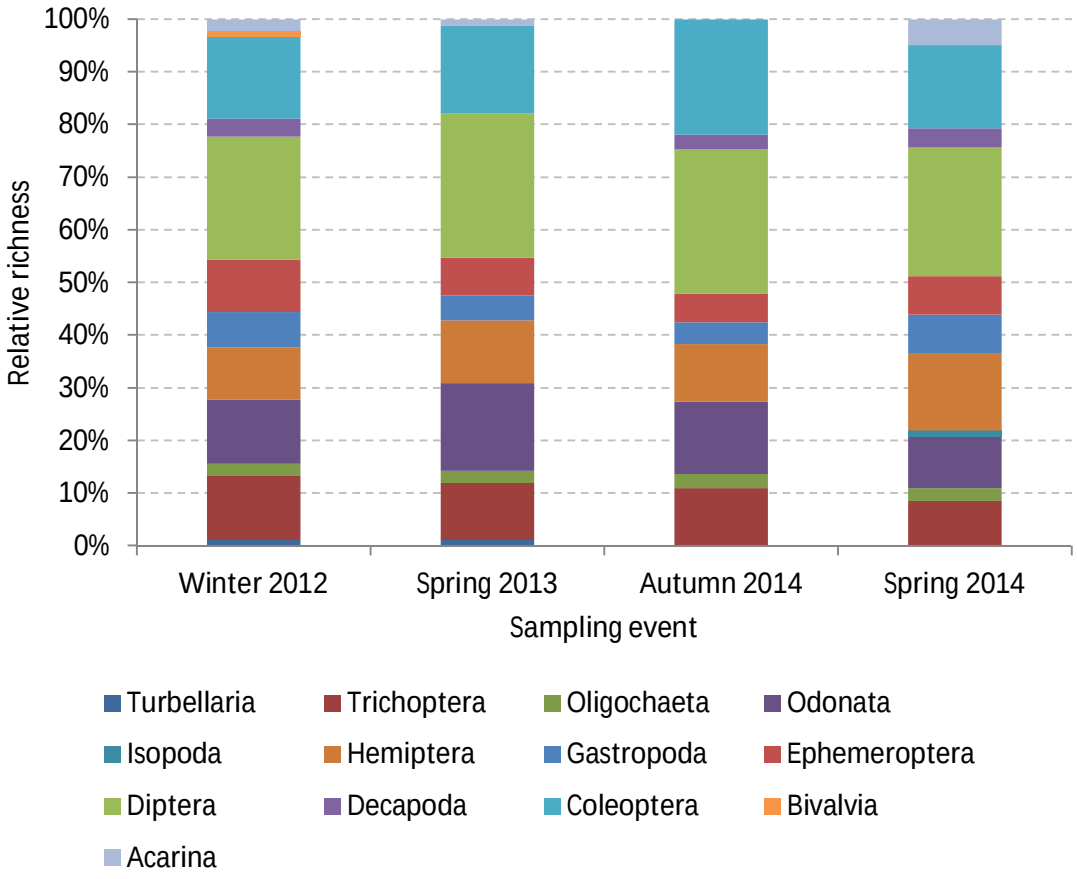


Figure 3-2 Relative richness for sites sampled at Cooranbong Services Site between 2012 and 2014

Univariate analysis

Taxonomic richness

The taxonomic richness for sites surveyed in winter 2012, spring 2013 and autumn and spring 2014 at Cooranbong Services Site is presented in Figure 3-3. At CCSC1, CCSR1 and SW017, taxonomic richness in the 2014 sampling events was lower than observed in previous events. The opposite trend was evident at SW001. When considering each event separately, there was no indication of a pattern in taxonomic richness between reference and impact sites. However, richness was visibly lower at SW001 in winter 2012 and spring 2013 compared to SW013 and CCSC1 in the same events. In the same event, taxonomic richness at CCSR1 was higher than most sites. Taxonomic richness was low at SW016 and SW017 in autumn 2014 compared to other sites.

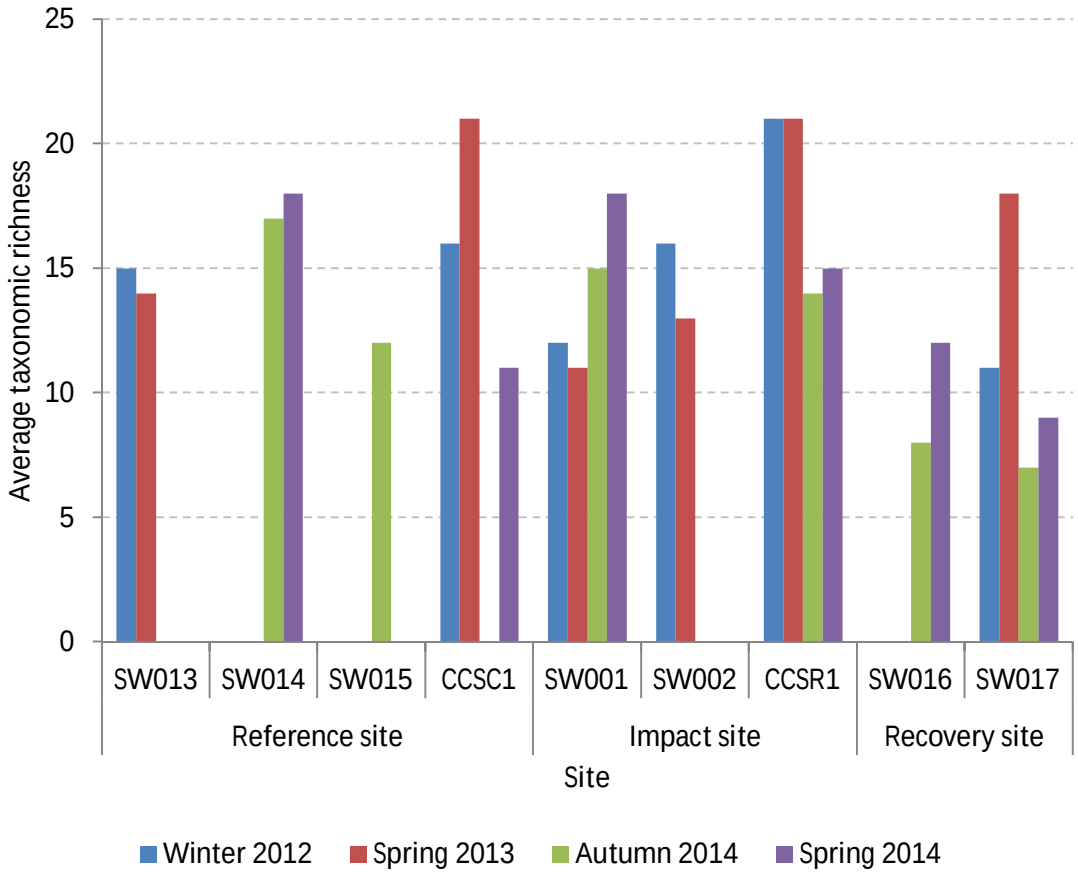


Figure 3-3 Taxonomic richness for sites surveyed at Cooranbong Services Site

The results of a two-way GLM test comparing macroinvertebrate taxonomic richness between site type and sampling event for the winter 2012, spring 2013 and autumn and spring 2014 surveys at Cooranbong Services Site is presented in Table 3-10. This test detected no significant difference (p<0.05) in taxonomic richness between sampling events or site type.

Table 3-10 Two-way GLM test output comparing macroinvertebrate taxonomic richness for surveys at Cooranbong Services Site

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	4,240.76	1	4,240.76	329.28	0.0000
Sampling event	82.23	3	27.41	2.13	0.1546
Site type	75.51	2	37.76	2.93	0.0954
Sampling event x site type	68.69	6	11.45	0.89	0.5345
Error	141.67	11	12.88		

Red text indicates significant effect based on p<0.05

The means plot presented in Figure 3-4 presents the variation in taxonomic richness between reference, impact and recovery sites for the winter 2012, spring 2013 and autumn and spring 2014 surveys at Cooranbong Services Site. This plot indicates the relatively low richness observed at recovery sites but little difference in richness between reference and impact sites.

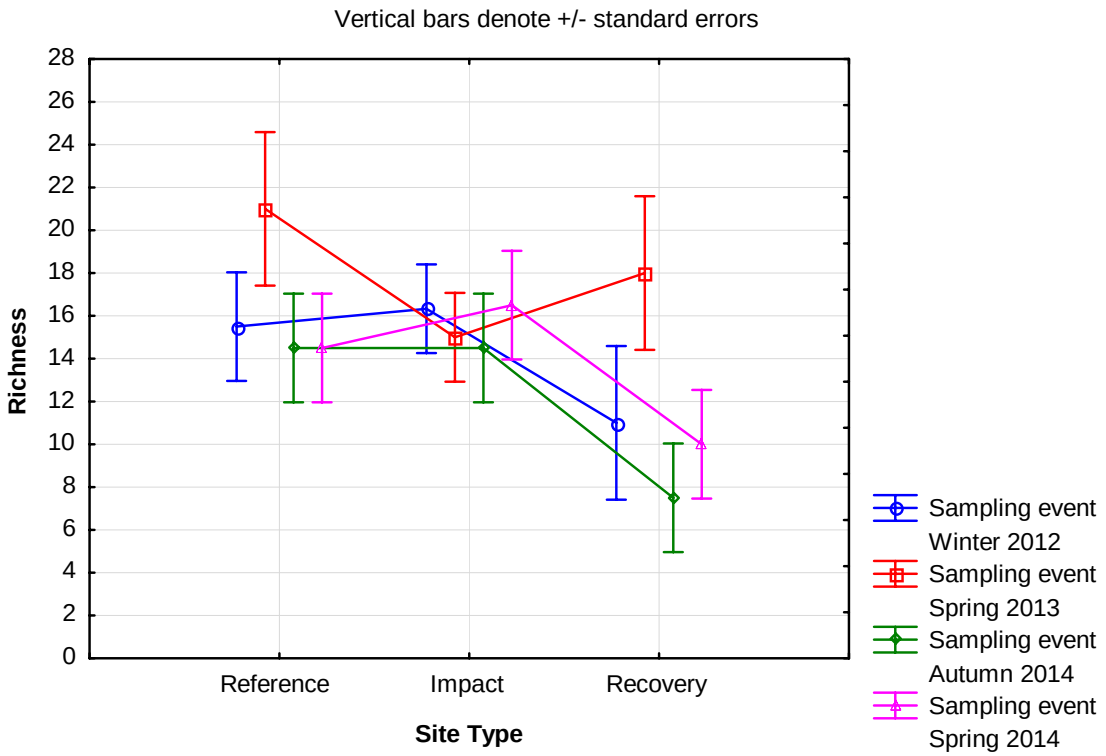


Figure 3-4 Means plot depicting variation in taxonomic richness between site type and sampling event at Cooranbong Services Site

EPT richness

The EPT richness for sites surveyed in winter 2012, spring 2013 and autumn and spring 2014 at Cooranbong Services Site is presented in Figure 3-5. EPT richness at impact sites was generally higher or consistent with levels at reference sites. The highest EPT richness was observed at SW001 in 2012 with five EPT taxa collected during this event. Four EPT taxa were observed at SW001 and CCSR1 in autumn 2013 and at SW017 in spring 2013.

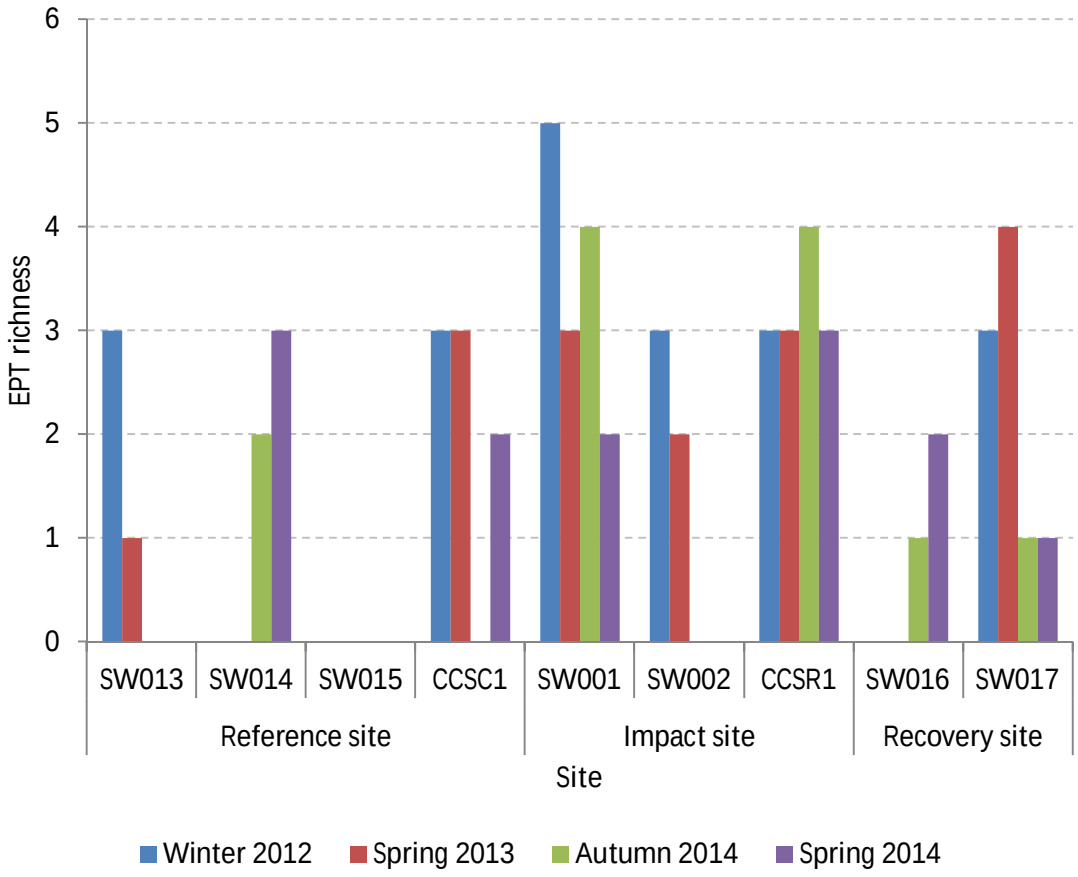


Figure 3-5 EPT richness for sites surveyed at Cooranbong Services Site

The results of a two-way GLM test comparing macroinvertebrate EPT richness between site type and sampling event for the winter 2012, spring 2013 and autumn and spring 2014 surveys at Cooranbong Services Site is presented in Table 3-11. This test detected no significant difference (p<0.05) in EPT richness between sampling events or site type.

Table 3-11 Two-way GLM test output comparing macroinvertebrate EPT richness for surveys at Cooranbong Services Site

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	141.40	1	141.40	227.62	0.0000
Sampling event	6.65	3	2.22	3.57	0.0506
Site type	3.67	2	1.83	2.95	0.0942
Sampling event x site type	11.18	6	1.86	2.99	0.0547
Error	6.83	11	0.62		

Red text indicates significant effect based on p<0.05

The means plot in Figure 3-6 portrays the variation in EPT richness between reference, impact and recovery sites for the winter 2012, spring 2013 and autumn and spring 2014 surveys at Cooranbong Services Site. The pattern in EPT richness between reference, impact and recovery sites varies for each sampling event. Mean EPT richness at impact sites was within the range observed at reference sites.

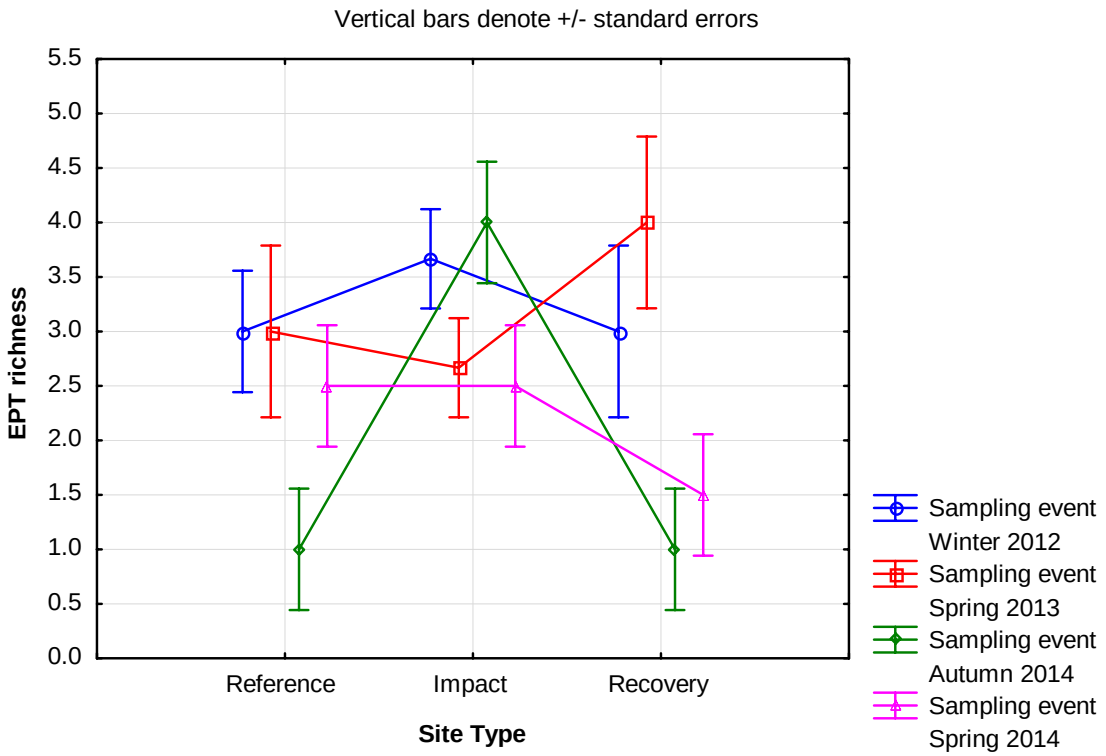


Figure 3-6 Means plot depicting variation in EPT richness between site type and sampling event at Cooranbong Services Site

SIGNAL 2 biotic index

The SIGNAL 2 scores calculated for sites surveyed in winter 2012, spring 2013 and autumn and spring 2014 at Cooranbong Services Site is presented in Figure 3-7. Average SIGNAL 2 scores, across all seasons, suggested a trend towards lower scores around the recovery sites compared with the reference sites however a consistent trend between the reference and impact sites.

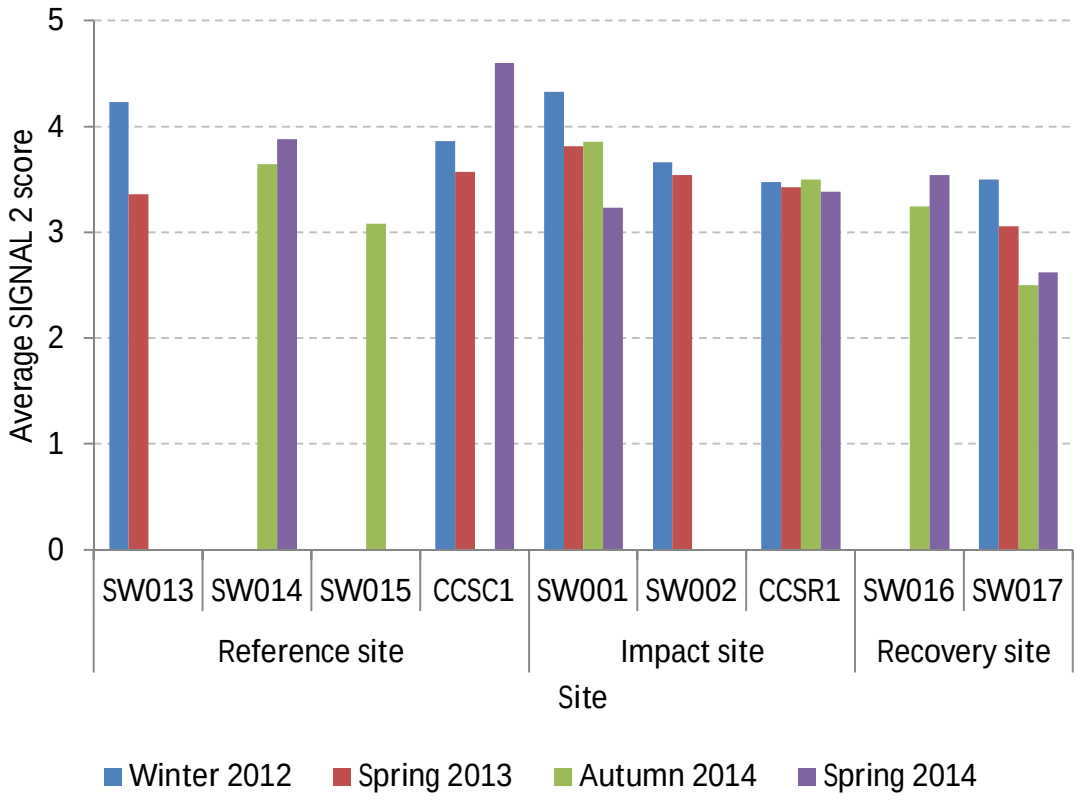


Figure 3-7 SIGNAL 2 scores for sites surveyed at Cooranbong Services Site

The results of a two-way GLM test comparing SIGNAL 2 scores between site type and sampling event for the winter 2012, spring 2013 and autumn and spring 2014 surveys at Cooranbong Services Site is presented in Table 3-12. A significant difference was detected in SIGNAL 2 scores between site types. Multiple comparisons testing detected a significant difference in SIGNAL 2 score between reference and recovery sites but not between reference and impact sites, as shown in Table 3-13. The means plot presented in Figure 3-8 shows that SIGNAL 2 scores were generally higher at reference sites than at recovery sites.

No significant difference (p<0.05) was detected in SIGNAL 2 scores between sampling events, as shown in Table 3-12. The means plot shows that SIGNAL 2 scores were more variable at the reference and recovery sites over time than was observed at the impact sites. This is partially due to the fact that more changes were made to the reference and recovery sites over time.

Table 3-12 Two-way GLM test output comparing SIGNAL 2 scores for surveys at Cooranbong Services Site

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	247.98	1	247.98	1560.92	0.0000
Sampling event	0.68	3	0.23	1.44	0.2850
Site type	1.39	2	0.69	4.37	0.0400
Sampling event x site type	0.87	6	0.15	0.91	0.5196
Error	1.75	11	0.15		

Red text indicates significant effect based on p<0.05

Table 3-13 Results of multiple comparisons (Unequal N HSD) test of SIGNAL 2 scores between site type at Cooranbong Services Site

	Reference	Impact
Impact	0.5847	
Recovery	0.0178	0.0877

Red text indicates significant effect based on $p<0.05$

Unequal N HSD test is a statistical model that considers significant differences between group means to analyse variance

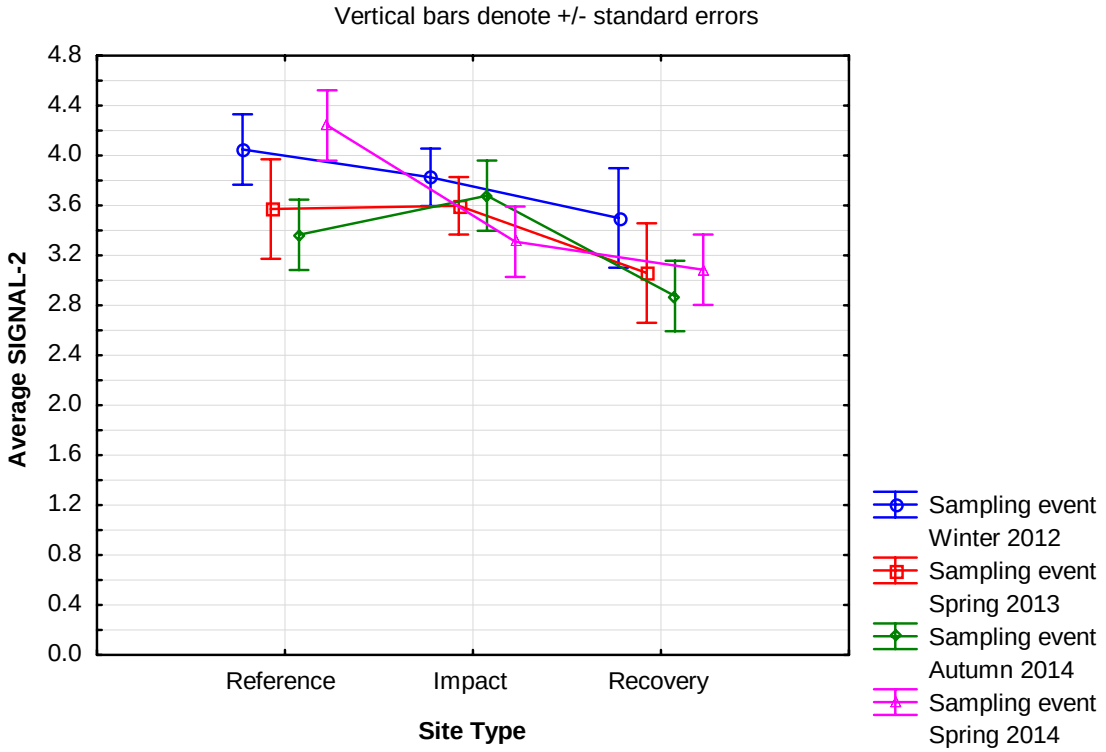


Figure 3-8 Means plot depicting variation in SIGNAL 2 score between site type and sampling event at Cooranbong Services Site

AUSRIVAS model

The results of AUSRIVAS model for Cooranbong Services Site data from spring 2013, autumn 2014 and spring 2014 are presented in Table 3-14. Several samples were found to be OEM and no result could be calculated. The macroinvertebrate community at reference sites ranged from 'reference condition' (AUSRIVAS Band A) at SW014 in autumn 2014 to 'significantly impaired' (AUSRIVAS Band B) at SW013 in spring 2013, SW015 in autumn 2014 and CCSC1 in spring 2013. An AUSRIVAS band of B was calculated for impact sites SW001 in spring 2014 and CCSR1 in spring 2013 and autumn 2014. This indicates that the macroinvertebrate community at impact sites was 'significantly impaired'. The recovery sites only achieved a C rating indicating that the macroinvertebrate community at SW016 and SW017 is 'severely impaired'.

Table 3-14 AUSRIVAS model results from Cooranbong Services Site

Site	Sampling event	OE50	Band
Reference sites			
SW013	Spring 2013	0.75	B
SW014	Autumn 2014	0.92	A
	Spring 2014	OEM	OEM
SW015	Autumn 2014	0.73	B
CCSC1	Spring 2013	0.77	B
	Spring 2014	OEM	OEM
On-site impact sites			
SW001	Spring 2013	OEM	OEM
	Autumn 2014	OEM	OEM
	Spring 2014	0.58	B
SW002	Spring 2013	OEM	OEM
Downstream impact site			
CCSR1	Spring 2013	0.59	B
	Autumn 2014	0.48	B
	Spring 2014	OEM	OEM
Downstream recovery sites			
SW016	Autumn 2014	0.26	C
	Spring 2014	0.49	C
SW017	Spring 2013	OEM	OEM
	Autumn 2014	OEM	OEM
	Spring 2014	0.4	C

OEM – outside the experience of the model

Multivariate analysis

A cluster analysis was conducted on the multivariate data to determine whether there were any differences in macroinvertebrate community composition between reference, impact and recovery sites or over time. The cluster diagram in Figure 3-9 indicates clustering of the samples according to site type. This was consistent across the sampling events.

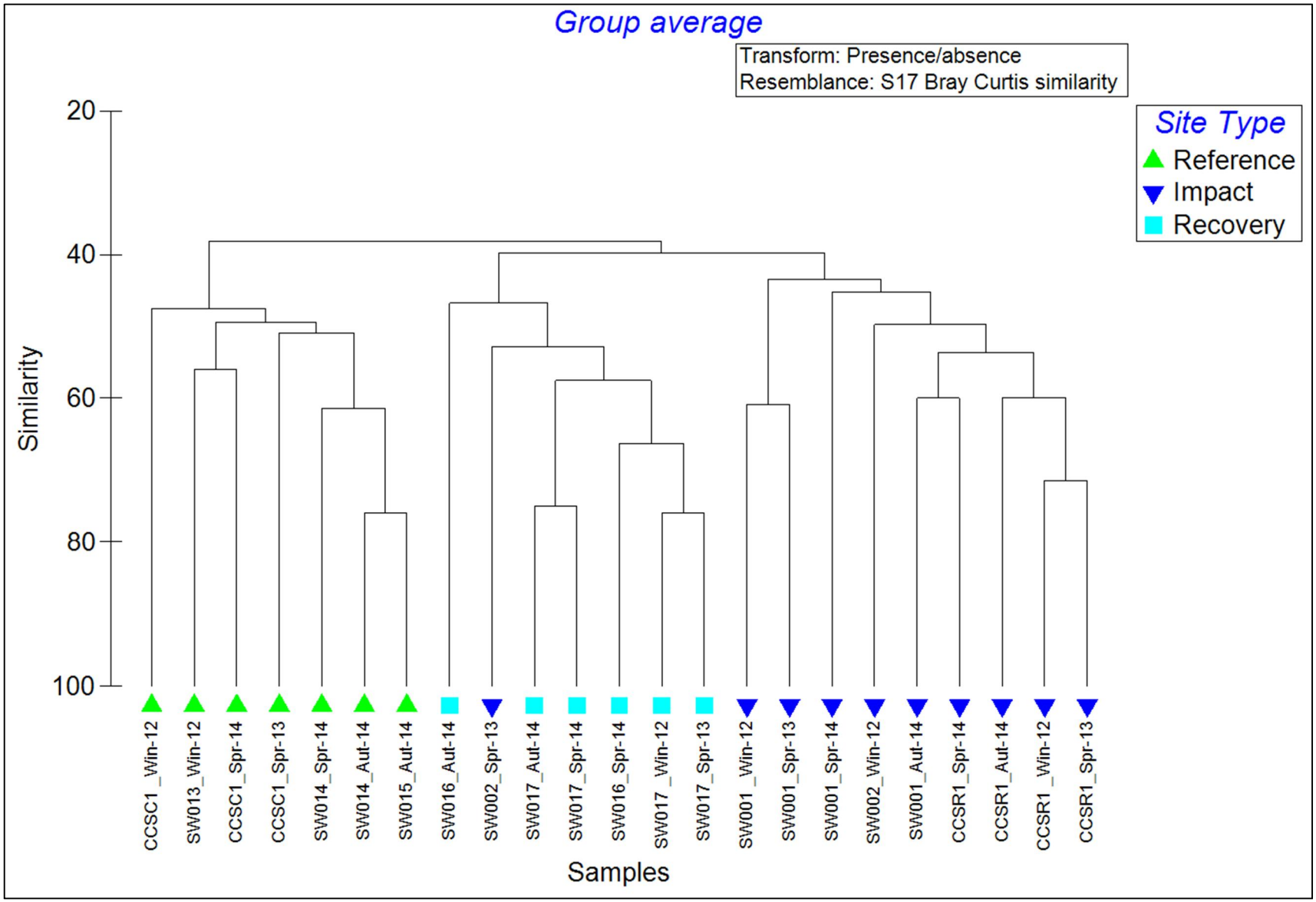


Figure 3-9 Cluster analysis of macroinvertebrate samples at Cooranbong Services Site displaying the similarity of sites based on the site type for winter 2012, spring 2013, autumn 2014 and spring 2014 surveys

ANOSIM detected significant differences (p<0.05) between all three pairwise groups as outlined in Table 3-15. SIMPER results presented in Table 3-16 indicate that average similarity was strongest within the recovery group while weakest similarity was observed within the impact group. This means that there was more variability in the macroinvertebrate community between impact sites than there was between recovery sites. The lowest between-group similarity was between reference and impact groups with only 37.71% similarity in macroinvertebrate community composition between these groups.

Table 3-15 ANOSIM results indicating significant differences in macroinvertebrate community composition between reference, impact and recovery sites at Cooranbong Services Site

Group 1	Group 2	*R* statistic	Significance level (%)	Possible permutations	Actual permutations	Number >=
Reference	Impact	0.561	0.03	19,448	9,999	2
Reference	Recovery	0.771	0.06	1,716	1,716	1
Impact	Recovery	0.455	0.09	8,008	8,008	7

Red text indicates significant effect based on p<0.05

Table 3-16 Average similarity between reference, impact and recovery sites at Cooranbong Services Site as identified by SIMPER

	Reference	Impact	Recovery
Reference	51.76%		
Impact	37.71%	47.23%	
Recovery	38.90%	40.53%	58.70%

The main taxa contributing to differences between reference and impact sites are outlined in Table 3-17. The impact sites generally have fewer Leptophlebidae, Veliidae, Scirtidae, Hydraenidae, Parastacidae and Notonectidae and greater numbers of Ceratopogonidae, Caenidae, Baetidae, Stratiomyidae, Tipulidae and Coenagrionidae. Leptophlebiidae have a SIGNAL 2 score of 8 and Scirtidae have a SIGNAL 2 score of 6. Therefore, their absence or low number from impact sites could suggests that the impact site may have aquatic influences from habitat rather than water quality.

SIMPER also identifies the taxa that contributed most strongly to differences in the macroinvertebrate community between the groups. The most influential taxa have been provided in Table 3-17, Table 3-18 and Table 3-19 for each pairwise comparison. Although this information can be useful, it is noted that in this case there was a list of several taxa which had a similar level of contribution to the differences between sites.

Table 3-17 Taxa contributing most strongly to differences in the macroinvertebrate community between reference and impact sites at Cooranbong Services Site

Taxa	SIGNAL 2 score	Average abundance		Contribution (%)	Cumulative (%)
		Reference sites	Impact sites		
Leptophlebiidae	8	0.86	0	4.42	4.42
Veliidae	3	0.86	0.2	3.83	8.25
Ceratopogonidae	4	0.29	0.9	3.61	11.87
Scirtidae	6	0.71	0.1	3.55	15.42
Hydraenidae	3	0.71	0.2	3.3	18.72
Caenidae	4	0	0.6	3.07	21.79
Baetidae	5	0.29	0.7	3.06	24.86
Parastacidae	4	0.57	0	3.03	27.88
Stratiomyidae	2	0.14	0.6	3.01	30.89
Tipulidae	5	0.14	0.6	2.98	33.87
Coenagrionidae	2	0.43	0.8	2.89	36.76
Notonectidae	1	0.57	0.2	2.78	39.54

The key taxa differences between the reference and impact sites, as shown in Table 3-17, was the greater prevalence of Leptophlebiidae, Veliidae and Scirtidae compared with a greater prevalence of Ceratopogonidae, Coenagrionidae and Baetidae at the impact sites.

Table 3-18 Taxa contributing most strongly to differences in the macroinvertebrate community between reference and recovery sites at Cooranbong Services Site

Taxa	Average abundance		Contribution (%)	Cumulative (%)
	Reference sites	Recovery sites		
Veliidae	0.86	0	5.48	5.48
Leptophlebiidae	0.86	0	5.39	10.88
Hydraenidae	0.71	0	4.52	15.39
Planorbidae	0	0.67	4.08	19.48
Oligochaeta sp.	0.14	0.67	3.95	23.42
Coenagrionidae	0.43	1	3.84	27.27
Parastacidae	0.57	0	3.7	30.97
Hydrophilidae	0.57	0.17	3.41	34.38

Taxa	Average abundance		Contribution (%)	Cumulative (%)
	Reference sites	Recovery sites		
Scirtidae	0.71	0.5	3.36	37.74
Belostomatidae	0	0.5	3.23	40.97
Notonectidae	0.57	0.5	3.23	44.2
Physidae	0.14	0.5	3.19	47.39
Orthocladiinae	0.43	0.33	3.02	50.41

The key taxa differences between reference and recovery sites, as shown in Table 3-18, was the greater prevalence of Coenagrionidae, Planorbidae, and Oligochaeta sp at recovery sites. It must be noted the dominant presence of Coenagrionidae at both the recovery site and the impact site.

Table 3-19 Taxa contributing most strongly to differences in the macroinvertebrate community between impact and recovery sites at Cooranbong Services Site

Taxa	Average abundance		Contribution (%)	Cumulative (%)
	Impact sites	Recovery sites		
Ceratopogonidae	0.9	0	5.97	5.97
Stratiomyidae	0.6	0	3.93	9.9
Tipulidae	0.6	0	3.89	13.79
Planorbidae	0.2	0.67	3.88	17.67
Baetidae	0.7	0.33	3.81	21.48
Oligochaeta sp.	0.3	0.67	3.7	25.17
Hydrophilidae	0.6	0.17	3.62	28.79
Caenidae	0.6	0.33	3.52	32.31
Belostomatidae	0	0.5	3.32	35.63
Physidae	0.1	0.5	3.28	38.9
Notonectidae	0.2	0.5	3.16	42.07
Scirtidae	0.1	0.5	3.03	45.1
Libellulidae	0.4	0.33	3	48.1
Hydrometridae	0.5	0	2.98	51.08

The most notable differences between impact and recovery sites, shown in Table 3-19, was the occurrence of Ceratopogonidae and Tipulidae and Stratiomyidae only present at the impact sites. Other key taxa differences between the impact and recovery sites was the greater prevalence of Baetidae at the impact sites and Oligochaeta species observed at the recovery sites.

3.1.5 Discussion

Water quality

The reference sites monitored at Cooranbong Services Site indicated that elevated TSS was evident at SW015 from spring 2013 onwards. SSTVs for TSS, total nitrogen and dissolved barium, cobalt and iron were exceeded at SW015 and CCSC1. As these reference sites are not affected by mine water discharge from Cooranbong Services Site, these exceedences were considered to be a result of other sources within the wider catchments of the respective waterways.

DO results were below the lower SSTV at the majority of sites; however there is no trend evident with regards to location or site type. The on-site and downstream impact sites indicated elevated levels of electrical conductivity, total nitrogen and phosphorus and dissolved barium, zinc and nickel concentrations.

At the recovery sites, concentrations of dissolved nickel had reduced through dilution however elevated nutrients, dissolved barium and zinc had concentrations that remained above the SSTVs for the site. Improvements in water management, specifically from water discharged through Cooranbong LDP002 have typically reduced metal concentrations entering Muddy Lake since 2013.

Reference sites indicated elevated concentrations of nickel present within soil sampled. Sediment concentrations for impact sites indicated isolated elevated concentrations of cadmium, nickel and zinc within soil sampled. Within recovery sites, lead was found to be elevated at SW017. It could be possible that this source of lead is from water entering Muddy Lake as part of tidal movements. Water quality concentrations do not suggest a source from the Cooranbong Services Site discharges or operations. Concentrations have slightly reduced in spring 2014 after being consistently high since 2012.

Cooranbong Services Site has had periods where discharges have either been reduced or nil. During the most recent no discharge period, February to September 2014, concentrations of specific trait water quality parameters reduced.

The results indicated that water quality downstream of the discharge is generally characterised by increased levels alkalinity, electrical conductivity, anions and cations. The recovery sites appear to be influenced by discharge from Cooranbong Services Site but there are signs of recovery. Water at the recovery sites exhibited higher concentration of TKN and turbidity and lower concentration nitrate + nitrite and total phosphorus compared to the reference sites.

Macroinvertebrates

Univariate macroinvertebrate metrics did not detect any differences between reference and impact sites that would suggest an impact of water discharge from Cooranbong Services Site on the macroinvertebrate community. The number of taxa (i.e. diversity) was comparable between impact and reference sites. The number of sensitive taxa at impact sites (based on EPT richness) was comparable to or higher than that of reference sites.

No significant difference in SIGNAL 2 score was observed between reference and impact sites which suggests that, on average, sensitivity of the macroinvertebrates was similar downstream of the discharge from Cooranbong Services Site to upstream.

AUSRIVAS model results indicated that the macroinvertebrate community at impact sites was significantly impaired as some taxa expected to occur were not collected. However, the AUSRIVAS results were similar between reference and impact sites, which do not suggest any impacts from water discharge.

Based on these results, the differences in water quality that were observed downstream of the discharge do not appear to have compromised the health of the macroinvertebrate community. It is probable that the water discharge into the unnamed creek from the Cooranbong Services Site is of positive benefit to aquatic macroinvertebrates in most regards as it provides a more permanent source of water than is otherwise provided by catchment runoff.

Some changes in the macroinvertebrate community were observed at the recovery sites including high variability of metrics between sampling events. Taxa richness at SW017 in spring 2013 was almost double that observed in the two sampling events conducted in 2014. SW016 was not sampled prior to 2014, however richness levels during this year were some of the lowest observed at the monitoring sites which suggests similar conditions to SW017. Electrical conductivity was particularly high (4,820 µS/cm) at SW017 in spring 2013, which makes the high taxa richness during this event unexpected. The taxa collected at this site were not restricted to those tolerant of high electrical conductivity which may indicate that the high electrical conductivity at this site is a temporary occurrence. EPT richness was also variable at SW016 and SW017 between events. Particularly high EPT richness (three to four taxa) was observed at SW017 in winter 2012 and spring 2013 (despite high electrical conductivity) but only one EPT taxon was observed during the 2014 events.

Some differences in community composition (the macroinvertebrate families collected) between reference, impact and recovery sites and the relatively high similarity between samples within each of these groups suggests that there are common characteristics which are driving the community changes. As there was no consistent pattern observed in the macroinvertebrate community regarding pollution sensitivity between site types, it is expected that the overall difference in the community is due to factors other than water quality.

Several habitat differences were observed during sampling that are expected to influence the macroinvertebrate community. Reference site SW014 had relatively small water availability with less flow and little macrophyte growth observed compared with impact sites. Impact sites were more disturbed through the presence of infrastructure however there was a higher coverage of macrophytes which would provide essential habitat for some macroinvertebrates. Additionally, discharge into unnamed creek from the Cooranbong Services Site provides a more permanent water source for the impact sites which is related to habitat attributes such as macrophyte growth. Recovery sites and reference site CCSC1 were wide and deep by comparison to the smaller streams of the impact sites.

These results indicate that although the discharge of water from Cooranbong Services Site into unnamed creek has led to some changes in the macroinvertebrate community, there is no evidence of a detrimental effect. The health of the macroinvertebrate community at impact sites was improved compared to some other sites, most likely as a result of the permanent water source and associated habitat produced by discharges.

3.2 Newstan Colliery Surface Site

3.2.1 Aquatic habitat assessment

A total of 18 sites have been monitored in the vicinity of Newstan Colliery Surface Site from 2011 to 2014, with all sites located in a lowland coastal catchment. Aquatic habitat at the majority of the freshwater sites could be considered to be a modified stream with the exception of the site By-Wash which is located at the Main By-Wash Dam. Riparian vegetation at these sites was characteristic coastal freshwater creeks and/or dams, and included various eucalypt and melaleuca species. There was considerable variation between sites, with site classification ranging between dams and lowland broad valley.

Assessment of aquatic habitat indicated that the majority of sites monitored at Newstan Colliery Surface Site are considered to be in a slightly to moderately disturbed condition. The catchment areas of the monitored sites are relatively small, which was reflected in the small shallow creeks of low flow dominated by pool and run habitat. Estuarine habitat was characterised by pools, with some artificial cover such as rock walls and boat jetties. These sites have been highly modified for residential and commercial development along the estuary banks.

In addition to mining, landuse practices in the area include those associated with urban areas including residential, recreation (ovals and archery range), major roads, railway and quarries. These landuse influences have caused a degree of change from the natural condition, particularly in relation to riparian vegetation condition and instream sedimentation.

Instream habitat complexity was found to be low to moderate at most sites, which was reflected in the assemblage of the macroinvertebrate community. Instream habitat characteristics were dominated by emergent macrophytes, woody debris, detritus and overhanging bank vegetation at the majority of freshwater sites. Emergent macrophytes mostly comprised species of *Typha,* which dominated the edge habitat at sites By-Wash and SP004. Instream habitat was largely dominated by artificial cover such as rock walls and boat jetties in the estuarine reaches. Seagrass communities was noted in the shallow more protected areas at the intertidal site.

Exotic weeds were present at the majority of sites with lantana, privet and exotic pasture grass dominating the understory of the riparian vegetation at most sites. Overstory riparian vegetation was predominantly native species and at all sites clearing of this vegetation to some extent was observed.

As discussed in Section 3.1.1, sediment composition can be highly influential on aquatic communities and may have contributed to differences observed between monitoring sites. The sediment at the majority of sites was found to be largely dominated by silt with little variation. Sediment particle size can influence many aspects of aquatic communities including type of macrophyte growth, length of water retention, type and diversity of macroinvertebrates as well as water and sediment quality.

A brief description of aquatic habitat conditions observed at each of the monitoring sites is provided below.

Freshwater sites

WMP20 –Reference site

WMP20 is a freshwater reference site located on Stony Creek upstream of Newstan LDP017 which has been monitored for aquatic ecology in autumn and spring 2014. Table 3-20 provides photographs of the site from both of these monitoring rounds.

In the autumn 2014 survey, WMP20 consisted of a small channel approximately 3 m wide. The water was highly turbid at the time of sampling with the surface flow slightly above the normal water level. Stony Creek was dry during the spring 2014 survey and two pools approximately 6 m wide connected to the Creek (one in native forest, one at the gabion wall) were surveyed. There was no flow velocity observed within either pool.

The instream habitat along Stony Creek at WMP20 was found to include isolated macrophytes, woody debris and abundant detritus, overhanging bank vegetation and trailing bank vegetation. The riparian vegetation was dominated by native over storey and a largely native eucalypt and melaleuca forest and grass understory. Substrate across the assessed reach was dominated by silt and clay with some sand.

There was no instream vegetation associated with the pool downstream of the gabion wall and riparian vegetation consisted of scattered remnant trees, shrubs and grasses, as most of the surrounding area had been previously cleared. Substrate across the assessed reach was dominated by boulders and cobbles associated with the gabion wall, with a silt/clay underlay.

The adjacent land use on both banks of Stony Creek at WMP20 was includes both native forest and cleared access tracks. The pool at the gabion wall has been cleared for the Newstan LDP017 discharge point, water quality monitoring station and associated access tracks.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events in 2014.

Table 3-20 Photographs of WMP20 at Newstan Colliery Surface Site during autumn and spring 2014 surveys

Sampling event	Description	Photograph
Autumn 2014 (08/04/2014)	Facing upstream at WMP20	
Spring 2014 (14/10/2014)	Pool upstream at WMP20	

By-Wash – On-site impact site

The on-site impact monitoring site By-Wash is located at the Main By-Wash Dam at the Newstan Colliery Surface Site. The primary discharge point for the Mine, Newstan LDP001, discharges into the Dam immediately upstream of the monitoring location. The By-Wash site has been monitored on nine occasions from autumn 2011 to spring 2014. Table 3-21 provides photographs of the site from these monitoring rounds.

The Main By-Wash Dam is a wetland system that is relatively large, approximately 35 m at its widest point. The dam collects clean water from a natural catchment as well as discharges from Newstan LDP001. Overflow from the Main By-Wash Dam discharges via a weir into the upper reaches of the northern arm of LT Creek.

Instream habitat at the By-Wash site was observed to be dominated by a slow flowing pool which featured submerged and emergent macrophytes, detritus, overhanging bank vegetation and trailing bank vegetation. The Main By-Wash Dam was relatively shallow around the edges (approximately 0.3 m deep) and dominated by dense emergent macrophytes (*Typha* and *Juncus*). The dense emergent macrophytes were uniformly distributed along the banks, limiting the variability of the edge habitat. Riparian vegetation was dominated by grasses and shrubs, with some mature shrubs and trees on the left bank, providing only limited shading of the aquatic habitat.

Substrate at this site was dominated by silt and clay with some sand. Strong odours were omitted from the sediment during sampling. Fine black silt and organic matter was evident in the plume when sampling disturbed the substrate, suggesting anaerobic conditions.

Adjacent land use comprises of undeveloped bushland on the left bank while mine infrastructure and facilities are present on the right bank.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events from 2011 to 2014.

Table 3-21 Photographs of By-Wash at Newstan Colliery Surface Site during autumn 2011 to spring 2014 surveys

Sampling event	Description	Photograph
Autumn 2011 (30/05/2011)	Facing upstream at By-Wash	

Sampling event	Description	Photograph
Summer 2013 (20/02/2013)	Facing upstream at By-Wash	
Autumn 2013 (23/04/2013)	Facing upstream at By-Wash	
Spring 2013 (25/10/2013)	Facing upstream at By-Wash	
Autumn 2014 (07/04/2014)	Facing upstream at By-Wash	

Sampling event	Description	Photograph
Spring 2014 (13/10/2014)	Facing upstream at By-Wash	

WMP03 – On-site impact site

WMP03 is located on the northern arm of LT Creek immediately downstream of the Main By-Wash Dam. This site has been monitored on nine occasions from autumn 2011 to spring 2014. Table 3-22 provides photographs of the site from these monitoring rounds.

The monitoring site WMP03 is located downstream of the weir at the outlet of the Main By-Wash Dam, which consists of a small and relatively shallow channel approximately 2.5 m wide and 0.4 m deep. It is likely that the discharge from the Bywash Dam provides a constant surface flow at this site, where otherwise, natural flow conditions in this system would be expected to be more ephemeral in nature.

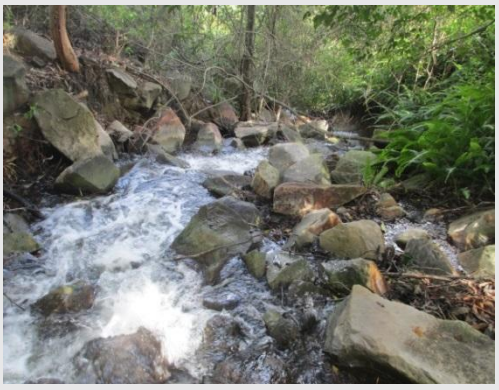
Instream habitat was made up of pool, run and riffle zones comprising of detritus, overhanging bank vegetation, trailing bank vegetation, with some macrophytes and filamentous algae. There was a small riffle zone that flowed into a larger deep pool with dense emergent macrophytes around the edges. The riparian vegetation at WMP03 was observed to be relatively dense, dominated by exotic shrubs (lantana) and grasses, with some tall trees (eucalypts) providing moderate shading of the aquatic habitat.

The substrate was dominated by bedrock, with some boulders, sand and silt. Land use was similar to that of the Main By-Wash Dam and was found to consist of native vegetation on the left bank and mine infrastructure and facilities on the right bank.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events from 2011 to 2014.

Table 3-22 Photographs of WMP03 at Newstan Colliery Surface Site during autumn 2011 to spring 2014 surveys

Sampling event	Description	Photograph
Autumn 2011 (30/05/2011)	Facing downstream at WMP03	

Sampling event	Description	Photograph
Summer 2013 (20/02/2013)	Facing upstream at WMP03	
Autumn 2013 (23/04/2013)	Facing upstream at WMP03	
Spring 2013 (24/10/2013)	Facing downstream at WMP03	
Autumn 2014 (07/04/2014)	Facing downstream at WMP03	

Sampling event	Description	Photograph
Spring 2014 (14/10/2014)	Facing downstream at WMP03	

SP003 – Downstream impact site

SP003 is located on the northern arm of LT Creek downstream of monitoring site WMP03. The site is located immediately downstream of a culvert and consists of a narrow channel between approximately 2 m and 3 m wide and approximately 0.4 m to greater than 1 m in depth. This site has been monitored in Autumn 2011 and Summer 2012. Table 3-23 provides photographs of the site from the Autumn 2011 monitoring round.

Instream habitat was observed to be made up of trailing bank vegetation, emergent macrophytes and limited woody debris. Extensive emergent and trailing bank vegetation was present along both banks. The substrate was found to be dominated by fine silts. An isolated riparian overstory (trees) was present along both banks. A low percentage cover of riparian understory was observed to be present in the form of young trees and shrubs. The overall vegetation disturbance rating was considered high.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events from 2011 to 2012.

Table 3-23 Photographs of SP003 at Newstan Colliery Surface Site during Autumn 2011 survey

Sampling event	Description	Photograph
Autumn 2011 (30/05/2011)	Facing downstream at SP003	

SP004 – Downstream impact site

SP004 is located on the northern arm of LT Creek downstream of monitoring site SP003 and downstream of the discharge from the Final Pollution Control Dam via Newstan LDP002. This site has been monitored on eight occasions from summer 2012 to spring 2014. Table 3-24 provides photographs of the site from these monitoring rounds. SP004 is sampled immediately downstream of a road crossing and consists of a small channel, approximately 3 m wide with little surface flow. The sampling site was relatively shallow, approximately 0.2 m to 0.5 m deep. There was a deeper pool immediately upstream of the Miller Road crossing. In 2012, the site was assessed downstream of the Miller Road crossing.

Instream habitat was observed to be made up of a series of pools and runs comprising of emergent macrophytes, detritus and some overhanging bank vegetation and trailing bank vegetation. Dense stands of emergent *Typha* grew around the edges. The riparian vegetation was dominated by grasses, shrubs (Lantana) and some small trees (Eucalyptus), which provided a moderate level of instream shading. The substrate was found to be dominated by silt with some sand, gravel and pebble.

Adjacent land use consisted of native vegetation on the right bank and an area cleared of vegetation used as an archery range on the left bank.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events between 2012 and 2014.

Table 3-24 Photographs of SP004 at Newstan Colliery Surface Site during summer 2012 to spring 2014 surveys

Sampling event	Description	Photograph
Summer 2012 (12/01/2012)	Facing downstream at SP004	
Summer 2013 (21/02/2013)	Facing downstream at SP004	

Sampling event	Description	Photograph
Autumn 2013 (23/04/2013)	Facing downstream at SP004	
Spring 2013 (24/10/2013)	Facing downstream at SP004	
Autumn 2014 (07/04/2014)	Facing downstream at SP004	
Spring 2014 (13/10/2014)	Facing downstream at SP004	

Weir – Downstream recovery site

Downstream recovery monitoring site Weir is located on the northern arm of LT Creek downstream of monitoring site SP004 and discharges from Newstan LDP001 and LDP002. This site has been monitored on eight occasions from summer 2012 to spring 2014. Table 3-25 provides photographs of the site from these monitoring rounds.

The Weir site is located immediately upstream of the Macquarie Road crossing. It consists of a small channel, approximately 4 m wide with little surface flow. The sampling site was relatively shallow, approximately 0.4 m deep. West of Macquarie Road the riparian vegetation was dominated by shrubs (Lantana), grasses and some small trees. East of Macquarie Road, the riparian vegetation has been cleared on both banks with some concreted areas leaving minimal aquatic habitat. Due to high water levels and deep pools west of Macquarie Road in autumn 2013, autumn 2014 and spring 2014, the downstream reach (east of Macquarie Road) of this site was assessed.

A series of pools and runs dominated the instream habitat, with some macrophytes, woody debris, detritus, overhanging bank vegetation and trailing bank vegetation. The substrate was dominated by silt and clay with some sand.

The riparian vegetation was dominated by shrubs (Lantana), grasses and some small trees. Immediately downstream of the site, the riparian vegetation has been cleared on both banks with some concreted areas leaving minimal aquatic habitat.

The adjacent land use consisted of native vegetation on the left bank and residential development on the right bank.

No major site differences, in terms of instream habitat, have been observed at this site across the sampling events.

Table 3-25 Photographs of Weir at Newstan Colliery Surface Site during summer 2012 to spring 2014 surveys

Sampling event	Description	Photograph
Summer 2012 (12/01/2012)	Facing upstream at Weir (west of Macquarie Road)	
Summer 2013 (21/02/2013)	Facing upstream at Weir (west of Macquarie Road)	

Sampling event	Description	Photograph
Autumn 2013 (22/04/2013)	Facing upstream at Weir (east of Macquarie Road)	
Spring 2013 (24/10/2013)	Facing upstream at Weir (west of Macquarie Road)	
Autumn 2014 (08/04/2014)	Facing upstream at Weir (east of Macquarie Road)	
Spring 2014 (13/10/2014)	Facing upstream at Weir (east of Macquarie Road)	

Estuarine sites

SCCIZ –Reference site

SCCIZ is an estuarine reference site that is located approximately 1,200 m upstream of the confluence of Stony Creek and Fennell Bay. At this point Stony Creek is relatively wide, on average approximately 20 m, and slow flowing. The sampling site was relatively deep at approximately 1.5 m. This site has been monitored in autumn and spring 2014. Table 3-26 provides photographs of the site from both monitoring rounds.

Instream habitat was characterised by pools, with some artificial cover such as rock walls and boat jetties. Seagrass was observed in the shallow more protected areas. The riparian vegetation had been generally cleared on both banks with turfed areas and planted vegetation present. Both banks comprised man-made rock walls, small areas of re-established mangroves and a number of jetties were present along the reach.

The substrate was dominated by silt with some sand, gravel, pebbles and clay. Residential development made up the land use on left bank with commercial and residential development on the right bank.

No major site differences, in terms of instream habitat, have been observed at this site through 2014.

Table 3-26 Photographs of SCCIZ at Newstan Colliery Surface Site during autumn and spring 2014 surveys

Sampling event	Description	Photograph
Autumn 2014 (09/04/2014)	Facing upstream at SCCIZ	
Spring 2014 (15/10/2014)	Facing upstream at SCCIZ	

IZ – Downstream recovery site

Estuarine downstream recovery site IZ is located approximately 280 m upstream of the confluence of LT Creek with Lake Macquarie. In 2012, the site was assessed at seven locations in the vicinity of this site and was referred to as LT1–LT7. Sampling of these seven locations was undertaken as an isolated exercise to determine whether there was any accumulation of metal loads occurring. IZ was maintained as monitoring location from 2012 from the results of this isolated monitoring round.

LT Creek at this site is relatively wide, approximately 13 m, and slow flowing. The sampling site was relatively deep at approximately 1.2 m. Site IZ was subsequently assessed on seven occasions from summer 2013 to spring 2014. Table 3-27 provides photographs of the site from these monitoring rounds.

Instream habitat was characterised as a large body of permanent water, with some artificial cover such as rock walls and boat jetties. The riparian vegetation had been cleared on both banks, which both comprised a man-made rock wall and a number of jetties were located along the reach. A few mangroves grew along the right bank.

The substrate was dominated by silt with some sand, gravel and clay. Residential development made up the land use on both banks.

No major site differences have been observed in between 2013 and 2014. A series of seven sites were assessed in the vicinity of the site in 2012, with slightly different habitat characteristics.

Table 3-27 Photographs of IZ at Newstan Colliery Surface Site during summer 2012 to spring 2014 surveys

Sampling event	Description	Photograph
Summer 2012 (13/01/2012)	Downstream of IZ (note the site was assessed at seven locations L1–L7 in the vicinity of the IZ site)	
Summer 2013 (21/02/2013)	Facing upstream at IZ	

Sampling event	Description	Photograph
Autumn 2013 (22/04/2013)	Facing upstream at IZ	
Spring 2013 (24/10/2013)	Facing upstream at IZ	
Autumn 2014 (09/04/2014)	Facing upstream at IZ	
Spring 2014 (15/10/2014)	Facing upstream at IZ	

3.2.2 Water quality

In situ water quality

Freshwater sites

Results of *in situ* water quality monitoring for freshwater sites are presented in Appendix C for reference sites WMP19-US and WMP20, on-site impact monitoring sites By-Wash and WMP03, downstream impact monitoring sites SP003, SP004 and WMP19-DS and downstream recovery site Weir. The SSTVs calculated for Newstan LDP001 (GHD, 2011) are also included for comparison in each table.

Electrical conductivity levels were observed to consistently exceed the SSTV of 2,200 µS/cm at on-site impact monitoring sites By-Wash and WMP03. A decreasing trend in electrical conductivity is evident with increasing distance downstream of the discharge at Newstan Colliery Surface Site, with occasional exceedences recorded at downstream sites SP003, SP004 and Weir.

Results for pH were found to be below the lower SSTV on several occasions at monitoring locations WMP19-US, WMP19-DS and WMP20 on Stony Creek. At the downstream recovery monitoring site Weir, recorded pH was consistently above the upper SSTV of 8.5. Site SP004 also recorded elevated pH above the SSTV on several occasions, with the pH recorded at on-site impact monitoring site WMP03 was slightly above the upper SSTV in the latest monitoring round in spring 2014.

Recorded DO levels were found to be highly variable between monitoring sites and sampling events. The results show that most sites were below the lower SSTV for DO, with sites occasionally recording DO levels exceeding the upper SSTV. This suggests that environmental and/or physical factors are likely to be influencing the change in DO at each site. It should be noted that DO recorded as part of aquatic ecology monitoring does not represent the full diurnal range of potential DO levels.

Turbidity levels were found to exceed the SSTV of 50 NTU at monitoring locations WMP19-US, WMP19-DS and WMP20 on Stony Creek. The SSTV for turbidity was also exceeded on one occasion at downstream sites SP003 and Weir.

Estuarine sites

Results of *in situ* water quality monitoring for estuarine sites are presented in Appendix C for reference site SSCIZ and downstream recovery sites IZ and LT1–LT7. DTVs recommended by ANZECC (2000) for estuaries are also included for comparison in each table.

Electrical conductivity at each estuarine site was relatively high, ranging between approximately 10,000 µS/cm and 48,000 µS/cm, which is expected for sites with tidal influences.

Results indicate that pH levels were relatively consistent and generally within the DTVs recommended by ANZECC (2000). However, site SSCIZ and LT1 both recorded pH below the lower DTV on one occasion.

Similar to the results recorded for freshwater monitoring sites, DO levels were found to be variable between sampling events. Site SCCIZ recorded DO below the lower DTV in both autumn and spring 2014. At site IZ, DO was generally found to also be below the lower DTV.

Turbidity levels were found to exceed the recommended upper DTV of 10 NTU at both SSCIZ and IZ monitoring sites.

Laboratory analysed water quality

Freshwater sites

Results of laboratory water quality monitoring for freshwater sites are presented in Appendix C for reference sites WMP19-US and WMP20, on-site impact monitoring sites By-Wash and WMP03, downstream impact monitoring sites SP003, SP004 and WMP19-DS and downstream recovery site Weir. The SSTVs calculated for Newstan LDP001 (GHD, 2011) are also included for comparison in each table.

TSS levels were relatively low at most sites, with the SSTV found to be exceeded in august 2011 at monitoring sites WMP20 and SP003 and in summer 2012 at the By-Wash site.

Nutrients were generally found to be below SSTVs for the monitoring sites, with the exception of exceedences of the SSTVs for ammonia, total nitrogen and total phosphorus on several occasions at monitoring sites WMP19-US, WMP19-DS and WMP20 on Stony Creek and By-Wash and SP003 on LT Creek.

The SSTV for dissolved aluminium, chromium, copper, iron and zinc were reported to be exceeded at monitoring sites WMP19-US, WMP19-DS and WMP20 on Stony Creek. It should be noted that no discharge has occurred via Newstan LDP017 into Stony Creek since August 2012.

Concentrations of dissolved arsenic slightly exceeded the SSTV at monitoring sites By-Wash, WMP03 and SP003 in autumn 2011. Concentrations of arsenic were low during all other sampling events from 2012 to 2014 and below the SSTV.

Dissolved iron concentrations were found to exceed the SSTV on one occasion at site Weir in summer 2013, however this result only slightly exceeded the SSTV. On all other occasions, concentrations of dissolved iron were generally well below the SSTV.

Sampling conducted in autumn 2011 reported exceedences of the SSTV for dissolved selenium at sites By-Wash, WMP003 and SP003. For all other sites and sampling events, dissolved selenium concentrations have been observed below the SSTV.

Concentrations of dissolved zinc have exceeded the SSTV at site WMP03 in autumn 2011 and spring 2013, at site SP004 in spring 2013 and at site Weir in summer 2014.

Estuarine sites

Results of laboratory water quality monitoring for estuarine sites are presented in Appendix C for reference site SSCIZ and downstream recovery sites IZ and LT1–LT7. DTVs recommended by ANZECC (2000) for estuaries are also included for comparison in each table.

Total nitrogen and total phosphorus concentrations were found to exceed DTVs in spring 2014 at site SSCIZ. These parameters were also exceeded at site IZ in summer 2012 (at sites LT1, LT3, LT4 and LT7) and summer and spring 2014.

The recommended DTVs for dissolved copper and zinc were also found to be exceeded at site IZ. Dissolved copper concentrations were found to exceed the DTV in summer 2012 (at sites LT4 and LT5), spring 2013 and summer and spring 2014. On one occasion in spring 2014, dissolved zinc was found to exceed the DTV.

Multivariate analysis

A PCA was conducted to evaluate the overall trends in water quality between site type and sampling event. The following variables were included in this analysis:

- Alkalinity
- Aluminium
- Arsenic
- Cadmium

- Calcium
- Chloride
- Chromium
- Cobalt
- Copper
- DO
- Electrical conductivity
- Iron
- Lead
- Magnesium
- Manganese
- Nickel
- Nitrate + nitrite
- pH
- Potassium
- Sodium
- Sulfate
- TKN
- TOC
- Total phosphorus
- Turbidity
- Zinc

Arrangement of the samples in the two dimensional PCA plot explains approximately 65.0% of the variation in the water quality data, as shown in Figure 3-10. Samples towards the right of the plot are those with increased levels of sodium, electrical conductivity, sulfate, chloride, magnesium, alkalinity, calcium, pH and nickel as well as reduced levels of iron, aluminium, TKN, copper, chromium, cadmium, zinc, turbidity and TOC. Samples to towards the top of the plot have increased levels of pH and alkalinity and decreased levels of arsenic, cobalt, lead, nickel, manganese, potassium, total phosphorus, calcium and turbidity.

The location of samples collected at WMP20 on the PCA plot indicates the strong difference in water quality at this monitoring site. The PCA indicates that water at WMP20 is generally has higher concentration of iron, aluminium, TKN, copper, chromium, cadmium, zinc, turbidity and TOC and a lower concentration of sodium, electrical conductivity, sulfate, chloride, magnesium, alkalinity, calcium, pH and nickel when compared to sites downstream of the Newstan LDP001 discharge. Majority of the samples collected at impact and recovery sites were clustered together on the PCA indicating similar water quality. The exception was the sample collected at By-Wash in summer 2011 and those collected at By-Wash, WMP03 and SP004 in autumn 2011. The sample collected at reference site WMP20 in autumn 2011 was also separated on the plot although this sample was also strongly separated from the impact and recovery sites during this event. Impact and recovery sites in autumn 2011 exhibited decreased levels of pH and alkalinity and increased levels of arsenic, cobalt, lead, nickel, manganese, potassium, total phosphorus, calcium and turbidity when compared to other sampling events.

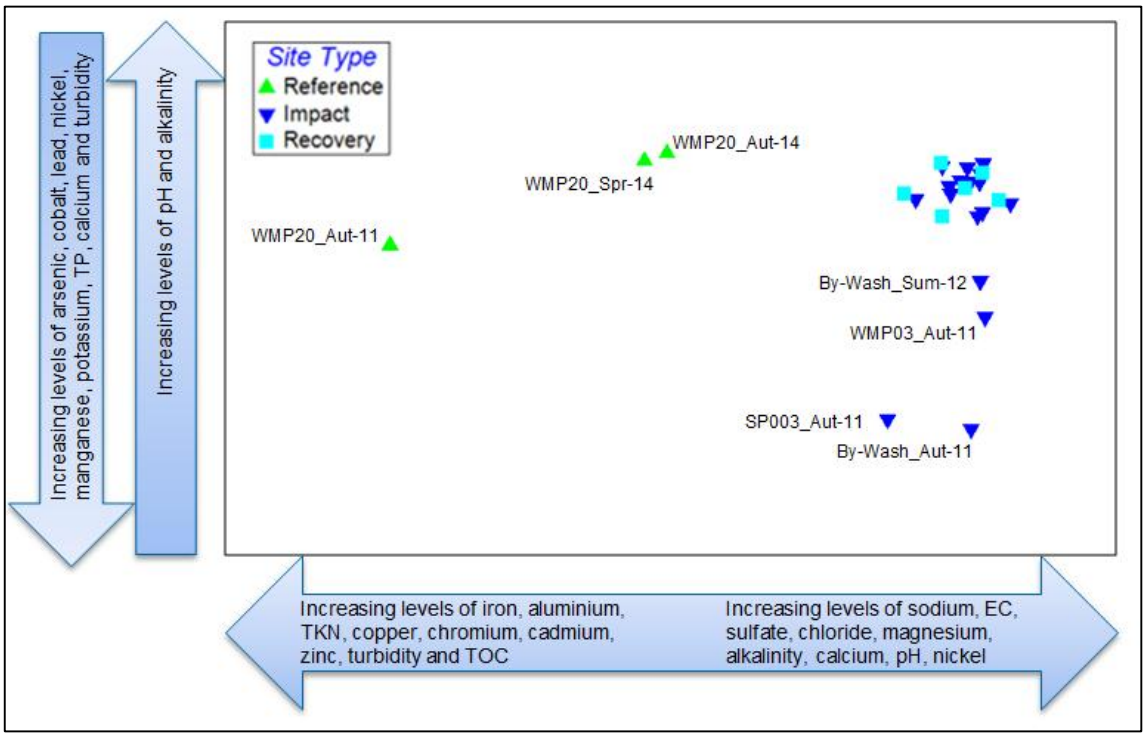


Figure 3-10 Principal component analysis showing overall trends in water quality at Newstan Colliery Surface Site

3.2.3 Sediment quality

Laboratory analysed sediment quality

Freshwater sites

Results of laboratory analysed sediment quality monitoring for freshwater sites are presented in Appendix D for reference site WMP20, on-site impact monitoring sites By-Wash and WMP03, downstream impact monitoring sites SP003, SP004 and WMP19-DS and downstream recovery site Weir. The low and high ISQG values recommended by ANZECC (2000) are also included for comparison in each table. It is important to note that results presented for total metals do not necessarily represent bioavailable concentrations.

Sediment sampling results indicate that total metal concentrations are generally higher at the on-site and downstream impact sites compared to the reference and downstream recovery sites. This result indicates that the majority of metals are associated with operations at Newstan Colliery Surface Site. A trend of decreasing metal concentrations with increasing distance downstream of discharges is evident from the sediment quality monitoring results. All sites monitored in the most recent survey in spring 2014 were found to be below the recommended ISQG values (ANZECC, 2000), with the exception of total lead and zinc concentrations recorded at site By-Wash.

Concentrations of lead were found to exceed the ISQG values during the majority of sampling events at on-site and downstream monitoring sites. Generally these exceedences occurred at sites By-Wash and WMP03, including the single exceedence of the high ISQG value which occurred at By-Wash in autumn 2011. It is likely that lead is bound to sediments and subsequently unlikely to be bioavailable to aquatic organisms. Elevated dissolved lead concentrations above SSTVs have not been observed in the water quality results at any of the monitoring sites, as shown in Section 3.2.2.

Zinc concentrations were found to exceed the low ISQG values at several monitoring sites including By-Wash, WMP03, SP004 and Weir. Elevated concentrations of zinc found in sediment were likely associated with discharge of water from Newstan LDP002 in March 2013. Elevated TSS, turbidity and zinc concentrations were observed in water quality results from autumn 2013 monitoring.

Concentrations of antimony, arsenic and mercury at site By-Wash were found to exceed the low ISQG values. In addition, total nickel concentrations at downstream impact monitoring site SP004 and total mercury concentrations at downstream recovery site Weir were also reported to exceed the low ISQG values. However, in the most recent round of monitoring (spring 2014), concentrations were reported to be below the low ISQG value, indicating exceedences were isolated incidents.

Estuarine sites

Results of laboratory analysed sediment quality monitoring for estuarine sites are presented in Appendix D for reference sites SSCIZ and Ref1, downstream recovery sites IZ and LT1–LT7. The low and high ISQG values recommended by ANZECC (2000) are also included for comparison in each table. It is important to note that results presented for total metals do not necessarily represent bioavailable concentrations.

Cadmium, lead and zinc concentrations have been reported to exceed the recommended ISQG values at both estuarine reference sites and downstream recovery sites. Given that concentrations found at both reference sites and downstream sites were consistent, it is likely that elevated concentrations are associated with background concentrations within the estuary or from other sources from within Lake Macquarie from tidal influences, rather than mine water discharge into LT Creek from Newstan Colliery Surface Site.

Concentrations of copper and antimony within sediment recorded at sites SSCIZ and IZ have also been found to exceed the low ISQG values. However, in subsequent sampling events, concentrations were reported below the low ISQG values, indicating exceedences were isolated incidents.

3.2.4 Freshwater macroinvertebrate results

Community composition

A total of 72 macroinvertebrate taxa were collected from the freshwater reaches of Newstan Colliery Surface Site over the seven sampling events carried out between 2011 and 2014. Community composition varied between sampling events as indicated by the relative richness plots in Figure 3-11. Individual relative richness plots for each sampling event are presented in Appendix A. The macroinvertebrate community was largely made up of insects, dominated by groups of, Diptera (flies), Odonata (dragonflies and damselflies), Trichoptera (caddisflies), Hemiptera (true bugs), Coleoptera (beetles) and Gastropoda (snails).These main groups were relatively consistent in the proportions across sampling events while greater variation was observed in the less dominant groups such as Isopoda (slaters etc.), Lepidoptera (moths/butterflies) and Oligochaeta (worms). This suggests that site conditions were relatively consistent across sampling events with only small changes in habitat, water level or water quality leading to the presence or absence of some niche taxa.

The most abundant families/sub-families collected were non-biting midge larvae (Tanypodinae/Chironominae), stick caddisfly larvae (Leptoceridae), water mites (Acarina), skimming dragonflies (Libellulidae) and narrow-winged damselflies (Coenagrionidae).

Chironominae and Tanypodinae have a SIGNAL 2 score of three and four respectively and are typical present within organically polluted waters due to their ability to survive in environments with low DO, however, their presence does not necessarily imply poor water quality. These animals are very common across Australian waterways. Leptoceridae have a SIGNAL 2 score of six and are one of the most common families of Trichoptera (caddisflies) in temperate Australia. They occur in a diverse range of habitats where organic matter is present and are tolerant of high electrical conductivity. Acarina are most abundant in shallow, slow-flowing waters including ephemeral streams. Mites are particularly sensitive to heavy metals, while some species can tolerate moderate salinity. Libellulidae live under a range of conditions, from still ephemeral waters to fast flowing streams. They are generally found living amongst vegetation, gravel or mud. This family has a SIGNAL 2 score of four although the variability of genera in this family suggests a greater range of tolerances. With a SIGNAL 2 score of two, Coenagrionidae are very pollution tolerant and widespread in Australia. They are usually found in and around submerged vegetation to which they cling.

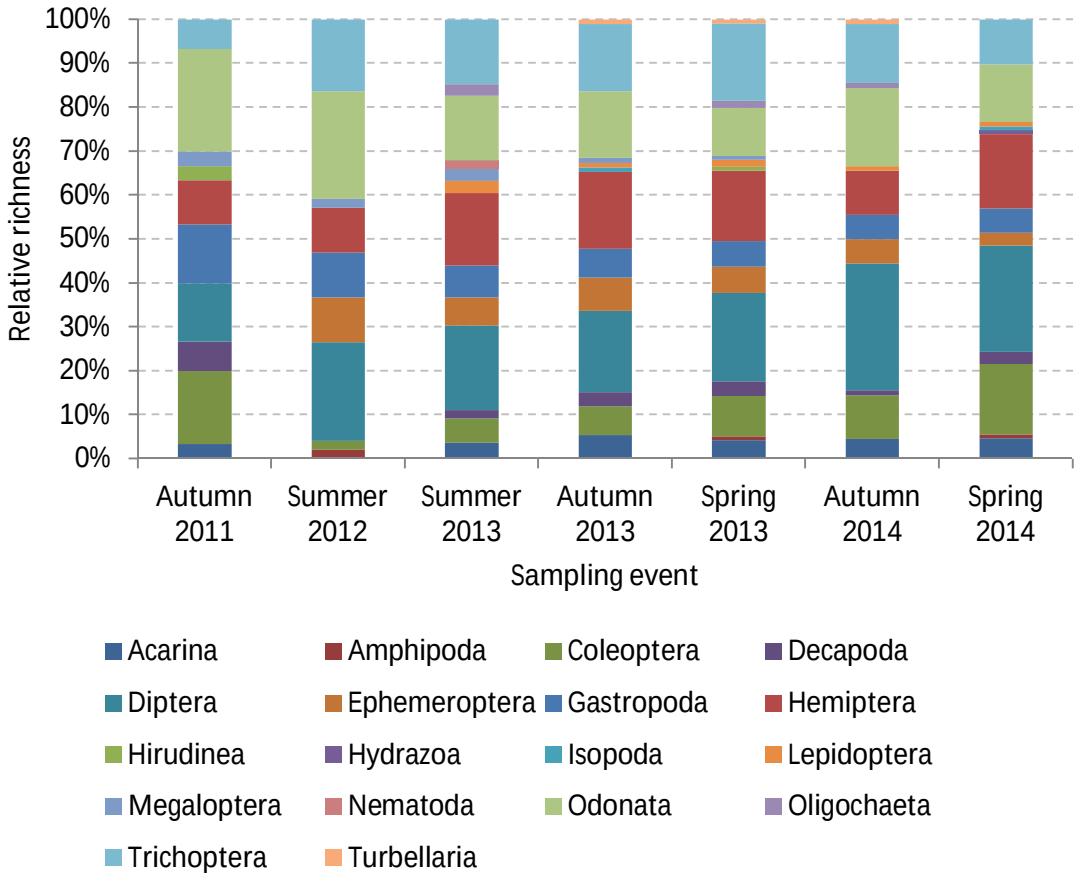


Figure 3-11 Relative richness for sites sampled at Newstan Colliery Surface Site sampled between 2011 and 2014

Univariate analysis

Univariate metrics including richness, EPT richness and SIGNAL 2 scores have been graphed to indicate temporal and spatial trends. Additionally, a series of two-way GLM tests were conducted to test for significant differences in each metric between sampling event and site type. As the reference site WMP20 was only sampled in 2014, this reference site was not included in the analysis. Similarly, as the recovery site Weir was not sampled in prior to 2013, analyses excluded these years. Riffle samples collected from WMP03 were also omitted from all GLM analyses.

Taxonomic richness

The taxonomic richness for sites surveyed at Newstan Colliery Surface Site between autumn 2011 and spring 2014 are presented in Figure 3-12. Taxonomic richness was generally highest at the By-Wash site, declining in a downstream direction along LT Creek. The lowest richness was generally observed at recovery site Weir. Richness in autumn and spring 2014 was lower than observed in 2013 but higher than observed in 2011 or 2012. At WMP03, richness was most frequently lower within the riffle compared to the edge habitat for each sampling event.

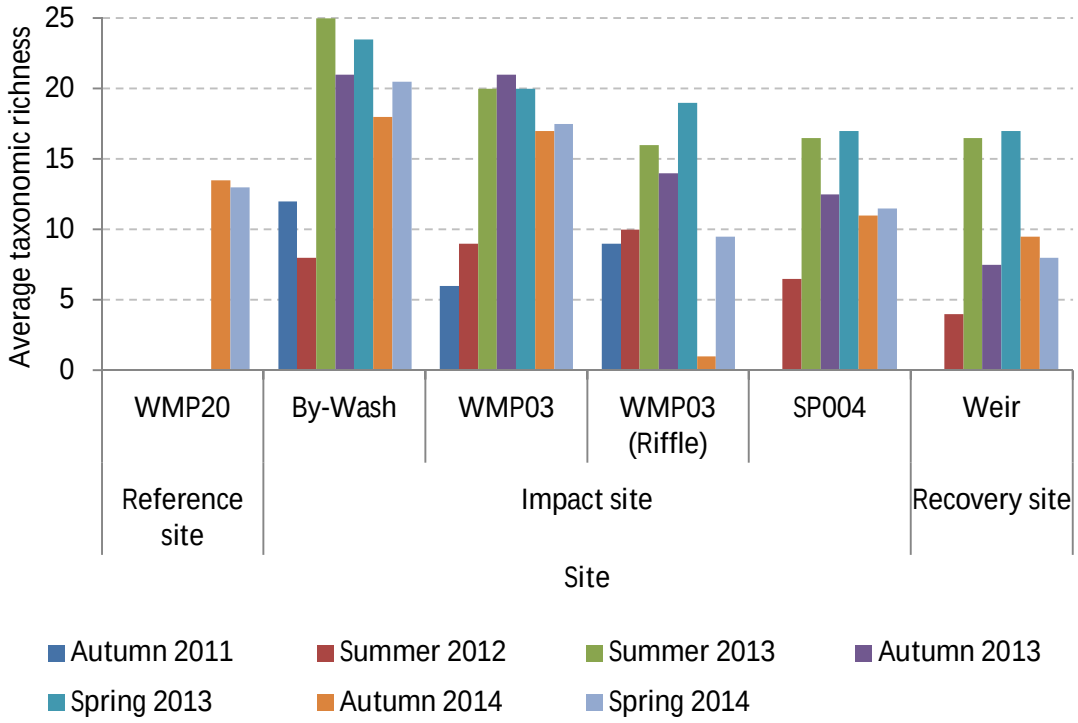


Figure 3-12 Average macroinvertebrate taxonomic richness for sites surveyed between 2011 and 2014 at Newstan Colliery Surface Site

A GLM conducted on taxonomic richness, as shown in Table 3-28, did not detect a significant (p<0.05) interaction between sampling event and site type. This means that the pattern of change in richness between site types was the same no matter which sampling event was being examined. The GLM indicated that taxonomic richness was significantly different (p<0.05) between recovery and impact sites. Multiple comparisons testing did not detect significant differences in taxonomic richness between sampling evens, as shown in Table 3-29.

Table 3-28 Two-way GLM test output comparing macroinvertebrate taxonomic richness for surveys at Newstan Colliery Surface Site (edge sites only)

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	6,352.66	1	6,352.66	341.12	0.0000
Sampling event	267.97	4	66.99	3.60	0.0184
Site type	284.41	1	284.41	15.27	0.0006
Sampling event x site type	49.45	4	12.36	0.66	0.6228
Error	484.20	26	18.62		

Red text indicates significant effect based on $p<0.05$

Table 3-29 Results of multiple comparisons (Unequal N HSD) test of taxonomic richness between sampling events at Newstan Colliery Surface Site

	Summer 2013	Autumn 2013	Spring 2013	Autumn 2014
Autumn 2013	0.2743			
Spring 2013	1.0000	0.3025		
Autumn 2014	0.0996	0.9801		
Spring 2014	0.2148	0.9999	0.2386	0.9937

*Unequal N HSD test is a statistical model that considers significant differences between group means to analyse variance

The means plot in Figure 3-14 shows that taxonomic richness was higher, on average, at impact sites compared to the recovery site Weir. Although the GLM also detected differences in taxonomic richness between the sampling events, the multiple comparisons test was too conservative to detect and significant differences in the pairwise tests, as shown in Table 2-1. However, Figure 3-13 does indicate that taxonomic richness was generally higher in summer and spring 2013 compared to other sampling events, although this pattern was less pronounced for the impact sites than for the recovery site Weir.

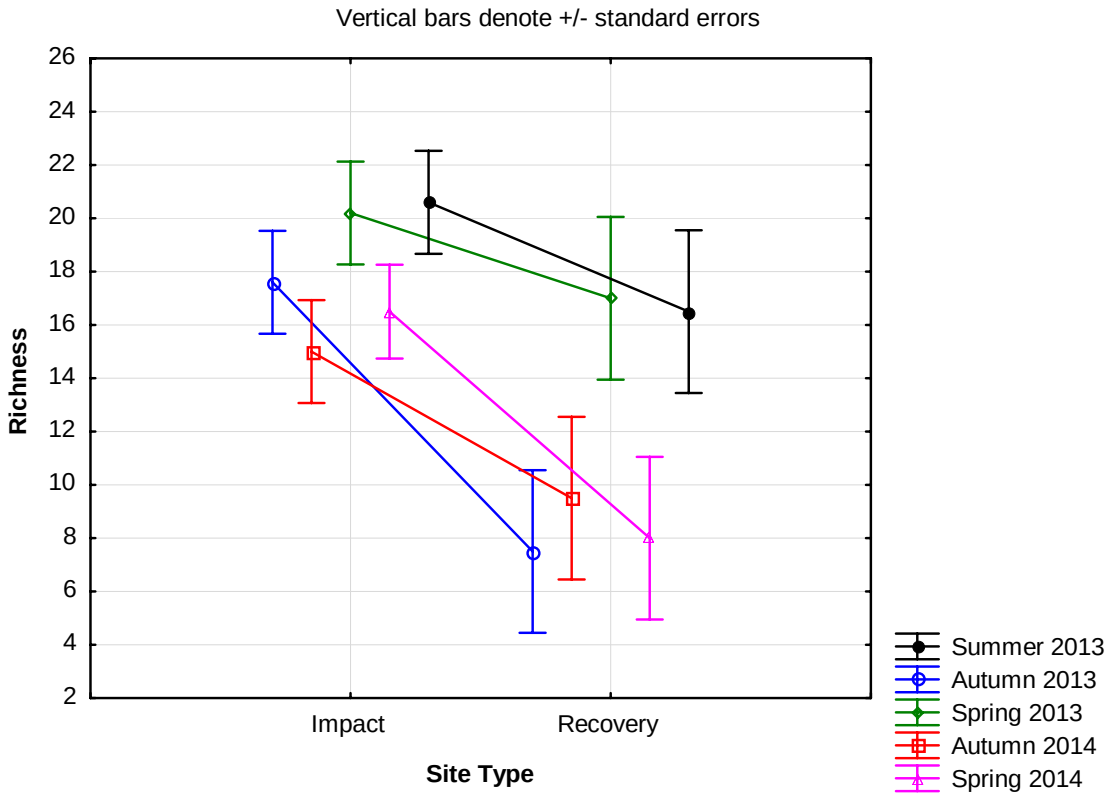


Figure 3-13 Means plot indicating differences in taxonomic richness between reference, impact and recovery sites at Newstan Colliery Surface Site

EPT richness

The EPT richness for sites surveyed between 2011 and 2014 at Newstan Colliery Surface Site is presented in Figure 3-14. EPT richness at WMP20 was often higher at the By-Wash site and WMP03 compared to the sites further downstream. EPT richness at reference site WMP20 was low during both 2014 events with levels similar to those observed at the Weir site. There was no consistent trend in EPT richness over time; however there was a notable decrease in EPT richness at WMP03, SP004 and Weir in 2014 when compared to the April 2013 event. However, EPT levels during these most recent events were not outside of the range observed at most sites in 2011 and 2012.

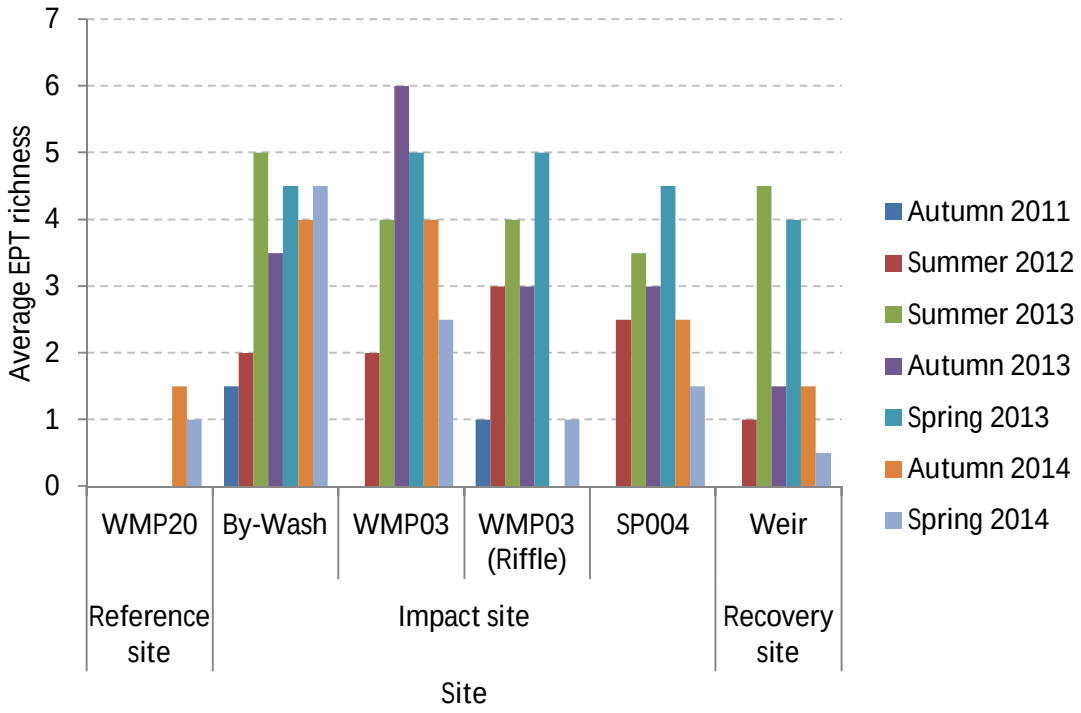


Figure 3-14 Average macroinvertebrate EPT richness for sites surveyed between 2011 and 2014 at Newstan Colliery Surface Site

A GLM indicated no significant interaction (p<0.05) between sampling event and site type, as shown in Table 3-30. A significant difference was detected in EPT richness between site type and between sampling event. Multiple comparisons testing detected a significant difference in EPT richness only between spring 2013 and spring 2014, as shown in Table 3-31.

Table 3-30 Two-way GLM test output comparing macroinvertebrate EPT richness for surveys at Newstan Colliery Surface Site between 2011 and 2014 (edge sites only)

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	274.24	1	274.24	152.25	0.0000
Sampling event	33.03	4	8.26	4.58	0.0062
Site type	13.47	1	13.47	7.48	0.0111
Sampling event x site type	7.86	4	1.96	1.09	0.3817
Error	46.83	26	1.80		

Red text indicates significant effect based on p<0.05

Table 3-31 Results of multiple comparisons (Unequal N HSD) test of EPT richness between sampling events at Newstan Colliery Surface Site

	Summer 2013	Autumn 2013	Spring 2013	Autumn 2014
Autumn 2013	0.5148			
Spring 2013	0.9997	0.3993		
Autumn 2014	0.2980	0.9944	0.2149	
Spring 2014	0.0609	0.7260	0.0395	0.9135

Red text indicates significant effect based on $p<0.05$

Unequal N HSD test is a statistical model that considers significant differences between group means to analyse variance

The means plot in Figure 3-15 indicates that EPT richness was higher in spring 2013 compared to spring 2014. The means plot also shows that EPT richness was higher at impact sites than the recovery site during autumn 2013, autumn 2014 and spring 2014 but of a similar level in summer 2013 and spring 2013.

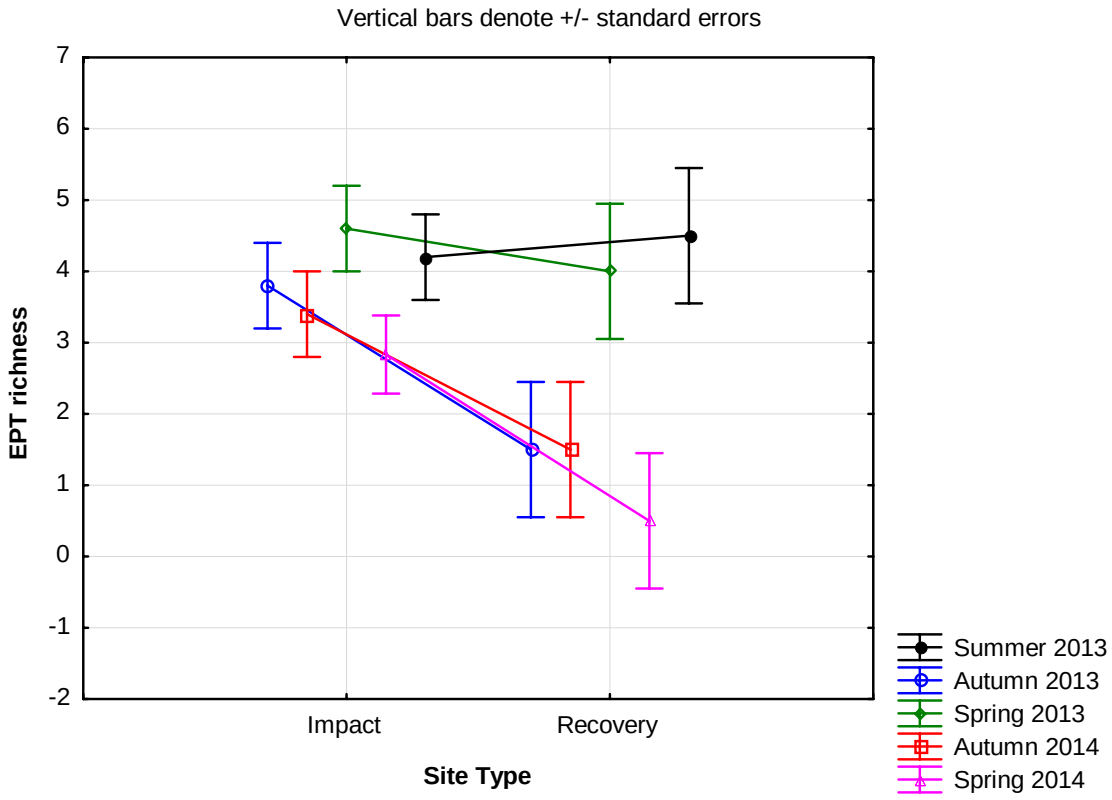


Figure 3-15 Means plot indicating differences in EPT richness between reference, impact and recovery sites at Newstan Colliery Surface Site

SIGNAL 2 biotic index

Unlike taxonomic richness and EPT richness, SIGNAL 2 scores were generally lowest at the By-Wash site (with the exception of WMP20), increasing at WMP03 and SP004, levels reducing again slightly at the Weir site, as shown in Figure 3-16. This pattern was relatively consistent across the sampling events. This may suggest a smaller number of sensitive taxa at site By-Wash or it could mean that any sensitive taxa collected were balanced out in the calculation by taxa with low sensitivity scores. SIGNAL 2 scores were relatively consistent across the sampling events with no consistent trend observed across the sites. SIGNAL 2 scores were higher from riffle habitat at WMP03 compared to the edge, with the exception of autumn 2014.

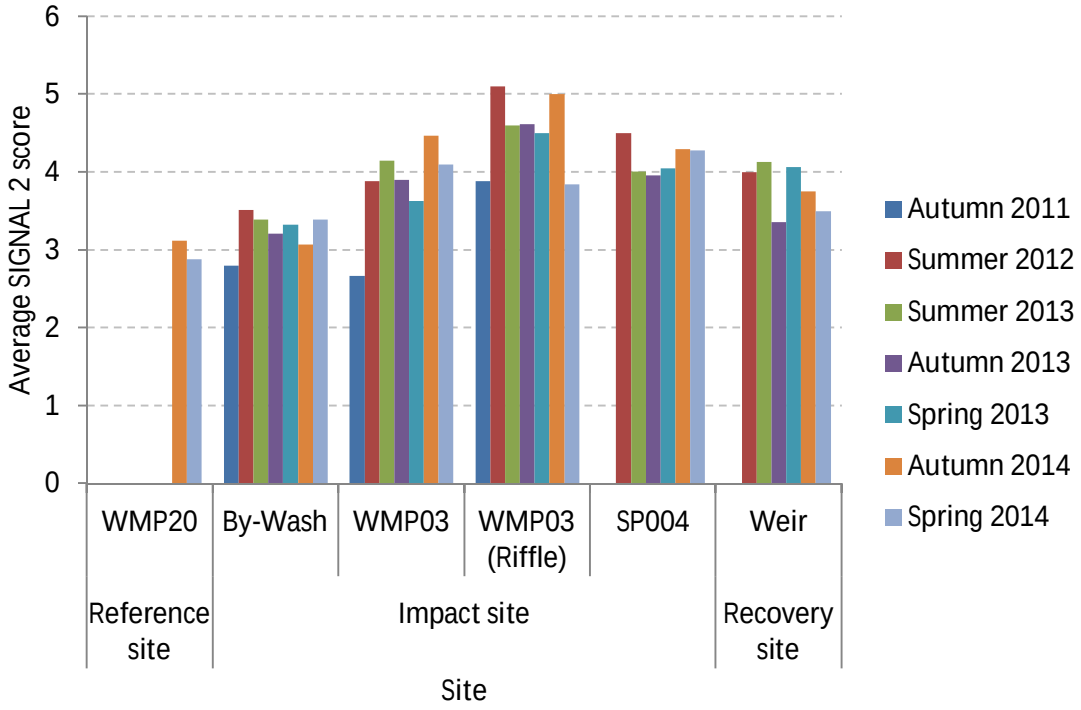


Figure 3-16 Average SIGNAL 2 for sites surveyed between 2011 and 2014 at Newstan Colliery Surface Site

The GLM did not detect any significant difference (p<0.05) in SIGNAL 2 between sampling event or site type, or any interaction between these factors, as shown in Table 3-32. The means plot provided in Figure 3-17 shows that mean SIGNAL 2 scores ranged between 3.31 and 4.13 although the variation was much greater at recovery site Weir compared to impact sites.

Table 3-32 Two-way GLM test output comparing average SIGNAL 2 scores for surveys at Newstan Colliery Surface Site between 2011 and 2014 (edge sites only)

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	274.24	1	274.24	152.25	0.0000
Sampling event	0.70	4	0.18	0.61	0.6583
Site type	0.00	1	0.00	0.01	0.9386
Sampling event x site type	0.78	4	0.19	0.68	0.6153
Error	7.47	26	0.29		

Red text indicates significant effect based on $p<0.05$

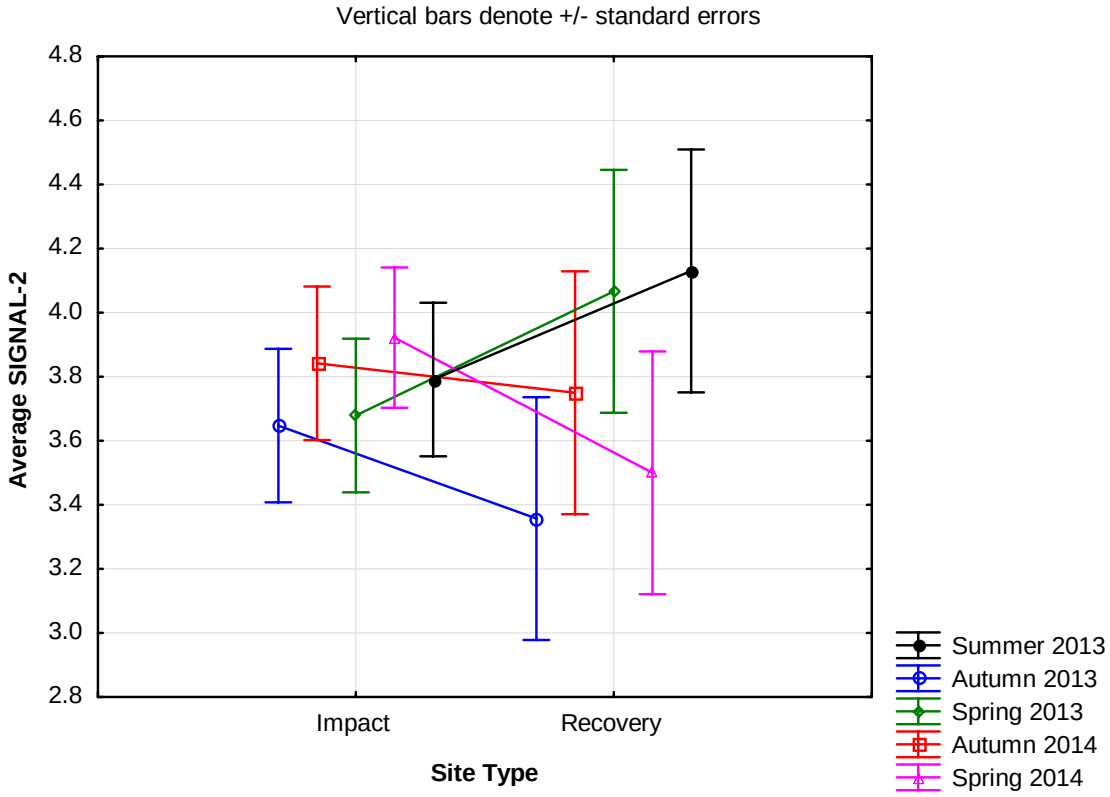


Figure 3-17 Means plot indicating differences in SIGNAL 2 score between reference, impact and recovery sites at Newstan Colliery Surface Site

NSW AUSRIVAS

The edge sample collected at WMP20 in spring 2014 and the edge sample collected at By-Wash in spring 2013 fell outside of the experience of the AUSRIVAS model. Results were produced for all other samples.

Within edge habitat, AUSRIVAS bands of A or B were observed at the reference site WMP20 and impact site By-Wash and WMP03, as shown in Table 3-33, indicating that the macroinvertebrate community at these sites was either 'near reference condition' or 'significantly impaired'. Macroinvertebrate community health at the downstream impact site SP004 was found to be 'significantly impaired' based on samples collected between autumn 2013 and autumn 2014 and 'extremely impaired' in the spring 2014. Results were similar at the Weir recovery site with AUSRIVAS bands indicating that the macroinvertebrate community was 'significantly impaired' between autumn 2013 and autumn 2014 and 'severely impaired' in spring 2014.

AUSRIVAS results for riffle habitat at WMP03 were variable across the four sampling events, ranging from 'significantly impaired' in spring 2013 to 'extremely impaired' in autumn 2014, as shown in Table 3-33. The particularly poor result in autumn 2014 was given due to the fact that only one taxon (Simuliidae; black fly larvae) was collected from this site. Observations in the field at the time of sampling suggest that there had been a scouring flush immediately preceding sampling which is likely the cause for the depauperate community on this occasion. This is further supported by the rainfall depths reported (Bureau of Meteorology, Toronto WWTP Station) during the month of April 2014 registering in the order of 120 mm falling over the month with approximately 60 mm falling with one to two days.

Table 3-33 AUSRIVAS model results from Newstan Colliery Surface Site

Site	Sampling event	OE50	Band
Reference site			
WMP20	Autumn 2014	0.95	A
	Spring 2014	OEM	OEM
On-site impact sites			
By-Wash	Autumn 2013	0.85	A
	Spring 2013	OEM	OEM
	Autumn 2014	0.51	B
	Spring 2014	0.77	B
WMP03 (edge)	Autumn 2013	0.88	A
	Spring 2013	0.98	A
	Autumn 2014	0.48	B
	Spring 2014	0.61	B
WMP03 (riffle)	Autumn 2013	0.51	C
	Spring 2013	0.57	B
	Autumn 2014	0.06	D
	Spring 2014	0.17	C

Site	Sampling event	OE50	Band
Downstream impact site			
SP004	Autumn 2013	0.75	B
	Spring 2013	0.7	B
	Autumn 2014	0.55	B
	Spring 2014	0.19	D
Downstream recovery site			
Weir	Autumn 2013	0.64	B
	Spring 2013	0.78	B
	Autumn 2014	0.64	B
	Spring 2014	0.29	C

Figure 3-18 indicates the variability in OE50 between sites and sampling events. The highest OE50 scores were observed at WMP20 in autumn 2014, WMP03 in autumn and spring 2013 and at By-Wash in autumn 2013. Some of the lowest OE50 scores were observed at SP004 and site Weir in spring 2014.

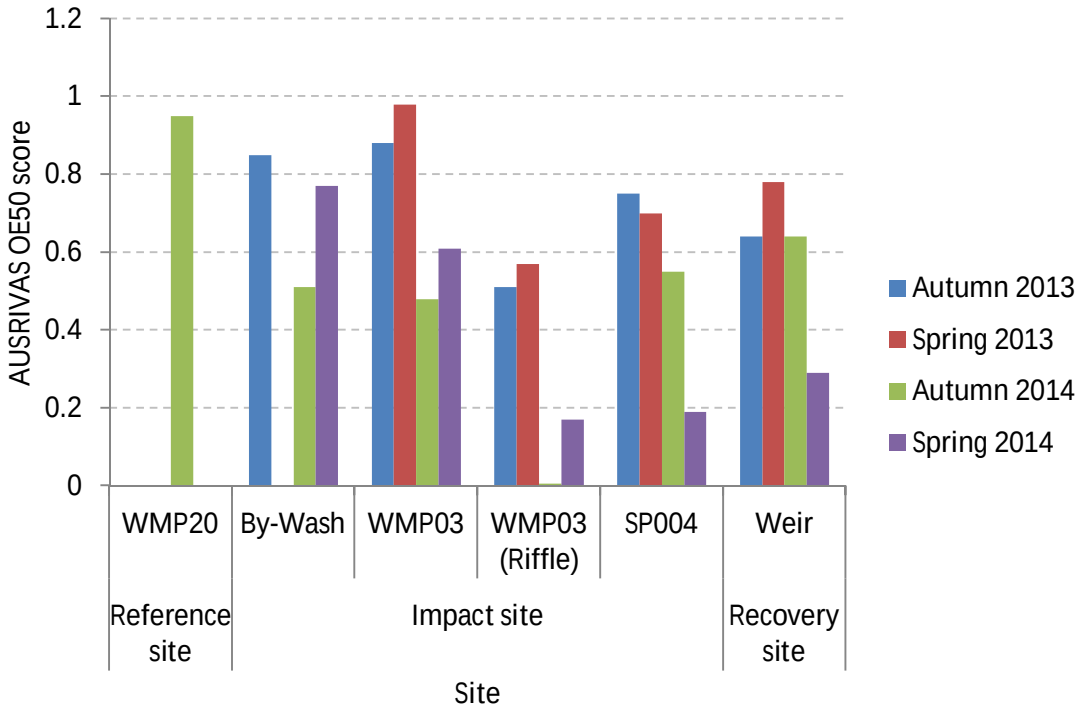


Figure 3-18 AUSRIVAS OE50 scores for Newstan Colliery Surface Site surveyed in autumn 2013, spring 2013, autumn 2014 and spring 2014

A GLM was conducted to test for significant differences in OE50 score between site type (impact and recovery sites only) and sampling event, as shown in Table 3-34. No significant difference (p<0.05) was detected in OE50 score between impact and recovery sites or between the four events. Although, closer examination of the results presented in Figure 3-18 suggests a decline in health during the spring 2014 event, at least as far as SP004 and Weir sites.

Table 3-34 Two-way GLM test output comparing OE50 scores for surveys at Newstan Colliery Surface Site in autumn 2013, spring 2013, autumn 2014 and spring 2014 (edge sites only)

Effect	Sum of squares	Degrees of freedom	Mean squares	*F* statistic	*p*-value
Intercept	4.31	1	4.31	78.82	0.0000
Sampling event	0.31	3	0.10	1.87	0.1932
Site type	0.00	1	0.00	0.00	0.9741
Sampling event x site type	0.07	3	0.02	0.44	0.7268
Error	0.60	11	0.05		

Red text indicates significant effect based on p<0.05

The means plot presented in Figure 3-19 indicates that OE50 score was less variable for impact sites across the sampling events when compared to the recovery site. This is an interesting result since the impact site group encompasses four sites compared to the one recovery site.

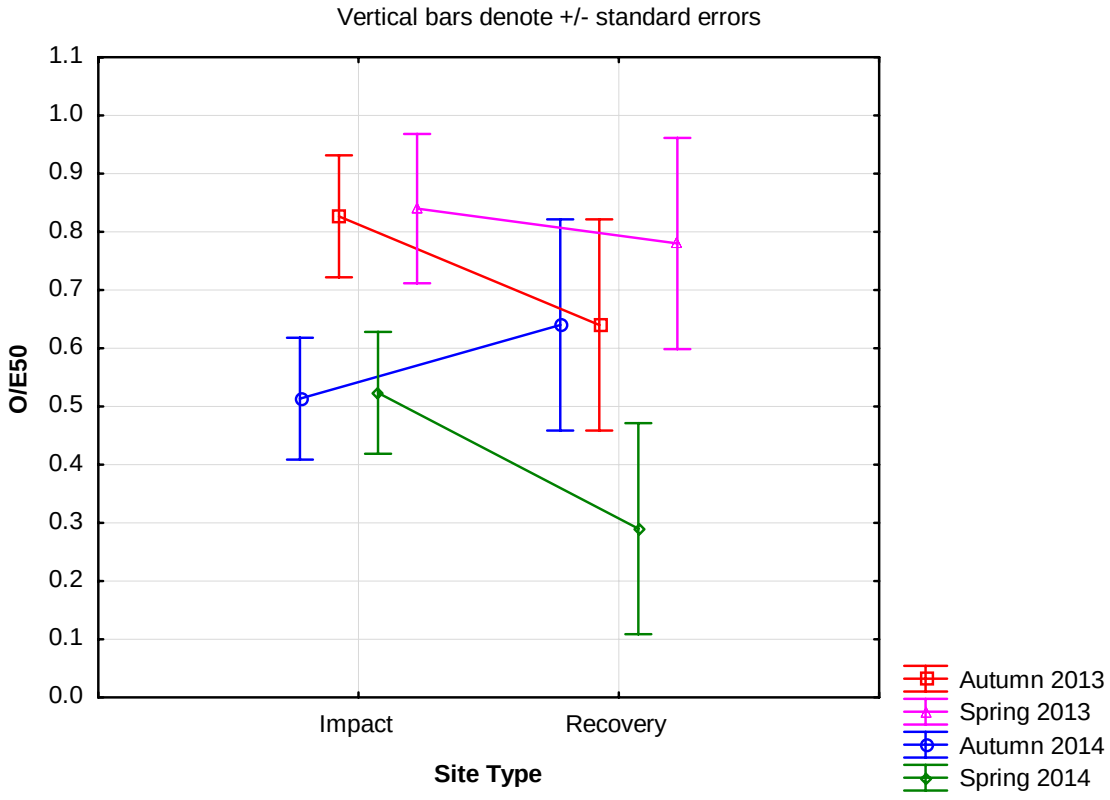


Figure 3-19 Means plot indicating differences in OE50 score between impact and recovery sites at Newstan Colliery Surface Site

Multivariate analysis

The cluster diagram presented in Figure 3-20 indicates that the community composition at the impact site By-Wash was different to that of some other sites. The highest similarity was observed between the community observed at By-Wash in 2013 and 2014 and samples collected at WMP03 in 2013. Community composition at WMP03 in 2014 was more strongly related to that of SP004. Community composition at site Weir was most strongly related to other samples collected at this site or in some cases SP004.

The significance level for the ANOSIM was 3.9% and the global *R* was 0.16 indicating that significant differences ($p<0.05$) were detected but that the differences were not strong. Pairwise comparisons detected significant ($p<0.05$) in community composition between reference and recovery sites only, as shown in Table 3-35. The *R* statistic of 0.629 indicates a moderately strong difference between these groups.

Table 3-35 ANOSIM results indicating significant differences in macroinvertebrate community composition between reference, impact and recovery sites at Newstan Colliery Surface Site

Group 1	Group 2	*R* statistic	Significance level (%)	Possible permutations	Actual permutations	Number >=
Reference	Impact	0.218	7.9	1,533,939	9,999	786
Reference	Recovery	0.629	0.02	4,368	4,368	1
Impact	Recovery	0.102	14.3	Very large	9,999	1,428

Red text indicates significant effect based on $p<0.05$

The average similarity between and within the site type groups are outlined in Table 3-36. These results show that within-group similarity was lower at impact sites. This was evident in the cluster plot where samples collected from sites By-Wash and SP004 were generally strongly separated. The higher within-group similarity for the reference and recovery groups is to be expected since only one site comprises each of these groups.

Table 3-36 Average similarity between reference, impact and recovery sites at Newstan Colliery Surface Site as identified by SIMPER

	Reference	Impact	Recovery
Reference	47.61%		
Impact	28.95%	36.12%	
Recovery	26.49%	32.75%	42.04%

The taxa contributing most strongly to differences between reference (WMP20) and recovery (Weir) sites are outlined in Table 3-37. The major differences between reference and recovery sites were due to, amongst others, higher numbers of Dytiscidae (diving beetle), Hydrophilidae (beetle), Notonectidae (backswimmer bugs) and Corixidae (waterboatmen bugs) and smaller numbers of Gerridae (water strider bugs) at the reference site compared to the recovery site. A majority of the taxa with higher numbers at the reference site WMP20 (including those listed here) have a low pollution sensitivity which suggests that the community is in poorer health at this site compared to the recovery site (Weir).

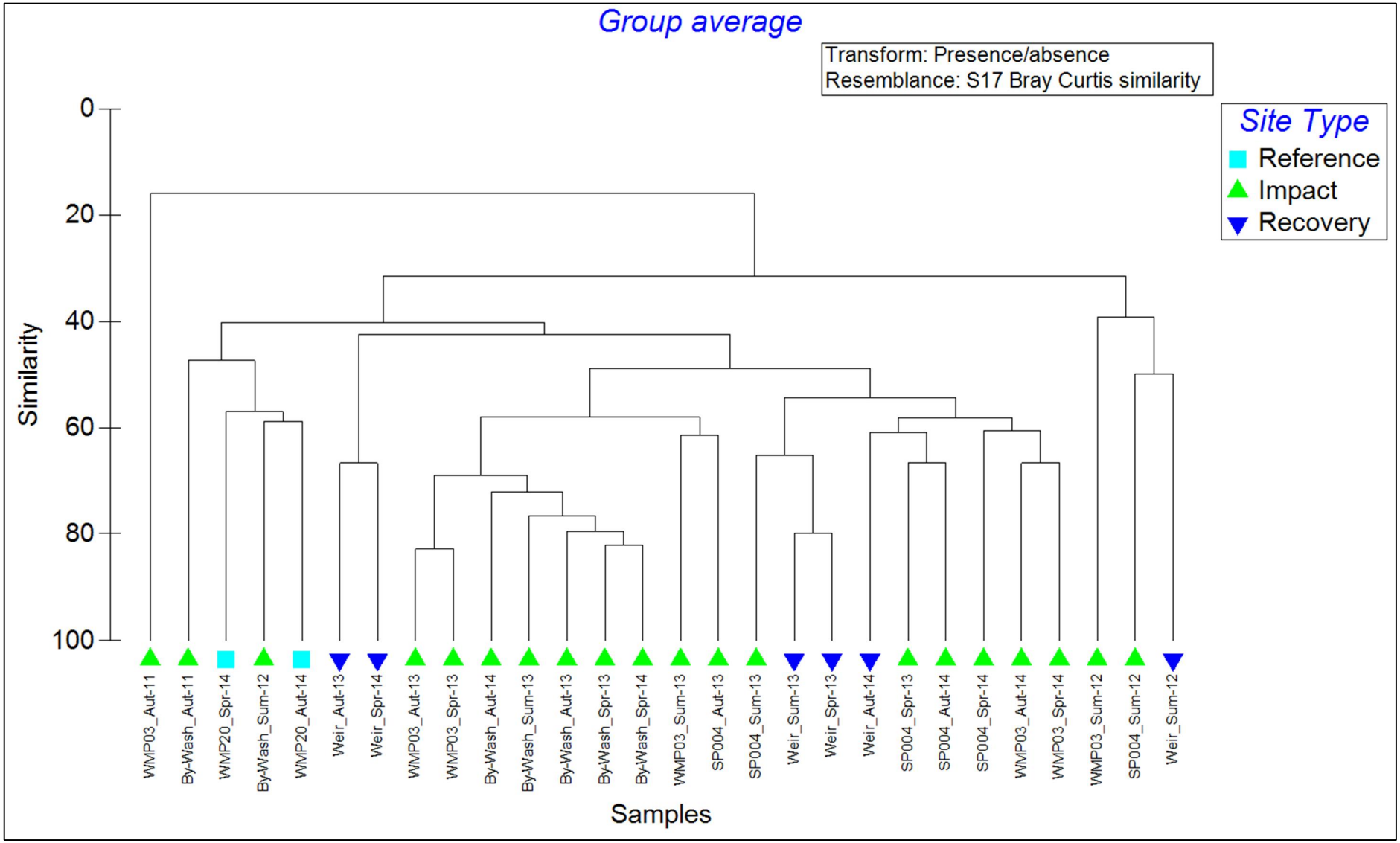


Figure 3-20 Cluster analysis of macroinvertebrate samples at Newstan Colliery Surface Site displaying the similarity of sites based on the site type for 2011 to 2014 surveys

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Table 3-37 Taxa contributing most strongly to differences in the macroinvertebrate community between reference and recovery sites at Newstan Colliery Surface Site

Taxa	Average abundance		Contribution (%)	Cumulative (%)
	Reference sites	Recovery sites		
Dytiscidae	1	0	6.74	6.74
Hydrophilidae	0.8	0	4.7	11.44
Notonectidae	0.8	0	4.7	16.13
Gerridae	0.2	0.82	4.5	20.63
Corixidae	0.6	0	4.42	25.05
Coenagrionidae	0.2	0.55	4.07	29.12
Orthocladiinae	0.2	0.73	4	33.12
Leptoceridae	0.4	0.73	3.73	36.85
Planorbidae	0.6	0.09	3.51	40.37
Acarina sp.	1	0.55	3.51	43.88
Atyidae	0	0.45	3.27	47.15
Tanypodinae	0.4	0.55	3.23	50.38

3.2.5 Estuarine macroinvertebrate results

Estuarine macroinvertebrate results are presented in Table 3-38. Macroinvertebrate richness was relatively low and similar across both locations and all survey times. Taxonomic richness and abundance was greatest at IZ in summer 2013 and at SCCIZ in spring 2014. Gastropods, polychaetes and malacostraca amphipods were the most abundant taxa collected across most locations and most survey periods. This is typical of a shallow water benthic community in soft substrata, which is largely controlled by physical conditions or organic loadings. Communities at this site may be influenced by fluctuations in salinity, fine sediment types, tidal flow and human disturbance (e.g. boat traffic, urban runoff).

Table 3-38 Estuarine invertebrates collected from reference monitoring site SSCIZ and downstream recovery monitoring site IZ at Newstan Colliery Surface Site

Class	Family	Operational taxonomic unit	SSCIZ		IZ				
			Autumn 2014	Spring 2014	Summer 2013	Autumn 2013	Spring 2013	Autumn 2014	Spring 2014
Malacostraca	Gammaridae	Gammaridae	0	2	0	2	3	2	4
Malacostraca	Maeridae	Maeridae	0	0	14	0	0	0	0
Penaeoidea	Penaeidae	Metapenaeus sp.1	0	0	1	0	0	0	0
Gastropoda	Potamididae	Potamididae	10	15	0	0	0	3	7
Bivalvia	Tellinidae	Tellinidae	1	3	0	0	0	0	1
Bivalvia	Mytilidae	Mytilidae	1	1	0	0	0	0	0
Bivalvia	Muricidae	Muricidae	0	2	0	0	0	0	0
Polychaeta	Capitellidae	Capitellidae	0	3	5	1	3	0	0
Polychaeta	Opheliidae	Armandia sp.1	0	0	21	2	1	0	0
Polychaeta	Spionidae	Spionidae	0	0	1	3	0	0	0
Polycheata	Pilargidae	Pilargidae	1	3	0	0	1	1	0
Polycheata	Nereididae	Nereididae	0	2	0	0	0	0	0
Abundance			**13**	**31**	**42**	**8**	**8**	**6**	**12**
Taxonomic richness			**4**	**8**	**5**	**4**	**4**	**3**	**3**

3.2.6 Discussion

Water quality

Newstan Colliery Surface Site water quality statistics over the period of monitoring indicates consistent trends between the reference, impact and recovery sites.

Electrical conductivity levels during sampling have ranged between approximately 1,500 µS/cm and 2,700 µS/cm for the impact and downstream sites. Comparing these sites with the reference site it is clear that there is a significant difference in the electrical conductivity with some recovery downstream of Newstan Colliery Surface Site. It must be noted that the tidal zone is not far beyond the recovery site with electrical conductivity at this location representing the salt water of Lake Macquarie. This is supported by sampling at the estuarine sites, IZ and LT1–LT7.

TSS and nutrient concentrations were relatively low at most sites, with the SSTVs found to be exceeded in august 2011 at monitoring sites WMP20 and SP003 and in summer 2012 at By-Wash. Reduced concentrations of these parameters more recently is due to the operation of the CWP which commenced in December 2013.

Impact sites such as By-Wash, WMP03 and SP004 have indicated isolated elevations in arsenic and iron as well as selenium. These concentrations sampled during the aquatic ecology monitoring have been isolated and do not respond to any specific trends in water quality.

Water quality sampling undertaken within Stony Creek indicated exceedances in dissolved aluminium, chromium, copper, iron and zinc. No discharges have occurred into Stony Creek since 2012, in addition to the construction of a water quality monitoring station which effectively manages the quality of discharges into Stony Creek.

The PCA indicated that water quality was similar between impact and recovery sites and relatively consistent across sampling events, with the exception of autumn 2011. Water downstream of the Newstan LDP001 discharge is characterised by lower concentration of iron, aluminium, TKN, copper, chromium, cadmium, zinc, turbidity and TOC and a higher concentration of sodium, electrical conductivity, sulfate, chloride, magnesium, alkalinity, calcium, pH and nickel when compared to sites downstream of the Newstan LDP001 discharge.

Freshwater macroinvertebrates

The general dominance of the macroinvertebrate community by groups with low pollution sensitivity suggests that the community is under some degree of stress. However, it is known that some of the LT Creek sites have low habitat complexity while others have limited water availability. This may be limiting diversity at some sites. For example, the macroinvertebrate community of WMP20 reflects the clear differences in water quality and habitat at this site. WMP20 is not considered to be an ideal reference site; however there are no other suitable reference sites in the area. Given the differences at this site, it is not recommended that conclusions regarding the impacts of discharge from Newstan Colliery Surface Site are made on the basis of comparison to WMP20.

The overall pattern based on univariate macroinvertebrate metrics at the remaining sites was of improved macroinvertebrate community health at sites closest to the discharge from Newstan LDP001. Richness was higher at sites By-Wash and WMP03 indicating increased diversity at these sites. EPT richness was also generally higher at sites closest to the discharge. Some trends in water quality have also been observed along this gradient; however as levels of potential pollutants such as metals and nutrients were generally highest closer to the discharge, the trend in macroinvertebrates is likely being driven by another factor.

Unlike richness and EPT richness, SIGNAL 2 score was generally lowest at By-Wash (with the exception of WMP20), increasing at WMP03 and SP004 and reducing again slightly at site Weir. This pattern was relatively consistent across the sampling events. This may suggest a smaller number of sensitive taxa at By-Wash or it could mean that any sensitive taxa collected were balanced out in the calculation by taxa with low sensitivity scores. Examination of the raw data for the most spring 2014 sampling event suggests that the latter is likely true. Some moderately to highly sensitive taxa were detected at By-Wash including Calamoceratidae (Caddisfly; SIGNAL 2 score of seven), Acarina (water mite; SIGNAL 2 score of six), Leptoceridae (caddisfly; SIGNAL 2 score of six) and Baetidae (mayfly; SIGNAL 2 score of five) but these were effectively cancelled out in the average SIGNAL 2 score calculation by the highly tolerant taxa that were also collected. Three taxa with a SIGNAL 2 score of five or greater were also collected at Weir in spring 2014 but as no taxa with a SIGNAL 2 score less than two was observed at this site, the result was an overall average that was higher than that of By-Wash. This is the difficulty with interpreting SIGNAL 2 score as the presence of highly tolerant taxa should not be seen to imply that the water quality is poor. Many of those taxa with low SIGNAL 2 scores are generalists and will live at sites with either good or poor water quality.

AUSRIVAS results indicated improved community health at sites closest to the discharge with a general decline in health in a downstream direction along LT Creek. It is noted that AUSRIVAS is designed for application to stream environments rather than dam style environments such as the By-Wash Dam. However, dam environments are generally expected to support less diversity and more tolerant taxa than stream habitats and, therefore, the improved AUSRIVAS score at By-Wash is expected to be fairly dependable in this case.

The indication of improved macroinvertebrate health at sites closest to the discharge would not be expected if there were impacts from the discharge. Improved health, particularly at By-Wash, could be partially due to the greater water availability at sites closest to the discharge. The permanent water source at By-Wash could be providing the opportunity for varied habitat and establishment of long-term populations. Site observations also indicate that habitat availability and heterogeneity is particularly low at SP004 and Weir which could explain the patterns seen in the macroinvertebrates. Further, there is the potential for impacts to SP004 and Weir due to urban pressures which are less evident further upstream.

Multivariate analyses provided similar results with the strongest similarity in community composition often observed between By-Wash and WMP03, particularly in 2013. Community composition at WMP03 in 2014 was more strongly similar to that of SP004. ANOSIM detected significant differences in community composition between sites WMP20 and Weir only. The majority of the taxa observed in high numbers at the reference site WMP20 have low pollution sensitivity which suggests that the community is in poorer health at this site compared to Weir.

Overall, the results of univariate and multivariate analysis indicated improved macroinvertebrate health at sites closest to the Newstan LDP001 discharge. Although water quality is clearly influenced by discharges from Newstan LDP001, there was little difference in water quality observed between impact and recovery sites. The improvements in macroinvertebrate health at By-Wash and WMP03 are most likely a combination of several factors such as habitat and water availability. Regardless of the drivers, the evidence does not suggest a negative influence of the discharge from Newstan Colliery Surface Site on the macroinvertebrate community.

Estuarine macroinvertebrates

The abundance and diversity of benthic macroinvertebrate taxa recorded was low at both the reference and impact site, with the families collected relatively common inhabitants of benthic marine environments. It was observed that there were similar benthic habitats available at both sites with the results reflecting the natural variation found in estuarine benthic macroinvertebrate assemblages.

The low abundance and diversity of benthic macroinvertebrate taxa recorded is likely to be reflective of the position in the upper estuary, limited habitat variation and samples being collected in the intertidal zone, which is subject to periodic tidal exposure, and wash from boats passing by. However, as diversity and abundance was low at both the reference and impact sites, these results do not suggest any impact from water discharge from Newstan LDP001.

4. Ecotoxicology assessments

4.1 Cooranbong Services Site

4.1.1 Toxicity testing

The toxicity testing conducted by ESA in September 2012 on Cooranbong LDP001 discharge fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met. A summary of the results is provided in Table 4-1 (GHD, 2011).

As discussed in Section 2.2.2, statistical analysis of the toxicity testing results provide the concentration of the sample where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibit the specific endpoint of the bioassay and the NOEC, which represents the highest concentration that has no effect upon the test species.

Table 4-1 Summary of ecotoxicology assessment results for Cooranbong LDP001 discharge

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	>100%	>100%	100%
	Reproduction	60.0% (53.5%–63.1%)	100%^	50%
Microalga*	Growth	–	>100%	100%
Shrimp	Survival	84.8% (78.9%–92.2%)	>100%	50%
Duckweed*	Growth	–	>96.8%	96.8%
Fish	Embryonic development	>100%	>100%	100%
	Post-hatch survival	16.1% (9.0%–20.9%)	28.6% (22.3%–35.0%)	25%

^ 95% confidence limits not available.

* EC_{10} result was indeterminable due to stimulation of algal/duckweed growth in the lower concentrations compared to the control.

The results of the toxicity testing of Cooranbong LDP001 discharge presented in Table 4-1 indicate that the discharge was not acutely toxic to the test species. However, chronic toxicity was observed in the fish and cladoceran species. No toxic impacts were found for the other test species.

4.1.2 Water quality analysis

The water quality testing conducted by ALS on the Cooranbong LDP001 discharge sample collected in September 2012 fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met. A summary of the results is presented in Appendix F, along with SSTVs derived for discharge from Cooranbong LDP001 (GHD, 2013a).

Results for electrical conductivity, dissolved cobalt and dissolved nickel were found to exceed SSTVs.

4.1.3 Dilution factor

As only two test species showed a response to the toxicity testing with mine water from Cooranbong LDP001, it was not appropriate to use the BurrliOZ program as effectively there would only be three data points. The data points do not provide a good fit for assessing a species sensitivity distribution due to the number of data points at 100% (i.e. no toxic response). In addition, the log-logistic method for calculating a distribution is not appropriate for this small set of data points.

A professional judgement approach used by the Environmental Research Institute of the Supervising Scientist (R. Van Dam pers. comm.) for determining an appropriate trigger value for mine water discharge was adopted for the ecotoxicology assessment (GHD, 2013b). This approach uses the key toxicant for the most sensitive species to determine an appropriate dilution factor. The most toxic effect was observed to occur in the rainbowfish bioassay for the 100% concentration of mine water discharge. The cause of toxicity to the test species was unable to be determined, however the elevated dissolved nickel concentration may have contributed to the observed toxicity.

The EC_{10} value for the most sensitive bioassay (rainbowfish post-hatch survival) was selected as the species protection value at 16.1% of the mine water discharge, which equates to a dilution factor of 1:6.25. Although this approach is not ideal, it does provide a conservative assessment for downstream species protection where the 95% species protection trigger values are met.

4.1.4 Discussion

The results of the toxicity testing of Cooranbong LDP001 discharge indicate no acute toxicity and slight chronic toxicity to the test species. Chronic toxicity was observed in the cladoceran reproduction bioassay and the rainbowfish post-hatch survival bioassay. However, the sensitive cladoceran species showed no mortalities in 100% concentration of the mine water discharge over the seven day exposure period, even with an electrical conductivity of 4,130 µS/cm and bicarbonate alkalinity concentration of 973 mg/L. The result for bicarbonate alkalinity is slightly below the concentration of 1,186 mg/L reported by Harper *et al.* (2014) as causing 50% mortality in the cladoceran *Ceriodaphnia dubia* in a 48 hour exposure. The observed chronic toxicity may possibly be due to the elevated dissolved nickel concentration, although the electrical conductivity of the sample tested was slightly above the level of 3,500 µS/cm indicated by Dr R. Krassoi (Director of ESA, pers. comm.) that is commonly the threshold for adverse impacts to the sensitive cladoceran test species in laboratory bioassays.

4.2 Newstan Colliery Surface Site

4.2.1 Toxicity testing

The toxicity testing conducted by ESA on Newstan LDP001 discharge in May 2011, April 2012, May 2014 and November 2014 fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met, with the exception of the cladoceran test in April 2012 where the results were slightly outside the reference toxicant criteria (+0.5%).

As discussed in Section 2.2.2, statistical analysis of the toxicity testing results provide the concentration of the sample where 10% (EC_{10}) and 50% (EC_{50}) of test organisms exhibit the specific endpoint of the bioassay and the NOEC, which represents the highest concentration that has no effect upon the test species.

May 2011

A summary of the toxicity testing results from May 2011 is provided in Table 4-2 (GHD, 2011).

Table 4-2 Summary of ecotoxicology assessment results for Newstan LDP001 discharge (May 2011)

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	>100%	>100%	100%
	Reproduction	28.3% (9.3%–34.0%)	78.4%^	25%
Microalga	Growth	54.1% (1.6%–62.2%)	98.9%^	50%
Shrimp	Survival	>100%	>100%	100%
Duckweed	Growth	>96.8%	>96.8%	96.8%
Fish	Embryonic development	58.0%^	81.8% (68.2%–98.0%)	50%
	Post-hatch survival	26.2% (3.1%–36.3%)	37.9% (3.1%–48.1%)	25%

^ 95% confidence limits are not available.

The results of toxicity testing conducted in May 2011 (GHD, 2011) presented in Table 4-2 indicate that the untreated discharge from Newstan LDP001 has low acute and chronic toxicity, with the cladoceran and fish bioassays showing the most sensitivity to the sample.

April 2012

A summary of the toxicity testing results from April 2012 is provided in Table 4-3 (GHD, 2012b).

Table 4-3 Summary of ecotoxicology assessment results for Newstan LDP001 discharge (April 2012)

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	>100%	>100%	100%
	Reproduction	56.1% (13.3%–57.8%)	86.0% (77.8%–90.8%)	50%
Microalga	Growth	>100%	>100%	100%
Shrimp	Survival	>100%	>100%	100%
Duckweed	Growth	>96.8%	>96.8%	96.8%
Chironomid	Survival	>100%	>100%	100%

The results of the toxicity testing conducted in April 2012 (GHD, 2012b) presented in Table 4-3 indicate that the laboratory treated discharge from Newstan LDP001 has slight chronic toxicity, with only the cladoceran reproduction bioassay showing sensitivity to the sample.

May 2014

A summary of the toxicity testing results from May 2014 is provided in Table 4-4 (GHD, 2014).

Table 4-4 Summary of ecotoxicology assessment results for Newstan LDP001 discharge (May 2014)

Bioassay	Endpoint	Concentration (95% confidence limits)		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	>100%	>100%	100%
	Reproduction	9.1%^	81.7%^	50%

^ 95% confidence limits are not available.

The results of the toxicity testing conducted in May 2014 (GHD, 2014) presented in Table 4-4 indicate that the discharge from Newstan LDP001 treated by the CWP has no acute toxicity and slight chronic toxicity.

November 2014

A summary of the toxicity testing results from November 2014 is provided in Table 4-5 (GHD, 2014).

Table 4-5 Summary of ecotoxicology assessment results for Newstan LDP001 discharge (November 2014)

Bioassay	Endpoint	Concentration		
		EC_{10}	EC_{50}	NOEC
Cladoceran	Survival	>100%	>100%	100%
	Reproduction	N/A	>100%	50%
Fish	Survival	N/A	>100%	100%
Shrimp	Survival	>100%	>100%	100%

N/A Results not reliable due to interrupted dose response in sample.

The results of the most recent toxicity testing conducted in November 2014 (GHD, 2014) presented in Table 4-5 indicate that the discharge from Newstan LDP001 treated by the CWP is not acutely or chronically toxic to the test species.

4.2.2 Water quality analysis

A summary of the results of water quality analysis for the Newstan LDP001 discharge samples collected are provided in Appendix F, along with SSTVs derived for discharge from Newstan LDP001 (GHD, 2011).

The water quality testing conducted by ALS on samples collected in May 2011, May 2014 and November 2014 fulfilled the criteria for NATA accredited tests with all quality assurance/quality control parameters being met. For the April 2012 sample of laboratory treated Newstan LDP001 discharge, water quality testing was conducted by Hunter Water Australia Laboratory which is NATA accredited, however no quality assurance/quality control information was available for review.

As shown in Appendix F, the SSTVs for electrical conductivity, dissolved arsenic and dissolved selenium were exceeded in the samples collected in May 2011. GHD (2011) found that the concentrations of these parameters were insufficient to account for the toxicity observed in the bioassays and an unknown toxicant in the untreated sample of Newstan LDP001 discharge was contributing to at least some of the toxicity observed.

The results of testing laboratory treated Newstan LDP001 discharge in April 2012 indicate a reduction in nutrients and a number of dissolved metals compared to results for untreated discharge. No parameters tested in April 2012 were found to exceed SSTVs.

The chemistry of the CWP discharge is similar to that of the laboratory treated discharge, with a reduction in turbidity, electrical conductivity, TSS and metals compared to the results for untreated discharge. None of the parameters analysed in May 2014 for the water treated by the CWP were found to exceed SSTVs.

The SSTV for electrical conductivity was exceeded in both samples collected during the second round of testing of CWP discharge in November 2014. Although the electrical conductivity reported in this round of testing exceeded the SSTV, this did not appear to affect the toxicity of the discharge.

4.2.3 Discussion

DTA testing of untreated Newstan LDP001 discharge in May 2011 was found to be slightly toxic to cladoceran and rainbowfish test species. This toxicity was attributed, in part, to the concentrations of arsenic and selenium found in the discharge. However, the concentrations of these analytes were not considered sufficient to cause all of the observed toxicity. Further, while the toxic effects of metals can be additive, it would be that there was an unknown toxicant in the sample which was contributing to some of the toxicity (GHD, 2011).

The laboratory-treated discharge tested in April 2012 was found to be less toxic than the untreated mine water tested in 2011 (GHD, 2012b). This reduction in toxicity was associated to a reduction in dissolved metals. In particular, concentrations of aluminium, arsenic, boron, molybdenum, lead, nickel, selenium and zinc were found to be substantially reduced compared to the untreated discharge tested in May 2011. The remaining toxicity observed in the cladoceran bioassay was attributed to unknown constituents with a slight contribution from sulfate (GHD, 2012b).

DTA testing in May 2014 found that the treated discharge from the CWP was not acutely toxic to the test species, which was the same for the untreated and laboratory treated discharge. The CWP treated discharge was also found to be slightly less chronically toxic than the untreated discharge tested in 2011 and similar to the laboratory treated discharge tested in 2012, based on the EC_{50} and NOEC results (GHD, 2014).

The results of the second round of toxicity testing of the CWP treated discharge from Newstan LDP001 show the water is not acutely or chronically toxic to the test species. The results indicate that the CWP discharge meets the requirements of Section U3.2 of EPL 395, where the EC_{50} value was found to not exceed a discharge concentration limit of 50% for the following bioassays:

- Cladoceran reproduction test.

- Eastern rainbowfish embryo development and post-hatch survival test.
- Freshwater shrimp survival test.

Water quality monitoring of the discharge through Newstan LDP001 shows that the chemistry of the treated discharge from the CWP is similar to that of the laboratory treated discharge, with a reduction in turbidity, electrical conductivity, TSS and metals compared with untreated discharge.

5. Key Findings

The following outlines the key findings of the seasonal aquatic health monitoring and ecotoxicology assessments:

5.1 Cooranbong Services Site

- A number of analyte concentrations, namely electrical conductivity, potassium, sodium, chloride, alkalinity, sulfate, calcium and magnesium were considered to be possibly associated with mine water discharge from Cooranbong LDP001. However, the concentrations were generally similar to previous monitoring rounds indicating that there is no increasing impact at this time due to mine discharge.
- Some differences in freshwater macroinvertebrate community composition were observed between reference, impact and recovery sites but most of these changes appeared to be attributable to physical differences between the sites.
- The health of the freshwater macroinvertebrate community at impact sites was comparable to reference sites based on diversity, numbers of sensitive taxa and AUSRIVAS results. Therefore, water quality effects from the discharge do not appear to be negatively impacting on the macroinvertebrate community.
- The results of the toxicity testing of Cooranbong LDP001 discharge indicate no acute toxicity and slight chronic toxicity to the test species, possibly due to elevated dissolved nickel concentration or electrical conductivity.

5.2 Newstan Colliery Surface Site

- Water quality monitoring of the discharge through Newstan LDP001 shows that the chemistry of the treated discharge from the CWP has lower toxicity, with a reduction in turbidity, electrical conductivity, TSS and metals compared with untreated discharge.
- No difference was detected in the freshwater or estuarine macroinvertebrate community downstream of the discharge from Newstan LDP001. Results indicate improved macroinvertebrate health at sites closest to the Newstan LDP001 discharge. This is likely due to a combination of factors such as habitat and water availability. Overall, the results of aquatic ecology monitoring does not suggest a negative impact from the Newstan LDP001 discharge on the macroinvertebrate community downstream on LT Creek.
- Discharge through Newstan LDP001 treated by the CWP was not found to be acutely or chronically toxic to test species.

7. References

ANZECC (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, National Water Quality Management Strategy, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Bray J.R., Curtis J.T. (1957): *An ordination of the upland forest communities of Southern Wisconsin*. Ecological Monographies 27:325-349.

Campbell, E., Palmer, M.J., Shao, Q., Warne, M.S. and Wilson, D. (2000), *BurrliOZ: A computer program for calculating toxicant trigger values for the ANZECC and ARMCANZ water quality guidelines*, CSIRO, Perth, Western Australia.

Chessman, B.C. (1995), Rapid assessment of rivers using macroinvertebrates: A procedure based on habitat-specific sampling, family level identification and a biotic index, *Australian Journal of Ecology*, 20(1), 122–129.

Chessman, B.C. (2001), *SIGNAL 2: A Scoring System for Macro-invertebrates ('Water Bugs') in Australian Rivers. User Manual. Version 2*.

Chessman, B.C. (2003), New sensitivity grades for Australian river macroinvertebrates, *Marine and Freshwater Research*, 54(2), 95–104.

Clarke, K. R, and Gorley, R. N, (2006) *PRIMER v6: User Manual/Tutorial. PRIMER-E*, Plymouth

Clarke, K.R. and Warwick, R.M. (2001), *Change in Marine Communities: An Approach to Statistical Analyses and Interpretation: 2nd Edition*, Plymouth Marine Laboratory, Plymouth.

Clifford, H.T. and Stephenson, W (1975) *An introduction to numerical classification,* Academic Press, New York

GHD (2011), *Report for LT Creek Ecotox Study: Ecotoxicological Assessment and Trigger Values*, prepared for Centennial Newstan Pty Limited by GHD Pty Ltd.

GHD (2012a), *Ecotoxicological, sediment, macroinvertebrate and water monitoring procedure: EPL 395*, prepared for Centennial Newstan Pty Ltd by GHD Pty Ltd.

GHD (2012b), *Report for Treated Discharge Water: Ecotoxicology*, prepared for Centennial Newstan Pty Ltd by GHD Pty Ltd.

GHD (2013a), *Surface Water Quality Assessment*, prepared for Centennial Mandalong Pty Limited by GHD Pty Ltd.

GHD (2013b), *Ecotoxicological Assessment: Cooranbong Entry Site*, prepared for Centennial Mandalong Pty Limited by GHD Pty Ltd.

GHD (2014), *Clean Water Treatment Plant: Ecotoxicology Assessment*, prepared for Centennial Newstan Pty Ltd by GHD Pty Ltd.

Harper, D.D., Farag, A.M. and Skaar, D. (2014), Acute toxicity of sodium bicarbonate, a major component of coal bed natural gas produced waters to 13 aquatic species as defined in the laboratory, *Environmental Toxicology and Chemistry*, 33(3), 525–531.

Hawking, J.H. (2000), *Key to Keys. A guide to keys and zoological information to identify invertebrates from Australian inland waters*, Cooperative Research Centre for Freshwater Ecology, Albury.

OECD (2006), *Lemna sp. Growth inhibition test*, Method 221, OECD guideline for the testing of chemicals, Organisation for Economic Cooperation and Development.

Plafkin, J.L., Barbour, M.T., Porter, K.D., Gross S.K. and Hughes R.M. (1989), *Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and fish*, U.S. Environmental Protection Agency, Office of Water Regulations and Standards, Washington, D.C.

Quinn, G.P. and Keough, M.J. (2002) *Experimental Design and Data Analysis for Biologists*.

Turak, E., Waddell, N. and Johnstone. G. (2004), *New South Wales (NSW) Australian River Assessment System (AUSRIVAS) Sampling Processing Manual*.

StatSoft Inc. (2013), *Electronic Statistics Textbook*, Tulsa, OK: StatSoft. WEB: http://www.statsoft.com/textbook/.

USEPA (1996), *Ecological Effect Test Guidelines*, OPPTS 850.1045, Panaeid Acute Toxicity Test, public draft, United States Environmental Protection Agency.

USEPA (2002), *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, fourth edition, United States Environmental Protection Agency.

Appendices

Appendix A – Aquatic ecology monitoring locations

Table A-1 Cooranbong Services Site – Aquatic ecology monitoring locations

Site ID	Location	Site type	Water type	Latitude	Longitude
SW013	Unnamed creek upstream of site	Reference	Freshwater	-33.057570	151.509670
SW014	Unnamed creek upstream of site	Reference	Freshwater	-33.053067	151.508677
SW015	Unnamed creek upstream of site	Reference	Freshwater	-33.050229	151.496717
CCSC1	Jigadee Creek at Newport Road	Reference	Freshwater	-33.071481	151.469781
SW001	Unnamed creek at Cooranbong LDP001	On-site impact	Freshwater	-33.057082	151.501887
SW002	Unnamed creek at Cooranbong LDP002	On-site impact	Freshwater	-33.058430	151.503637
CCSR1	Unnamed creek at Simpson Road downstream of site	Downstream impact	Freshwater	-33.061766	151.504433
SW016	Muddy Lake downstream of site	Downstream recovery	Freshwater	-33.071545	151.499630
SW017	Muddy Lake at Wangi Road downstream of site	Downstream recovery	Freshwater	-33.079449	151.503607

Table A-2 Newstan Colliery Surface Site – Aquatic ecology monitoring locations

Site ID	Location	Site type	Water type	Latitude	Longitude
WMP19-US	Stony Creek upstream of Newstan LDP017	Reference	Freshwater	-32.995425	151.570005
WMP20	Stony Creek upstream of Newstan LDP017	Reference	Freshwater	-32.993662	151.568724
SCCIZ	Stony Creek upstream of discharge to Lake Macquarie	Reference	Estuarine	-33.006660	151.590395
Ref1	Reference site on Lake Macquarie shore north-east of LT Creek	Reference	Estuarine	-32.982077	151.618762
By-Wash	Main By-Wash Dam downstream of Newstan LDP001 discharges	On-site impact	Freshwater	-32.972704	151.571159
WMP03	LT Creek downstream of By-Wash	On-site impact	Freshwater	-32.973719	151.573522
SP003	LT Creek downstream of WMP03	Downstream impact	Freshwater	-32.978570	151.577338
SP004	LT Creek downstream of SP003	Downstream impact	Freshwater	-32.982793	151.580268
WMP19-DS	Stony Creek downstream of Newstan LDP017	Downstream impact	Freshwater	-32.999025	151.570955
Weir	LT Creek at Macquarie Road	Downstream recovery	Freshwater	-32.984852	151.584074
IZ	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.991455	151.592579
LT1*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.993532	151.590697

Site ID	Location	Site type	Water type	Latitude	Longitude
LT2*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.993608	151.591104
LT3*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.994007	151.591556
LT4*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.993917	151.591881
LT5*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.993334	151.591593
LT6*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.992956	151.591684
LT7*	LT Creek upstream of discharge to Lake Macquarie	Downstream recovery	Estuarine	-32.994308	151.592885

* Approximate latitude and longitude only

Appendix B – Ecotoxicology testing concentrations tested

Table B-1 Summary of concentrations of mine water discharge used in ecotoxicology testing

Sample		Bioassay	Diluent	Concentrations tested (% discharge)							
Cooranbong Services Site											
Cooranbong LDP001 discharge	September 2012	Cladoceran	Dilute mineral water	0	3.1	6.3	12.5	25	50	100	
		Microalga	USEPA media	0	3.1	6.3	12.5	25	50	100	
		Shrimp	Dilute mineral water	0	3.1	6.3	12.5	25	50	100	
		Duckweed	Swedish standard medium	0	3.1	6.1	12.1	24.2	48.4	96.8	
		Fish	Dilute mineral water	0	3.1	6.3	12.5	25	50	100	
Newstan Colliery Surface Site											
Untreated Newstan LDP001 discharge	May 2011	Cladoceran	Dilute mineral water	0	3.1	6.3	12.5	25	50	100	
		Microalga	USEPA media	0	1.6	3.1	6.3	12.5	25	50	100
		Shrimp	Dilute mineral water	0	3.1	6.3	12.5	25	50	100	
		Duckweed	Swedish standard medium	0	1.6	3.1	6.1	12.1	24.2	48.4	96.8
		Fish	Dilute mineral water	0	3.1	6.3	12.5	25	50	100	
Laboratory treated Newstan LDP001 discharge	April 2012	Cladoceran	Dilute mineral water	0	6.3	12.5	25	50	100		
		Microalga	USEPA media	0	6.3	12.5	25	50	100		
		Shrimp	Dilute mineral water	0	6.3	12.5	25	50	100		
		Duckweed	Swedish standard medium	0	6.1	12.1	24.2	48.4	96.8		
		Chironomid	Dilute mineral water	0	6.3	12.5	25	50	100		

Sample		Bioassay	Diluent	Concentrations tested (% discharge)						
CWP treated Newstan LDP001 discharge	May 2014	Cladoceran	Dilute mineral water	0	3.1	6.3	12.5	25	50	100
CWP treated Newstan LDP001 discharge	November 2014	Cladoceran	Dilute mineral water	0	3.1	6.3	12.5	25	50	100
		Shrimp	Dilute mineral water	0	3.1	6.3	12.5	25	50	100
		Fish	Dilute mineral water	0	3.1	6.3	12.5	25	50	100

Appendix C – Aquatic ecology water quality results

C.1 Cooranbong Services Site

C.1.1 *In situ* water quality monitoring

Table C-1 Results of *in situ* water quality monitoring at reference monitoring sites at Cooranbong Services Site

Parameter	Units	SSTVs (GHD, 2013a)	SW013		SW014		SW015	CCSC1		
			Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Time	24 hr	N/A	12:59	10:50	13:32	08:00	12:51	12:53	11:53	13:40
Temperature	°C	N/A	11.7	18.6	18.5	14.3	19.2	12.7	19.7	14.2
Electrical conductivity	µS/cm	2,200	1,409	**5,260**	461	481#	70	405	492	327#
pH	pH unit	6.5–9.0	6.80	**3.68**	7.87	6.78	7.54	7.24	**5.94**	**6.32**
DO	mg/L	N/A	5.29	2.84	1.08	2.36	1.73	7.52	4.06	2.16
DO	% sat.	85–110	**48.5**	**30.4***	**11.4**	**23.0***	**18.9**	**69.7**	**44.4***	**21.0***
Turbidity	NTU	56	**91.6**	0.3	34.1	35.9	**753**	14.7	2.1	32.9
Alkalinity	mg/L	N/A	60	<1	93	80^	3.5	22	47	22^

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

Electrical conductivity values were measured by laboratory analysis due to a faulty probe on the water quality meter.

* DO (% saturation) values calculated from DO (mg/L) and temperature values. As such, DO values are indicative only.

^ Alkalinity values were measured by laboratory analysis.

Table C-2 Results of *in situ* water quality monitoring at on-site and downstream impact monitoring sites at Cooranbong Services Site

Parameter	Units	SSTVs (GHD, 2013a)	SW001				SW002		CCSR1			
			Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Time	24 hr	N/A	10:23	14:14	11:32	10:00	10:35	15:08	14:31	9:55	15:06	8:00
Temperature	°C	N/A	16.6	21.9	17.9	20.2	15.6	27.8	15.3	21.6	21.3	17.4
Electrical conductivity	µS/cm	2,200	**3,842**	**3,840**	1,215	**4,580#**	**3,474**	548	**3,326**	**3,720**	**3,281**	**4,370#**
pH	pH unit	6.5–9.0	8.45	7.13	8.37	7.83	8.77	**6.36**	8.82	8.07	7.81	8.24
DO	mg/L	N/A	7.20	5.15	1.19	6.86	8.81	5.06	9.26	8.81	6.30	4.85
DO*	% sat.	85–110	**74.1**	**58.8***	**11.2**	**75.7***	88.1	**64.4***	92.3	100.0*	**72.2**	**50.6***
Turbidity	NTU	56	22.1	21.9	15.8	**80.4**	18.7	44.7	16.6	3.1	42.5	10.5
Alkalinity	mg/L	N/A	690	910	138	1,290^	340	110	410	857	99	1,040^

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

Electrical conductivity values were measured by laboratory analysis due to a faulty probe on the water quality meter.

* DO (% saturation) values calculated from DO (mg/L) and temperature values. As such, DO values are indicative only.

^ Alkalinity values were measured by laboratory analysis.

Table C-3 Results of *in situ* water quality monitoring at downstream recovery monitoring sites at Cooranbong Services Site

Parameter	Units	SSTVs (GHD, 2013a)	SW016		SW017			
			Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Time	24 hr	N/A	09:26	12:00	8:20	12:01	11:01	13:15
Temperature	°C	N/A	21.3	23.8	12.3	24.5	22.7	20.6
Electrical conductivity	µS/cm	2,200	**3,069**	**3,630#**	1,751	**4,820**	1,921	1,590#
pH	pH unit	6.5–9.0	8.52	7.90	8.52	8.06	8.96	7.19
DO	mg/L	N/A	3.75	9.64	6.76	10.18	5.53	2.51
DO*	% sat.	85–110	**42.1**	**114.1***	**63.2**	**122.1***	**65.1**	**27.9***
Turbidity	NTU	56	6.04	42.8	12.1	14.9	9.98	**77.7**
Alkalinity	mg/L	N/A	240	205^	195	536	274	145^

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

Electrical conductivity values were measured by laboratory analysis due to a faulty probe on the water quality meter.

* DO (% saturation) values calculated from DO (mg/L) and temperature values. As such, DO values are indicative only.

^ Alkalinity values were measured by laboratory analysis.

C.1.2 Laboratory analysed water quality monitoring

Table C-4 Results of laboratory water quality analysis at reference monitoring sites at Cooranbong Services Site

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW013		SW014		SW015	CCSC1		
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Physicochemical parameters											
TDS	mg/L	10.0	N/A	268	5,130	296	304	277	254	272	230
TSS	mg/L	5	50	6	<5	8	<5	**80**	5	<5	**100**
Nutrients											
Ammonia as N	mg/L	0.01	0.9	–	0.02	<0.01	<0.01	0.02	–	0.05	<0.01
Nitrate as N	mg/L	0.01	N/A	–	<0.01	<0.01	<0.01	0.01	–	0.04	0.02
Nitrite as N	mg/L	0.01	N/A	–	<0.01	<0.01	<0.01	<0.01	–	<0.01	0.02
Nitrite + nitrate as N	mg/L	0.01	N/A	0.02	<0.01	<0.01	<0.01	0.01	0.05	0.04	0.8
TKN	mg/L	0.1	N/A	0.7	0.3	0.9	0.5	1.6	0.5	0.6	0.8
Total nitrogen	mg/L	0.1	1.3	0.7	0.3	0.9	0.5	**1.6**	0.6	0.6	0.05
Total phosphorus	mg/L	0.01	0.1	0.04	<0.01	0.03	0.02	0.08	0.04	0.03	0.04
Anions											
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	48	<1	92	80	8	32	47	22
Total alkalinity $CaCO_3$	mg/L	1	N/A	48	<1	92	80	8	32	47	22

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW013		SW014		SW015	CCSC1		
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Chloride	mg/L	1	N/A	57	626	72	77	12	110	110	77
Sulfate	mg/L	1	N/A	33	2,460	16	30	10	13	5	14
Cations											
Calcium	mg/L	1	N/A	11	278	10	10	2	6	6	4
Magnesium	mg/L	1	N/A	11	353	12	12	2	10	9	6
Potassium	mg/L	1	N/A	3	27	4	4	2	4	4	4
Sodium	mg/L	1	N/A	40	750	63	64	12	61	70	45
Dissolved metals											
Aluminium	mg/L	0.01	1.97	1.36	**2.78**	–	0.12	–	0.14	0.04	0.07
Arsenic	mg/L	0.001	0.024	<0.001	<0.01	–	<0.001	–	<0.001	<0.001	<0.001
Barium	mg/L	0.001	0.02	–	**0.079**	–	0.016	–	–	**0.035**	**0.029**
Beryllium	mg/L	0.001	N/A	<0.001	–	–	–	–	<0.001	–	–
Boron	mg/L	0.05	0.37	0.06	–	–	–	–	0.10	–	–
Cadmium	mg/L	0.0001	0.0008	<0.0001	0.0001	–	<0.0001	–	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0037	0.001	<0.001	–	<0.001	–	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	0.001	<0.001	**0.707**	–	<0.001	–	<0.001	**0.002**	0.001

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW013		SW014		SW015	CCSC1		
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Copper	mg/L	0.001	0.00546	0.001	0.003	–	0.001	–	<0.001	0.002	<0.001
Iron	mg/L	0.05	2.58	1.45	**10.0**	–	0.63	–	**2.77**	1.40	0.83
Lead	mg/L	0.001	0.02584	0.001	0.004	–	<0.001	–	<0.001	<0.001	<0.001
Lithium	mg/L	0.001	N/A	0.008	–	–	–	–	0.003	–	–
Manganese	mg/L	0.001	1.9	0.024	**10.1**	–	0.018	–	0.063	0.515	0.190
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	–	<0.0001	–	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	<0.001	–	–	–	–	<0.001	–	–
Nickel	mg/L	0.001	0.0429	0.002	**1.17**	–	<0.001	–	<0.001	0.002	<0.001
Selenium	mg/L	0.01	0.011	<0.01	–	–	–	–	<0.01	–	–
Silver	mg/L	0.001	0.001	<0.001	–	–	–	–	<0.001	–	–
Vanadium	mg/L	0.01	N/A	<0.01	–	–	–	–	<0.01	–	–
Zinc	mg/L	0.005	0.0312	0.023	**1.61**	–	0.016	–	0.016	0.012	0.024
Total metals											
Aluminium	mg/L	0.01	N/A	–	–	0.52	–	13.1	–	–	–
Arsenic	mg/L	0.001	N/A	–	–	0.002	–	0.002	–	–	–
Barium	mg/L	0.001	N/A	–	–	0.023	–	0.052	–	–	–

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW013		SW014		SW015	CCSC1		
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Cadmium	mg/L	0.0001	N/A	–	–	<0.0001	–	<0.0001	–	–	–
Chromium	mg/L	0.001	N/A	–	–	0.001	–	0.009	–	–	–
Cobalt	mg/L	0.001	N/A	–	–	0.002	–	0.002	–	–	–
Copper	mg/L	0.001	N/A	–	–	<0.001	–	0.005	–	–	–
Iron	mg/L	0.05	N/A	–	–	4.92	–	12.8	–	–	–
Lead	mg/L	0.001	N/A	–	–	<0.001	–	0.008	–	–	–
Manganese	mg/L	0.001	N/A	–	–	0.107	–	0.107	–	–	–
Mercury	mg/L	0.0001	N/A	–	–	<0.0001	–	<0.0001	–	–	–
Nickel	mg/L	0.001	N/A	–	–	0.002	–	0.004	–	–	–
Zinc	mg/L	0.005	N/A	–	–	<0.005	–	0.023	–	–	–
Other parameters											
Silica	mg/L	0.1	N/A	19.0	–	–	–	–	15.9	–	–
Total hardness as $CaCO_3$*	mg/L	1	N/A	73	–	–	–	–	56	–	–
TOC	mg/L	1	N/A	18	6	31	19	24	9	12	15

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

* Estimated based on magnesium and calcium.

Table C-5 Results of laboratory water quality analysis at on-site and downstream impact monitoring sites at Cooranbong Services Site

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW001				SW002		CCSR1			
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Physicochemical parameters													
TDS	mg/L	10.0	N/A	2,290	2,120	298	2,350	1,960	263	1,920	2,070	2,240	2,440
TSS	mg/L	5	50	9	6	18	<5	5	19	6	<5	6	<5
Nutrients													
Ammonia as N	mg/L	0.01	0.9	–	0.51	0.12	0.80	–	<0.01	–	<0.01	0.01	0.04
Nitrate as N	mg/L	0.01	N/A	–	0.28	0.05	0.04	–	<0.01	–	0.45	0.01	0.28
Nitrite as N	mg/L	0.01	N/A	–	<0.01	<0.01	<0.01	–	<0.01	–	<0.01	<0.01	0.02
Nitrite + nitrate as N	mg/L	0.01	N/A	0.49	0.28	0.05	0.04	0.56	<0.01	0.43	0.45	0.01	0.30
TKN	mg/L	0.1	N/A	0.7	0.8	1.0	0.9	0.4	0.7	1.5	0.3	0.3	0.3
Total nitrogen	mg/L	0.1	1.3	1.2	1.1	1.0	0.9	1.0	0.7	**1.9**	0.8	0.3	0.6
Total phosphorus	mg/L	0.01	0.1	<0.01	0.01	0.09	<0.01	0.02	<0.01	0.08	**0.55**	0.01	<0.01
Anions													
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	842	910	128	1,290	703	98	662	842	109	1,040
Total alkalinity $CaCO_3$	mg/L	1	N/A	842	910	128	1,290	703	110	691	857	109	1,040

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW001				SW002		CCSR1			
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Chloride	mg/L	1	N/A	757	626	60	713	651	66	655	640	406	669
Sulfate	mg/L	1	N/A	201	223	19	199	170	28	165	230	920	374
Cations													
Calcium	mg/L	1	N/A	73	65	18	43	58	17	58	48	142	71
Magnesium	mg/L	1	N/A	58	56	7	40	48	5	49	56	150	58
Potassium	mg/L	1	N/A	24	24	5	17	22	3	20	24	17	16
Sodium	mg/L	1	N/A	788	735	71	949	700	72	683	751	420	885
Dissolved metals													
Aluminium	mg/L	0.01	1.97	0.03	0.01	–	0.01	0.31	0.05	0.40	0.01	–	0.04
Arsenic	mg/L	0.001	0.024	0.001	0.005	–	0.002	<0.001	<0.001	<0.001	0.003	–	0.001
Barium	mg/L	0.001	0.02	–	**0.155**	–	**0.180**	–	**0.049**	–	**0.134**	–	**0.124**
Beryllium	mg/L	0.001	N/A	<0.001	–	–	–	<0.001	–	<0.001	–	–	–
Boron	mg/L	0.05	0.37	0.27	–	–	–	0.22	–	0.23	–	–	–
Cadmium	mg/L	0.0001	0.0008	<0.0001	<0.0001	–	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	–	<0.0001
Chromium	mg/L	0.001	0.0037	<0.001	<0.001	–	<0.001	<0.001	<0.001	<0.001	<0.001	–	<0.001
Cobalt	mg/L	0.001	0.001	**0.004**	**0.009**	–	<0.001	**0.004**	<0.001	**0.003**	**0.010**	–	**0.018**

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW001				SW002		CCSR1			
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Copper	mg/L	0.001	0.00546	<0.001	<0.001	–	<0.001	<0.001	0.002	<0.001	<0.001	–	0.001
Iron	mg/L	0.05	2.58	1.62	0.17	–	0.06	1.10	0.20	0.84	0.06	–	<0.05
Lead	mg/L	0.001	0.02584	<0.001	<0.001	–	<0.001	<0.001	<0.001	<0.001	<0.001	–	<0.001
Lithium	mg/L	0.001	N/A	0.219	–	–	–	0.163	–	0.168	–	–	–
Manganese	mg/L	0.001	1.9	0.039	0.050	–	0.088	0.047	0.050	0.030	0.014	–	0.450
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	–	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	–	<0.0001
Molybdenum	mg/L	0.001	N/A	0.016	–	–	–	0.016	–	0.012	–	–	–
Nickel	mg/L	0.001	0.0429	0.037	**0.055**	–	0.039	0.034	0.007	0.031	**0.054**	–	**0.074**
Selenium	mg/L	0.01	0.011	<0.01	–	–	–	<0.01	–	<0.01	–	–	–
Silver	mg/L	0.001	0.001	<0.001	–	–	–	<0.001	–	<0.001	–	–	–
Vanadium	mg/L	0.01	N/A	<0.01	–	–	–	<0.01	–	<0.01	–	–	–
Zinc	mg/L	0.005	0.0312	0.015	<0.005	–	0.006	0.010	0.014	0.008	0.015	–	0.041
Total metals													
Aluminium	mg/L	0.01	N/A	–	–	0.57	–	–	–	–	–	0.03	–
Arsenic	mg/L	0.001	N/A	–	–	0.003	–	–	–	–	–	<0.001	–
Barium	mg/L	0.001	N/A	–	–	0.076	–	–	–	–	–	0.119	–

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW001				SW002		CCSR1			
				Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Cadmium	mg/L	0.0001	N/A	–	–	<0.0001	–	–	–	–	–	<0.0001	–
Chromium	mg/L	0.001	N/A	–	–	<0.001	–	–	–	–	–	0.006	–
Cobalt	mg/L	0.001	N/A	–	–	<0.001	–	–	–	–	–	0.012	–
Copper	mg/L	0.001	N/A	–	–	0.001	–	–	–	–	–	<0.001	–
Iron	mg/L	0.05	N/A	–	–	1.69	–	–	–	–	–	0.18	–
Lead	mg/L	0.001	N/A	–	–	<0.001	–	–	–	–	–	<0.001	–
Manganese	mg/L	0.001	N/A	–	–	0.459	–	–	–	–	–	1.22	–
Mercury	mg/L	0.0001	N/A	–	–	<0.0001	–	–	–	–	–	<0.0001	–
Nickel	mg/L	0.001	N/A	–	–	0.004	–	–	–	–	–	0.145	–
Zinc	mg/L	0.005	N/A	–	–	0.007	–	–	–	–	–	0.142	–
Other parameters													
Silica	mg/L	0.1	N/A	14.6	–	–	–	12.8	–	13.0	–	–	–
Total hardness as $CaCO_3$*	mg/L	1	N/A	421	–	–	–	342	–	347	–	–	–
TOC	mg/L	1	N/A	1	1	21	3	2	11	5	<1	9	5

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

* Estimated based on magnesium and calcium.

Table C-6 Results of laboratory water quality analysis at downstream recovery monitoring sites at Cooranbong Services Site

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW016		SW017			
				Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Physicochemical parameters									
TDS	mg/L	10.0	N/A	1,620	304	966	2,510	960	716
TSS	mg/L	5	50	14	<5	12	16	9	7
Nutrients									
Ammonia as N	mg/L	0.01	0.9	0.02	<0.01	–	<0.01	<0.01	0.02
Nitrate as N	mg/L	0.01	N/A	<0.01	<0.01	–	<0.01	<0.01	<0.01
Nitrite as N	mg/L	0.01	N/A	<0.01	<0.01	–	<0.01	<0.01	<0.01
Nitrite + nitrate as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TKN	mg/L	0.1	N/A	0.9	0.5	1.4	1.0	1.1	1.4
Total nitrogen	mg/L	0.1	1.3	0.9	0.5	**1.4**	1.0	1.1	**1.4**
Total phosphorus	mg/L	0.01	0.1	0.03	0.02	**0.12**	0.04	0.07	**0.15**
Anions									
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	230	80	210	323	242	145
Total alkalinity $CaCO_3$	mg/L	1	N/A	246	80	210	536	267	145
Chloride	mg/L	1	N/A	685	77	461	999	420	415

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW016		SW017			
				Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Sulfate	mg/L	1	N/A	170	30	69	264	64	99
Cations									
Calcium	mg/L	1	N/A	42	10	24	23	22	25
Magnesium	mg/L	1	N/A	72	12	34	82	36	35
Potassium	mg/L	1	N/A	18	4	13	30	12	14
Sodium	mg/L	1	N/A	518	64	345	898	344	280
Dissolved metals									
Aluminium	mg/L	0.01	1.97	–	0.12	0.05	0.02	–	0.02
Arsenic	mg/L	0.001	0.024	–	<0.001	<0.001	0.001	–	0.001
Barium	mg/L	0.001	0.02	–	**0.160**	–	**0.042**	–	**0.062**
Beryllium	mg/L	0.001	N/A	–	–	<0.001	–	–	–
Boron	mg/L	0.05	0.37	–	–	0.11	–	–	–
Cadmium	mg/L	0.0001	0.0008	–	<0.0001	<0.0001	<0.0001	–	<0.0001
Chromium	mg/L	0.001	0.0037	–	<0.001	<0.001	<0.001	–	<0.001
Cobalt	mg/L	0.001	0.001	–	<0.001	<0.001	<0.001	–	<0.001
Copper	mg/L	0.001	0.00546	–	0.001	<0.001	0.002	–	<0.001

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW016		SW017			
				Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Iron	mg/L	0.05	2.58	–	0.63	0.31	<0.05	–	<0.05
Lead	mg/L	0.001	0.02584	–	<0.001	<0.001	<0.001	–	<0.001
Lithium	mg/L	0.001	N/A	–	–	0.038	–	–	–
Manganese	mg/L	0.001	1.9	–	0.018	0.045	0.006	–	0.016
Mercury	mg/L	0.0001	0.0006	–	<0.0001	<0.0001	<0.0001	–	<0.0001
Molybdenum	mg/L	0.001	N/A	–	–	0.002	–	–	–
Nickel	mg/L	0.001	0.0429	–	<0.001	0.011	0.026	–	0.002
Selenium	mg/L	0.01	0.011	–	–	<0.01	–	–	–
Silver	mg/L	0.001	0.001	–	–	<0.001	–	–	–
Vanadium	mg/L	0.01	N/A	–	–	<0.01	–	–	–
Zinc	mg/L	0.005	0.0312	–	0.016	0.007	0.012	–	**0.054**
Total metals									
Aluminium	mg/L	0.01	N/A	0.22	–	–	–	0.22	–
Arsenic	mg/L	0.001	N/A	0.001	–	–	–	<0.001	–
Barium	mg/L	0.001	N/A	0.116	–	–	–	0.057	–
Cadmium	mg/L	0.0001	N/A	<0.0001	–	–	–	<0.0001	–

Parameter	Units	LOR	SSTV (GHD, 2013a)	SW016		SW017			
				Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Chromium	mg/L	0.001	N/A	<0.001	–	–	–	<0.001	–
Cobalt	mg/L	0.001	N/A	<0.001	–	–	–	<0.001	–
Copper	mg/L	0.001	N/A	<0.001	–	–	–	<0.001	–
Iron	mg/L	0.05	N/A	0.20	–	–	–	0.36	–
Lead	mg/L	0.001	N/A	<0.001	–	–	–	<0.001	–
Manganese	mg/L	0.001	N/A	0.048	–	–	–	0.013	–
Mercury	mg/L	0.0001	N/A	<0.0001	–	–	–	<0.0001	–
Nickel	mg/L	0.001	N/A	0.007	–	–	–	0.008	–
Zinc	mg/L	0.005	N/A	<0.005	–	–	–	<0.005	–
Other parameters									
Silica	mg/L	0.1	N/A	–	–	2.3	–	–	–
Total hardness as $CaCO_3$*	mg/L	1	N/A	–	–	200	–	–	–
TOC	mg/L	1	N/A	19	19	12	<1	23	20

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

* Estimated based on magnesium and calcium.

C.2 Newstan Colliery Surface Site

C.2.1 *In situ* water quality monitoring

Freshwater sites

Table C-7 Results of *in situ* water quality monitoring at freshwater reference monitoring sites at Newstan Colliery Surface Site

Parameter	Units	SSTVs (GHD, 2011)	WMP19-US	WMP20		
			Summer 2013	Autumn 2011#	Autumn 2014	Spring 2014
Time	24 hr	N/A	14:50	–	11:57	08:15
Temperature	°C	N/A	21.8	14.8	18.3	13.9
Electrical conductivity	µS/cm	2,200	181.5	64.4	178.7	320.3
pH	pH unit	6.5–8.5	**6.21**	**5.51**	7.62	6.82
DO	mg/L	N/A	3.91	11.21*	3.91	3.71
DO	% sat.	85–110	**44.5**	**110.6**	**41.5**	**35.9**
Turbidity	NTU	50	**80.8**	**370~**	**133.1**	**62.5**
Alkalinity^	mg/L	N/A	21	9	56	29

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

Unreliable results taken following high rainfall.

* DO (mg/L) results calculated from DO (% saturation), temperature and electrical conductivity values. As such, DO values are indicative only.

~ Turbidity value was measured by laboratory analysis.

^ Alkalinity values were measured by laboratory analysis.

Table C-8 Results of *in situ* water quality monitoring at freshwater on-site impact monitoring site By-Wash at Newstan Colliery Surface Site

Parameter	Units	SSTVs (GHD, 2011)	By-Wash							
			Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Time	24 hr	N/A	11:19	–	12:40	14:06	11:00	09:30	11:36	12:40
Temperature	°C	N/A	20.7	23.1	26.4	21.8	21.6	25.6	22.1	23.1
Electrical conductivity	µS/cm	2,200	**2,540**	1,600	**2,330**	**2,470**	**2,290**	**2,252**	**2,730**	**2,327**
pH	pH unit	6.5–8.5	7.01	7.51	7.87	8.18	8.33	8.45	7.65	8.50
DO	mg/L	N/A	8.40	7.83*	13.28	9.24	6.88	7.33	6.34	11.21
DO	% sat.	85–110	93.1	91.5	**165.3**	103.0	**59.5**	90.2	**72.6**	**131.1**
Turbidity	NTU	50	9.4~	5.4	14.2	4.2	0.5	0.0	3.3	9.3
Alkalinity	mg/L	N/A	652^	684^	574^	500	612^	556^	496^	695^

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

* DO (mg/L) results calculated from DO (% saturation) and temperature values. As such, DO values are indicative only.

~ Turbidity value was measured by laboratory analysis.

^ Alkalinity values were measured by laboratory analysis.

Table C-9 Results of *in situ* water quality monitoring at freshwater on-site impact monitoring site WMP03 at Newstan Colliery Surface Site

Parameter	Units	SSTVs (GHD, 2011)	WMP03							
			Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Time	24 hr	N/A	13:00	–	14:55	11:42	12:46	10:28	13:45	10:15
Temperature	°C	N/A	16.2	26.0	28.9	19.3	24.1	25.7	22.4	21.3
Electrical conductivity	µS/cm	2,200	**2,440**	**2,370**	**2,310**	**2,210**	**2,350**	**2,258**	**2,350**	**2,282**
pH	pH unit	6.5–8.5	7.87	7.60	8.48	8.45	8.25	8.50	8.28	**8.53**
DO	mg/L	N/A	9.97	5.35*	9.82	7.84	6.29	7.50	10.06	7.96
DO	% sat.	85–110	101.6	**65.9**	**148.4**	**86.0**	**54.4**	92.5	**115.9**	90.2
Turbidity	NTU	50	6.2~	3.2	2.4	0.7	0.5	1.9	2.9	2.5
Alkalinity	mg/L	N/A	614^	673^	571^	500	616^	553^	502^	648^

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

* DO (mg/L) results calculated from DO (% saturation) and temperature values. As such, DO values are indicative only.

~ Turbidity value was measured by laboratory analysis.

^ Alkalinity values were measured by laboratory analysis.

Table C-10 Results of *in situ* water quality monitoring at freshwater downstream impact monitoring sites at Newstan Colliery Surface Site

Parameter	Units	SSTVs (GHD, 2011)	SP003		SP004							WMP19-DS
			Autumn 2011	Summer 2012	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014	Summer 2013
Time	24 hr	N/A	14:30	–	–	8.20	9.07	12.40	11.20	9.05	8.15	13.45
Temperature	°C	N/A	15.4	24.0	25.1	22.1	16.8	20.7	24.5	20.7	20.6	21.5
Electrical conductivity	µS/cm	2,200	**2,370**	1,605	**2,440**	1,850	2,190	**2,328**	2,197	2,060	1,940	302.0
pH	pH unit	6.5–8.5	8.07	8.13	8.28	7.22	**8.62**	8.33	**8.57**	8.38	**8.56**	**5.65**
DO	mg/L	N/A	10.20	4.66*	7.55*	13.52	8.86	7.87	7.38	8.29	7.73	1.65
DO	% sat.	85–110	102.1	**55.3**	91.6	**155.4**	91.0	**68.0**	89.0	92.4	86.3	**18.7***
Turbidity	NTU	50	**151~**	7.6	0.4	33.2	0.4	0.2	0.0	4.9	21.9	**83.2**
Alkalinity	mg/L	N/A	9^	673^	676^	458^	600	616^	554^	535^	656^	17^

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

* DO (mg/L) results calculated from DO (% saturation) and temperature values. DO (% saturation) results calculated from DO (mg/L) and temperature values. As such, DO values are indicative only.

~ Turbidity value was measured by laboratory analysis.

^ Alkalinity values were measured by laboratory analysis.

Table C-11 Results of *in situ* water quality monitoring at freshwater downstream recovery monitoring site Weir at Newstan Colliery Surface Site

Parameter	Units	SSTVs (GHD, 2011)	Weir						
			Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Time	24 hr	N/A	–	10:15	13:56	10:30	11:52	14:00	10:15
Temperature	°C	N/A	20.7	21.9	18.5	19.2	24.0	21.6	20.6
Electrical conductivity	µS/cm	2,200	**2,400**	1,650	**2,560**	**2,380**	2,177	2,060	**2,288**
pH	pH unit	6.5–8.5	8.50	7.58	**8.71**	**8.86**	**8.59**	**8.52**	**8.59**
DO	mg/L	N/A	7.72*	10.96	7.32	5.62	6.50	7.56	6.87
DO	% sat.	85–110	86.1	**126.1**	**76**	**48.6**	**77.7**	85.8	**76.7**
Turbidity	NTU	50	1.2	45.7	9.3	0.3	0.0	21.6	**72.1**
Alkalinity	mg/L	N/A	673^	410^	600	608^	549^	537^	665^

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

* DO (mg/L) results calculated from DO (% saturation) and temperature values. As such, DO values are indicative only.

^ Alkalinity values were measured by laboratory analysis.

Estuarine sites

Table C-12 Results of *in situ* water quality monitoring at estuarine reference monitoring site SSCIZ at Newstan Colliery Surface Site

Parameter	Units	DTVs (ANZECC, 2000)	SSCIZ	
			Autumn 2014	Spring 2014
Time	24 hr	N/A	08:36	09:35
Temperature	°C	N/A	25.0	17.4
Electrical conductivity	µS/cm	N/A	40,900	29,229
pH	pH unit	7.0–8.5	**6.75**	7.50
DO	mg/L	N/A	3.16	5.58
DO	% sat.	80–110	**38.2**	**65.1**
Turbidity	NTU	0.5–10	5.7	**26.9**
Alkalinity^	mg/L	N/A	101	160

Results highlighted in **orange bold** exceed the ANZECC (2000) DTVs.

^ Alkalinity values were measured by laboratory analysis.

Table C-13 Results of *in situ* water quality monitoring at estuarine downstream recovery monitoring sites at Newstan Colliery Surface Site

Parameter	Units	DTVs (ANZECC, 2000)	IZ						LT1	LT2	LT3	LT4	LT5	LT6	LT7
			Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012
Time	24 hr	N/A	12:15	11:48	7:15	12:30	10:06	08:15	–	–	–	–	–	–	–
Temperature	°C	N/A	29.0	19.9	21.7	27.7	23.8	14.7	24.9	26.7	25.5	26.5	27.2	28.0	28.8
Electrical conductivity	µS/cm	N/A	42,800	35,100	36,000	41,032	41,600	10,602	48,000	48,400	46,400	42,200	37,700	11,800	–
pH	pH unit	7.0–8.5	7.83	7.93	7.92	7.99	7.87	8.16	**5.20**	8.01	7.60	8.04	7.94	7.50	8.00
DO	mg/L	N/A	9.77	6.56	3.28	4.52	4.21	8.20	6.21*	8.33*	7.33*	8.01*	6.14*	–	10.06*
DO	% sat.	80–110	**134.1**	**77**	**28.4**	**66.2**	**49.8**	83.6	**75.0**	104.0	89.5	99.6	**77.4**	–	**130.4**
Turbidity	NTU	0.5–10	**10.7**	1.2	5.4	2.0	**12.8**	**12.1**	**14.4**	6.3	4.2	**11.3**	**19.1**	8.9	9.9
Alkalinity^	mg/L	N/A	118^	453	291^	185^	159^	230^	136^	127^	247^	283^	360^	150^	123^

Results highlighted in **orange bold** exceed the ANZECC (2000) DTVs.

* DO (mg/L) results calculated from DO (% saturation) and temperature values. As such, DO values are indicative only.

^ Alkalinity values were measured by laboratory analysis.

C.2.2 Laboratory analysed water quality monitoring

Freshwater sites

Table C-14 Results of laboratory water quality analysis at freshwater reference monitoring sites at Newstan Colliery Surface Site

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP19-US	WMP20		
				Summer 2013	Autumn 2011	Autumn 2014	Spring 2014
Physicochemical parameters							
TDS	mg/L	10.0	N/A	222	174	224	183
TSS	mg/L	5	50	24	**78**	10	8
Nutrients							
Ammonia as N	mg/L	0.01	0.9	<0.01	0.002	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	0.006	0.009	0.02	<0.01
TKN	mg/L	0.1	N/A	1.9	1.0	0.9	1.2
Total nitrogen	mg/L	0.1	0.5	**2.0**	**1.1**	**0.9**	**1.2**
Total phosphorus	mg/L	0.01	0.05	**0.06**	**0.13**	0.04	0.04
Anions							
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	21	9	56	29
Total alkalinity $CaCO_3$	mg/L	1	N/A	21	9	56	29
Chloride	mg/L	1	N/A	30	15	16	33

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP19-US	WMP20		
				Summer 2013	Autumn 2011	Autumn 2014	Spring 2014
Sulfate	mg/L	1	N/A	18	2	25	7
Cations							
Calcium	mg/L	1	N/A	5	2	6	2
Magnesium	mg/L	1	N/A	3	2	4	2
Potassium	mg/L	1	N/A	5	3	3	3
Sodium	mg/L	1	N/A	26	11	26	23
Dissolved metals							
Aluminium	mg/L	0.01	0.68	**1.99**	**5.75**	0.24	0.44
Antimony	mg/L	0.001	N/A	–	<0.001	–	–
Arsenic	mg/L	0.001	0.024	<0.001	0.001	0.001	0.001
Barium	mg/L	0.001	N/A	0.039	0.036	0.051	0.013
Beryllium	mg/L	0.001	N/A	–	<0.001	–	–
Boron	mg/L	0.05	0.37	–	<0.05	–	–
Cadmium	mg/L	0.0001	0.00054	<0.0001	0.0003	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0025	<0.001	**0.003**	<0.001	<0.001
Cobalt	mg/L	0.001	N/A	<0.001	<0.001	0.001	<0.001

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP19-US	WMP20		
				Summer 2013	Autumn 2011	Autumn 2014	Spring 2014
Copper	mg/L	0.001	0.0035	**0.006**	**0.006**	**0.009**	0.003
Iron	mg/L	0.05	0.30	**1.03**	**1.77**	**0.69**	**0.75**
Lead	mg/L	0.001	0.0136	0.001	0.003	0.001	<0.001
Lithium	mg/L	0.001	N/A	–	0.005	–	–
Manganese	mg/L	0.001	1.9	0.004	0.036	0.06	0.093
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	–	<0.001	–	–
Nickel	mg/L	0.001	0.0275	0.002	0.002	0.004	0.002
Selenium	mg/L	0.01	0.03	–	<0.01	–	–
Silver	mg/L	0.001	0.00005	–	<0.001	–	–
Tin	mg/L	0.001	N/A	–	<0.001	–	–
Titanium	mg/L	0.01	N/A	–	0.19	–	–
Vanadium	mg/L	0.01	N/A	–	<0.01	–	–
Zinc	mg/L	0.005	0.02	**0.035**	**0.122**	**0.045**	0.016
Other parameters							
Silica	mg/L	0.1	N/A	–	12.3	–	–

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP19-US	WMP20		
				Summer 2013	Autumn 2011	Autumn 2014	Spring 2014
TOC	mg/L	1	N/A	16	20	22	43

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

Table C-15 Results of laboratory water quality analysis at freshwater on-site impact monitoring site By-Wash at Newstan Colliery Surface Site

Parameter	Units	LOR	SSTVs (GHD, 2011)	By-Wash							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Physicochemical parameters											
TDS	mg/L	10.0	N/A	1,730	1,110	1,340	1,560	1,300	1,260	1,180	1,290
TSS	mg/L	5	50	6	**117**	<5	8	<5	<5	<5	6
Nutrients											
Ammonia as N	mg/L	0.01	0.9	**0.12**	–	0.03	–	–	–	–	–
Nitrate as N	mg/L	0.01	N/A	–	–	0.03	–	–	–	–	–
Nitrite as N	mg/L	0.01	N/A	–	–	<0.01	–	–	–	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	0.02	0.02	0.03	0.40	0.04	0.02	0.1	0.05
TKN	mg/L	0.1	N/A	0.2	0.2	0.2	1.5	0.4	<0.1	0.1	0.2
Total nitrogen	mg/L	0.1	0.5	0.2	0.2	0.2	**1.9**	0.4	<0.1	0.2	0.2
Total phosphorus	mg/L	0.01	0.05	<0.01	<0.01	0.03	0.03	<0.01	0.03	<0.01	<0.01
Anions											
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	652	684	544	733	583	524	471	627
Total alkalinity $CaCO_3$	mg/L	1	N/A	652	684	574	733	612	556	496	695

Parameter	Units	LOR	SSTVs (GHD, 2011)	By-Wash							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Chloride	mg/L	1	N/A	440	286	295	261	324	314	331	373
Sulfate	mg/L	1	N/A	132	202	140	211	151	145	106	96
Cations											
Calcium	mg/L	1	N/A	26	31	11	12	13	11	19	10
Magnesium	mg/L	1	N/A	9	12	12	13	10	9	8	6
Potassium	mg/L	1	N/A	4	5	4	8	5	4	4	3
Sodium	mg/L	1	N/A	621	558	506	511	543	494	449	421
Dissolved metals											
Aluminium	mg/L	0.01	0.68	0.16	<0.01	<0.01	–	0.01	<0.01	<0.01	0.01
Antimony	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–	–
Arsenic	mg/L	0.001	0.024	**0.029**	0.001	0.001	0.001	0.002	<0.001	<0.001	<0.001
Barium	mg/L	0.001	N/A	0.173	–	0.069	–	0.086	0.052	0.124	0.093
Beryllium	mg/L	0.001	N/A	<0.001	<0.001	–	–	–	–	–	–
Boron	mg/L	0.05	0.37	0.24	0.20	–	–	–	–	–	–
Cadmium	mg/L	0.0001	0.00054	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0025	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter	Units	LOR	SSTVs (GHD, 2011)	By-Wash							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Cobalt	mg/L	0.001	N/A	0.003	0.001	<0.001	–	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0035	<0.001	<0.001	0.002	0.002	0.001	<0.001	<0.001	0.001
Iron	mg/L	0.05	0.30	0.05	0.06	<0.05	–	<0.185	<0.05	<0.05	<0.05
Lead	mg/L	0.001	0.0136	0.007	0.005	<0.001	0.001	<0.001	<0.001	<0.001	0.003
Lithium	mg/L	0.001	N/A	0.160	0.132	–	–	–	–	–	–
Manganese	mg/L	0.001	1.9	0.105	0.129	0.008	–	0.025	0.001	0.003	0.005
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	0.039	0.024	–	–	–	–	–	–
Nickel	mg/L	0.001	0.0275	0.016	0.015	0.009	0.016	0.009	0.008	0.008	0.009
Selenium	mg/L	0.01	0.03	**0.12**	<0.01	–	–	–	–	–	–
Silver	mg/L	0.001	0.00005	<0.001	<0.001	–	–	–	–	–	–
Tin	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–	–
Titanium	mg/L	0.01	N/A	<0.01	–	–	–	–	–	–	–
Vanadium	mg/L	0.01	N/A	<0.01	<0.01	–	–	–	–	–	–
Zinc	mg/L	0.005	0.02	0.012	0.005	<0.005	0.006	0.006	<0.005	<0.005	0.009

Parameter	Units	LOR	SSTVs (GHD, 2011)	By-Wash							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Other parameters											
Silica	mg/L	0.1	N/A	14.2	14.6	–	–	–	–	–	–
TOC	mg/L	1	N/A	2	2	7	<1	3	6	2	4

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

Table C-16 Results of laboratory water quality analysis at freshwater on-site impact monitoring site WMP03 at Newstan Colliery Surface Site

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP03							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Physicochemical parameters											
TDS	mg/L	10.0	N/A	1,670	1,330	1,350	1,360	1,340	1,300	1,250	1,260
TSS	mg/L	5	50	7	<5	<5	<5	<5	13	<5	<5
Nutrients											
Ammonia as N	mg/L	0.01	0.9	–	–	0.01	–	–	–	–	–
Nitrate as N	mg/L	0.01	N/A	–	–	0.02	–	–	–	–	–
Nitrite as N	mg/L	0.01	N/A	–	–	<0.01	–	–	–	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	<0.01	<0.01	0.02	<0.01	0.11	0.02	0.08	0.01
TKN	mg/L	0.1	N/A	<0.1	0.3	0.2	0.2	0.4	0.1	0.1	0.2
Total nitrogen	mg/L	0.1	0.5	<0.1	0.3	0.2	0.2	0.5	0.1	0.2	0.2
Total phosphorus	mg/L	0.01	0.05	<0.01	0.04	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
Anions											
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	590	632	531	619	569	517	468	611
Total alkalinity $CaCO_3$	mg/L	1	N/A	614	673	571	620	616	553	502	648

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP03							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Chloride	mg/L	1	N/A	437	304	281	263	307	315	326	359
Sulfate	mg/L	1	N/A	128	194	139	166	155	147	106	106
Cations											
Calcium	mg/L	1	N/A	18	23	11	13	13	11	20	13
Magnesium	mg/L	1	N/A	9	12	11	14	10	9	9	8
Potassium	mg/L	1	N/A	4	5	4	6	5	4	4	4
Sodium	mg/L	1	N/A	599	565	498	444	539	496	458	568
Dissolved metals											
Aluminium	mg/L	0.01	0.68	0.12	<0.01	<0.01	–	0.02	<0.01	<0.01	0.01
Antimony	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–	–
Arsenic	mg/L	0.001	0.024	**0.028**	0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001
Barium	mg/L	0.001	N/A	0.124	–	0.068	–	0.086	0.050	0.124	0.091
Beryllium	mg/L	0.001	N/A	<0.001	<0.001	–	–	–	–	–	–
Boron	mg/L	0.05	0.37	0.23	0.19	–	–	–	–	–	–
Cadmium	mg/L	0.0001	0.00054	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0025	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP03							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Cobalt	mg/L	0.001	N/A	0.002	<0.001	<0.001	–	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0035	<0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001	0.001
Iron	mg/L	0.05	0.30	<0.05	<0.05	<0.05	–	<0.05	<0.05	<0.05	<0.05
Lead	mg/L	0.001	0.0136	0.003	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.003
Lithium	mg/L	0.001	N/A	0.148	0.129	–	–	–	–	–	–
Manganese	mg/L	0.001	1.9	0.007	0.023	0.006	–	0.016	0.002	0.005	0.004
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	0.036	0.022	–	–	–	–	–	–
Nickel	mg/L	0.001	0.0275	0.016	0.014	0.009	0.007	0.009	0.008	0.008	0.008
Selenium	mg/L	0.01	0.03	**0.11**	<0.01	–	–	–	–	–	–
Silver	mg/L	0.001	0.00005	<0.001	<0.001	–	–	–	–	–	–
Tin	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–	–
Titanium	mg/L	0.01	N/A	<0.01	–	–	–	–	–	–	–
Vanadium	mg/L	0.01	N/A	<0.01	<0.01	–	–	–	–	–	–
Zinc	mg/L	0.005	0.02	**0.028**	<0.005	<0.005	<0.005	**0.028**	<0.005	<0.005	0.010

Parameter	Units	LOR	SSTVs (GHD, 2011)	WMP03							
				Autumn 2011	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Other parameters											
Silica	mg/L	0.1	N/A	13.2	14.0	–	–	–	–	–	–
TOC	mg/L	1	N/A	2	3	<1	<1	3	8	2	4

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

Table C-17 Results of laboratory water quality analysis at freshwater downstream impact monitoring sites at Newstan Colliery Surface Site

Parameter	Units	LOR	SSTVs (GHD, 2011)	SP003		SP004							WMP19 -DS
				Autumn 2011	Summer 2012	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014	Summer 2013
Physicochemical parameters													
TDS	mg/L	10.0	N/A	1,570	1,480	1,400	1,090	1,320	1,390	1,230	1,270	1,270	207
TSS	mg/L	5	50	**278**	<5	12	10	<5	<5	8	<5	<5	34
Nutrients													
Ammonia as N	mg/L	0.01	0.9	0.02	–	–	0.01	–	–	–	–	–	0.02
Nitrate as N	mg/L	0.01	N/A	–	–	–	0.10	–	–	–	–	–	–
Nitrite as N	mg/L	0.01	N/A	–	–	–	<0.01	–	–	–	–	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	0.18	<0.01	0.01	0.10	0.05	0.08	0.02	0.04	0.06	0.009
TKN	mg/L	0.1	N/A	0.4	0.2	0.2	0.3	0.2	0.1	0.1	0.2	0.1	0.7
Total nitrogen	mg/L	0.1	0.5	0.4	0.2	0.2	0.3	0.2	0.2	0.1	0.2	0.2	**0.8**
Total phosphorus	mg/L	0.01	0.05	**0.10**	0.03	0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01	0.06

Parameter	Units	LOR	SSTVs (GHD, 2011)	SP003		SP004							WMP19-DS
				Autumn 2011	Summer 2012	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014	Summer 2013
Anions													
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	545	602	606	435	579	568	508	502	607	17
Total alkalinity $CaCO_3$	mg/L	1	N/A	573	673	676	458	614	616	554	535	656	17
Chloride	mg/L	1	N/A	417	300	304	236	277	308	319	331	373	24
Sulfate	mg/L	1	N/A	119	191	190	121	165	159	141	99	95	21
Cations													
Calcium	mg/L	1	N/A	16	21	22	12	12	14	11	18	10	4
Magnesium	mg/L	1	N/A	8	12	13	9	14	10	9	8	6	3
Potassium	mg/L	1	N/A	9	5	5	4	6	5	4	5	2	5
Sodium	mg/L	1	N/A	497	573	577	362	449	533	494	442	426	22
Dissolved metals													
Aluminium	mg/L	0.01	0.68	0.29	<0.01	<0.01	0.55	–	<0.01	0.02	<0.01	<0.01	**1.90**
Antimony	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–	–	–	–

Parameter	Units	LOR	SSTVs (GHD, 2011)	SP003		SP004							WMP19-DS
				Autumn 2011	Summer 2012	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014	Summer 2013
Arsenic	mg/L	0.001	0.024	**0.027**	0.002	0.001	0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	N/A	0.119	–	–	0.068	–	0.080	0.062	0.115	0.085	0.049
Beryllium	mg/L	0.001	N/A	<0.001	<0.001	<0.001	–	–	–	–	–	–	–
Boron	mg/L	0.05	0.37	0.29	0.20	0.19	–	–	–	–	–	–	–
Cadmium	mg/L	0.0001	0.00054	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0025	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Cobalt	mg/L	0.001	N/A	0.002	<0.001	<0.001	<0.001	–	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0035	0.001	<0.001	<0.001	0.002	0.003	0.001	0.001	<0.001	0.001	**0.008**
Iron	mg/L	0.05	0.30	0.29	0.09	0.05	0.30	–	<0.95	<0.05	<0.05	<0.05	**1.10**
Lead	mg/L	0.001	0.0136	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.002
Lithium	mg/L	0.001	N/A	0.132	0.123	0.129	–	–	–	–	–	–	–
Manganese	mg/L	0.001	1.9	0.029	0.021	0.007	0.007	–	0.010	0.005	0.005	0.005	0.005
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	0.034	0.021	0.022	–	–	–	–	–	–	–

Parameter	Units	LOR	SSTVs (GHD, 2011)	SP003		SP004							WMP19-DS
				Autumn 2011	Summer 2012	Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014	Summer 2013
Nickel	mg/L	0.001	0.0275	0.016	0.015	0.016	0.008	0.007	0.009	0.009	0.008	0.009	0.003
Selenium	mg/L	0.01	0.03	**0.11**	<0.01	<0.01	–	–	–	–	–	–	–
Silver	mg/L	0.001	0.00005	<0.001	<0.001	<0.001	–	–	–	–	–	–	–
Tin	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–	–	–	–
Titanium	mg/L	0.01	N/A	<0.01	–	–	–	–	–	–	–	–	–
Vanadium	mg/L	0.01	N/A	<0.01	<0.01	<0.01	–	–	–	–	–	–	–
Zinc	mg/L	0.005	0.02	0.020	<0.005	0.007	0.007	<0.005	**0.022**	0.009	<0.005	0.007	**0.042**
Other parameters													
Silica	mg/L	0.1	N/A	12.6	13.9	14.2	–	–	–	–	–	–	–
TOC	mg/L	1	N/A	38	2	2	2	<1	3	1*	3	4	17

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

* Non-purgable organic carbon.

Table C-18 Results of laboratory water quality analysis at freshwater downstream recovery monitoring site Weir at Newstan Colliery Surface Site

Parameter	Units	LOR	SSTVs (GHD, 2011)	Weir						
				Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Physicochemical parameters										
TDS	mg/L	10.0	N/A	1,470	1,000	1,580	1,370	1,310	1,230	1,260
TSS	mg/L	5	50	<5	12	8	<5	8	17	10
Nutrients										
Ammonia as N	mg/L	0.01	0.9	–	0.01	–	–	–	–	–
Nitrate as N	mg/L	0.01	N/A	–	0.15	–	–	–	–	–
Nitrite as N	mg/L	0.01	N/A	–	<0.01	–	–	–	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	0.01	0.15	0.05	0.07	0.02	0.04	0.07
TKN	mg/L	0.1	N/A	0.3	0.4	0.2	0.2	0.1	0.2	0.2
Total nitrogen	mg/L	0.1	0.5	0.3	0.4	0.2	0.3	0.1	0.2	0.3
Total phosphorus	mg/L	0.01	0.05	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01
Anions										
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	600	392	559	555	502	493	596
Total alkalinity $CaCO_3$	mg/L	1	N/A	673	410	589	608	549	537	665

Parameter	Units	LOR	SSTVs (GHD, 2011)	Weir						
				Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Chloride	mg/L	1	N/A	305	213	390	299	318	331	375
Sulfate	mg/L	1	N/A	206	109	178	151	142	99	95
Cations										
Calcium	mg/L	1	N/A	21	12	12	14	11	18	11
Magnesium	mg/L	1	N/A	13	8	21	11	9	8	7
Potassium	mg/L	1	N/A	5	4	9	5	4	5	3
Sodium	mg/L	1	N/A	565	329	551	541	496	445	464
Dissolved metals										
Aluminium	mg/L	0.01	0.68	<0.01	0.60	–	<0.01	0.01	0.01	0.01
Arsenic	mg/L	0.001	0.024	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.001	N/A	–	0.061	–	0.071	0.052	0.107	0.087
Beryllium	mg/L	0.001	N/A	<0.001	–	–	–	–	–	–
Boron	mg/L	0.05	0.37	0.18	–	–	–	–	–	–
Cadmium	mg/L	0.0001	0.00054	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0025	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	N/A	<0.001	<0.001	–	<0.001	<0.001	<0.001	<0.001

Parameter	Units	LOR	SSTVs (GHD, 2011)	Weir						
				Summer 2012	Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Copper	mg/L	0.001	0.0035	<0.001	0.002	<0.001	0.001	<0.001	<0.001	0.001
Iron	mg/L	0.05	0.30	0.06	**0.31**	–	<0.140	<0.05	<0.05	<0.05
Lead	mg/L	0.001	0.0136	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.006
Lithium	mg/L	0.001	N/A	0.133	–	–	–	–	–	–
Manganese	mg/L	0.001	1.9	0.009	0.007	–	0.015	0.004	0.005	0.009
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	0.021	–	–	–	–	–	–
Nickel	mg/L	0.001	0.0275	0.014	0.006	0.007	0.009	0.007	0.009	0.009
Selenium	mg/L	0.01	0.03	<0.01	–	–	–	–	–	–
Silver	mg/L	0.001	0.00005	<0.001	–	–	–	–	–	–
Vanadium	mg/L	0.01	N/A	<0.01	–	–	–	–	–	–
Zinc	mg/L	0.005	0.02	<0.005	0.007	0.006	0.010	**0.090**	<0.005	0.014
Other parameters										
Silica	mg/L	0.1	N/A	13.8	–	–	–	–	–	–
TOC	mg/L	1	N/A	3	<1	<1	3	16	3	4

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

Estuarine sites

Table C-19 Results of laboratory water quality analysis at estuarine reference monitoring site SCCIZ at Newstan Colliery Surface Site

Parameter	Units	LOR	DTVs (ANZECC, 2000)	SCCIZ	
				Autumn 2014	Spring 2014
Physicochemical parameters					
TDS	mg/L	10.0	N/A	32,500	28,900
TSS	mg/L	5	N/A	<5	<5
Nutrients					
Nitrite + nitrate as N	mg/L	0.01	N/A	0.02	0.07
TKN	mg/L	0.1	N/A	<0.5	0.5
Total nitrogen	mg/L	0.1	0.3	<0.5	**0.6**
Total phosphorus	mg/L	0.01	0.03	<0.05	**0.09**
Anions					
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	101	106
Total alkalinity $CaCO_3$	mg/L	1	N/A	101	106
Chloride	mg/L	1	N/A	14,100	13,700
Sulfate	mg/L	1	N/A	2,060	2,090
Cations					
Calcium	mg/L	1	N/A	352	312
Magnesium	mg/L	1	N/A	1060	991
Potassium	mg/L	1	N/A	368	331
Sodium	mg/L	1	N/A	9,780	9,020
Dissolved metals					
Aluminium	mg/L	0.01	N/A	<0.10	<0.01
Arsenic	mg/L	0.001	N/A	<0.010	<0.001
Barium	mg/L	0.001	N/A	0.019	0.016
Cadmium	mg/L	0.0001	0.0055	<0.0010	<0.0001
Chromium	mg/L	0.001	0.0274	<0.010	<0.001

Parameter	Units	LOR	DTVs (ANZECC, 2000)	SCCIZ	
				Autumn 2014	Spring 2014
Cobalt	mg/L	0.001	0.001	<0.010	<0.001
Copper	mg/L	0.001	0.0013	<0.010	<0.001
Iron	mg/L	0.05	N/A	<0.50	<0.05
Lead	mg/L	0.001	0.0044	<0.010	<0.001
Manganese	mg/L	0.001	N/A	0.018	0.023
Mercury	mg/L	0.0001	0.0004	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	<0.010	<0.001
Nickel	mg/L	0.001	0.07	<0.010	<0.001
Zinc	mg/L	0.005	0.0015	<0.050	0.332
Other parameters					
TOC	mg/L	1	N/A	5	5

Results highlighted in **orange bold** exceed the ANZECC (2000) DTVs.

Table C-20 Results of laboratory water quality analysis at estuarine downstream recovery monitoring site IZ at Newstan Colliery Surface Site

Parameter	Units	LOR	DTVs (ANZECC, 2000)	IZ					
				Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Physicochemical parameters									
TDS	mg/L	10.0	N/A	32,200	4,990	25,700	35,900	32,900	10,500
TSS	mg/L	5	N/A	8	12	<5	5	<5	<5
Nutrients									
Ammonia as N	mg/L	0.01	0.91	0.02	–	–	–	–	–
Nitrate as N	mg/L	0.01	N/A	0.06	–	–	–	–	–
Nitrite as N	mg/L	0.01	N/A	<0.01	–	–	–	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	0.06	0.07	0.03	0.02	<0.01	0.09
TKN	mg/L	0.1	N/A	<0.1	0.2	0.1	0.4	<0.5	0.4
Total nitrogen	mg/L	0.1	0.3	<0.1	0.3	0.1	**0.4**	<0.5	**0.5**
Total phosphorus	mg/L	0.01	0.03	<0.01	0.02	<0.01	**0.05**	<0.05	**0.06**
Anions									
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	118	453	291	185	159	230
Total alkalinity $CaCO_3$	mg/L	1	N/A	118	453	291	185	159	230

Parameter	Units	LOR	DTVs (ANZECC, 2000)	IZ					
				Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Chloride	mg/L	1	N/A	14,300	2,540	11,100	13,800	14,000	5,650
Sulfate	mg/L	1	N/A	2,140	430	1,760	2,250	2,030	780
Cations									
Calcium	mg/L	1	N/A	266	72	284	381	342	125
Magnesium	mg/L	1	N/A	1,030	157	826	1,180	1,000	375
Potassium	mg/L	1	N/A	461	60	300	402	364	127
Sodium	mg/L	1	N/A	8,900	1,570	6,900	10,300	9,330	3,250
Dissolved metals									
Aluminium	mg/L	0.01	N/A	<0.01	–	<0.01	<0.10	<0.10	0.01
Arsenic	mg/L	0.001	N/A	<0.001	<0.001	0.003	<0.010	<0.010	0.002
Barium	mg/L	0.001	N/A	0.017	–	0.036	0.020	0.028	0.027
Cadmium	mg/L	0.0001	0.0055	<0.0001	<0.0001	0.0001	<0.0010	<0.0010	<0.0001
Chromium	mg/L	0.001	0.0274	<0.001	<0.001	<0.001	<0.010	<0.010	<0.001
Cobalt	mg/L	0.001	0.001	<0.001	–	<0.001	<0.010	<0.010	<0.001
Copper	mg/L	0.001	0.0013	<0.001	0.001	**0.002**	**0.011**	<0.010	**0.008**
Iron	mg/L	0.05	N/A	<0.05	–	<0.50	<0.50	<0.50	<0.05

Parameter	Units	LOR	DTVs (ANZECC, 2000)	IZ					
				Summer 2013	Autumn 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Lead	mg/L	0.001	0.0044	<0.001	0.001	<0.001	<0.010	<0.010	<0.001
Manganese	mg/L	0.001	N/A	<0.005	–	0.068	0.015	0.024	0.042
Mercury	mg/L	0.0001	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nickel	mg/L	0.001	0.07	<0.001	0.006	0.002	<0.010	<0.010	0.002
Zinc	mg/L	0.005	0.015	<0.050	0.010	<0.005	<0.050	<0.050	**0.017**
Other parameters									
Silica	mg/L	0.1	N/A	–	–	–	–	–	–
TOC	mg/L	1	N/A	5	<1	10	4	3	6

Results highlighted in **orange bold** exceed the ANZECC (2000) DTVs.

Table C-21 Results of laboratory water quality analysis at other estuarine downstream recovery monitoring sites at Newstan Colliery Surface Site

Parameter	Units	LOR	DTVs (ANZECC, 2000)	LT1	LT2	LT3	LT4	LT5	LT6	LT7
				Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012
Physicochemical parameters										
TDS	mg/L	10.0	N/A	34,600	33,600	26,800	20,700	18,600	35,200	39,800
TSS	mg/L	5	N/A	48	28	70	11	16	30	10
Nutrients										
Nitrite + nitrate as N	mg/L	0.01	N/A	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01
TKN	mg/L	0.1	N/A	0.4	0.1	0.4	0.4	0.3	0.2	0.4
Total nitrogen	mg/L	0.1	0.3	**0.4**	0.1	**0.4**	**0.4**	0.3	0.2	**0.4**
Total phosphorus	mg/L	0.01	0.03	**0.05**	<0.01	**0.06**	**0.04**	0.02	0.02	**0.06**
Anions										
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	136	127	247	283	360	150	123
Total alkalinity $CaCO_3$	mg/L	1	N/A	136	127	247	283	360	150	123
Chloride	mg/L	1	N/A	18,900	19,100	13,800	12,000	8,920	17,800	19,000
Sulfate	mg/L	1	N/A	2,440	2,350	1,760	1,670	1,290	2,220	2,260

Parameter	Units	LOR	DTVs (ANZECC, 2000)	LT1	LT2	LT3	LT4	LT5	LT6	LT7
				Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012
Cations										
Calcium	mg/L	1	N/A	397	405	315	260	221	364	421
Magnesium	mg/L	1	N/A	1,260	1,260	905	714	605	1,160	1,400
Potassium	mg/L	1	N/A	458	439	317	250	222	424	464
Sodium	mg/L	1	N/A	11,200	10,900	8,050	6,530	5,690	10,400	11,200
Dissolved metals										
Aluminium	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.10	<0.10
Arsenic	mg/L	0.001	N/A	<0.010	<0.010	<0.010	0.003	0.002	<0.010	<0.010
Beryllium	mg/L	0.001	N/A	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Boron	mg/L	0.05	N/A	3.69	3.57	2.07	1.67	1.83	3.38	4.17
Cadmium	mg/L	0.0001	0.0055	<0.0001	<0.0001	<0.0001	0.0001	<0.0001	<0.0010	<0.0010
Chromium	mg/L	0.001	0.0274	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Cobalt	mg/L	0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Copper	mg/L	0.001	0.0013	<0.001	<0.001	0.001	**0.002**	**0.002**	<0.020	<0.020
Iron	mg/L	0.05	N/A	<0.05	<0.05	<0.05	<0.05	<0.05	<0.50	<0.50
Lead	mg/L	0.001	0.0044	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010

Parameter	Units	LOR	DTVs (ANZECC, 2000)	LT1	LT2	LT3	LT4	LT5	LT6	LT7
				Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012	Summer 2012
Lithium	mg/L	0.001	N/A	0.160	0.157	0.150	0.136	0.144	0.156	0.175
Manganese	mg/L	0.001	N/A	0.046	0.017	0.035	0.050	0.054	0.021	0.012
Mercury	mg/L	0.0001	0.0004	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	0.018	0.019	0.016	0.017	0.016	0.018	0.017
Nickel	mg/L	0.001	0.07	<0.001	<0.001	0.003	0.005	0.004	<0.010	<0.010
Selenium	mg/L	0.01	N/A	<0.01	<0.01	<0.01	<0.01	<0.01	<0.10	<0.10
Silver	mg/L	0.001	0.0014	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Vanadium	mg/L	0.01	0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.10	<0.10
Zinc	mg/L	0.005	0.015	<0.005	<0.005	0.005	0.006	0.010	<0.050	<0.050
Other parameters										
Silica	mg/L	0.1	N/A	2.7	2.1	7.2	8.1	9.2	2.8	2.0
TOC	mg/L	1	N/A	<1	<1	<1	3	2	<1	<1

Results highlighted in **orange bold** exceed the ANZECC (2000) DTVs.

Appendix D – Aquatic ecology sediment quality results

D.1 Cooranbong Services Site

Table D-1 Results of laboratory sediment quality analysis at reference monitoring sites at Cooranbong Services Site

Parameter	Units	LOR	ISQG values		SW013		SW014		SW015	CCSC1		
			Low	High	Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Total metals												
Aluminium	mg/kg	50	N/A	N/A	3190	–	–	–	–	2,640	–	–
Arsenic	mg/kg	5	20	70	–	<5	<5	<5	<5	–	6	<5
Beryllium	mg/kg	1	N/A	N/A	0.2	–	–	–	–	0.3	–	–
Cadmium	mg/kg	1	1.5	10	0.1	<1	<1	<1	<1	<0.1	<1	<1
Chromium	mg/kg	2	80	370	4.4	6	6	6	12	2.3	10	3
Cobalt	mg/kg	2	N/A	N/A	1.6	–	–	–	–	4.0	–	–
Copper	mg/kg	5	65	270	6.0	11	7	7	14	1.4	6	<5
Iron	mg/kg	50	N/A	N/A	7,790	–	–	–	–	3,450	–	–
Lead	mg/kg	5	50	220	9.7	18	12	12	21	6.6	15	13
Lithium	mg/kg	0.1	N/A	N/A	3.0	–	–	–	–	1.2	–	–
Manganese	mg/kg	5	N/A	N/A	57.8	–	–	–	–	62.9	–	–
Mercury	mg/kg	0.1	0.15	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	0.4	–	–	–	–	0.2	–	–

Parameter	Units	LOR	ISQG values		SW013		SW014		SW015	CCSC1		
			Low	High	Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Autumn 2014	Winter 2012	Spring 2013	Spring 2014
Nickel	mg/kg	2	21	52	3.8	**30**	6	7	7	1.2	13	4
Selenium	mg/kg	5	N/A	N/A	<1	–	–	–	–	<1	–	–
Silver	mg/kg	2	1	3.7	<0.1	–	–	–	–	<0.1	–	–
Vanadium	mg/kg	5	N/A	N/A	15	–	–	–	–	8	–	–
Zinc	mg/kg	5	200	410	35.9	117	18	19	53	7.1	88	10
Other parameters												
Moisture content	%	1.0	N/A	N/A	28.8	33.5	60.3	61.9	50.3	41.0	68.6	25.2
pH value	pH unit	0.1	N/A	N/A	6.8	–	–	–	–	8.3	–	–
TOC	%	0.5	N/A	N/A	1.4	–	–	–	–	2.6	–	–

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Table D-2 Results of laboratory sediment quality analysis at on-site and downstream impact monitoring sites at Cooranbong Services Site

Parameter	Units	LOR	ISQG values		SW001				SW002		CCSR1			
			Low	High	Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Total metals														
Aluminium	mg/kg	50	N/A	N/A	3,710	–	–	–	12,200	–	4,480	–	–	–
Arsenic	mg/kg	5	20	70	–	7	<5	12	–	<5	–	6	<5	<5
Beryllium	mg/kg	1	N/A	N/A	0.5	–	–	–	7.0	–	0.4	–	–	–
Cadmium	mg/kg	1	1.5	10	<0.1	<1	<1	<1	**1.8**	<1	0.3	<1	<1	<1
Chromium	mg/kg	2	80	370	6.9	7	4	3	10.6	8	7.1	10	12	3
Cobalt	mg/kg	2	N/A	N/A	6.5	–	–	–	417	–	27.9	–	–	–
Copper	mg/kg	5	65	270	11.7	7	<5	8	29.1	<5	8.6	6	<5	<5
Iron	mg/kg	50	N/A	N/A	14,000	–	–	–	25,600	–	11,500	–	–	–
Lead	mg/kg	5	50	220	9.2	13	5	10	39.1	8	11.0	15	14	13
Lithium	mg/kg	0.1	N/A	N/A	4.2	–	–	–	35.0	–	10.9	–	–	–
Manganese	mg/kg	5	N/A	N/A	203	–	–	–	8,180	–	128	–	–	–
Mercury	mg/kg	0.1	0.15	1	<0.1	<0.1	<0.1	<0.1	**0.7**	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	0.9	–	–	–	6.8	–	1.5	–	–	–

Parameter	Units	LOR	ISQG values		SW001				SW002		CCSR1			
			Low	High	Winter 2012	Spring 2013	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Nickel	mg/kg	2	21	52	11.0	**30**	<2	3	**763**	<2	**72.1**	13	<2	4
Selenium	mg/kg	5	N/A	N/A	<1	–	–	–	11	–	2	–	–	–
Silver	mg/kg	2	1	3.7	<0.1	–	–	–	0.3	–	<0.1	–	–	–
Vanadium	mg/kg	5	N/A	N/A	25	–	–	–	26	–	26	–	–	–
Zinc	mg/kg	5	200	410	55.5	114	14	70	**1,150**	23	124	88	8	10
Other parameters														
Moisture content	%	1.0	N/A	N/A	40.3	55.3	36.5	59.2	81.4	39.3	41.0	68.6	32.7	25.2
pH value	pH unit	0.1	N/A	N/A	7.8	–	–	–	8.1	–	8.3	–	–	–
TOC	%	0.5	N/A	N/A	1.4	–	–	–	13.3	–	2.6	–	–	–

Results highlighted in **orange bold** exceed the low ISQGs (ANZECC, 2000).

Results highlighted in **green bold** exceed the high ISQGs (ANZECC, 2000).

Table D-3 Results of laboratory sediment quality analysis at downstream recovery monitoring sites at Cooranbong Services Site

Parameter	Units	LOR	ISQG values		SW016		SW017			
			Low	High	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Total metals										
Aluminium	mg/kg	50	N/A	N/A	–	–	8,960	–	–	–
Arsenic	mg/kg	5	20	70	<5	9	–	<5	<5	9
Beryllium	mg/kg	1	N/A	N/A	–	–	1.3	–	–	–
Cadmium	mg/kg	1	1.5	10	<1	<1	0.3	<1	<1	<1
Chromium	mg/kg	2	80	370	6	12	12.4	5	9	6
Cobalt	mg/kg	2	N/A	N/A	–	–	5.2	–	–	–
Copper	mg/kg	5	65	270	5	12	25.7	23	20	11
Iron	mg/kg	50	N/A	N/A	–	–	20,900	–	–	–
Lead	mg/kg	5	50	220	12	42	**63.1**	**55**	**75**	21
Lithium	mg/kg	0.1	N/A	N/A	–	–	16.9	–	–	–
Manganese	mg/kg	5	N/A	N/A	–	–	451	–	–	–
Mercury	mg/kg	0.1	0.15	1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	–	–	6.0	–	–	–

Parameter	Units	LOR	ISQG values		SW016		SW017			
			Low	High	Autumn 2014	Spring 2014	Winter 2012	Spring 2013	Autumn 2014	Spring 2014
Nickel	mg/kg	2	21	52	4	10	12.1	4	6	6
Selenium	mg/kg	5	N/A	N/A	–	–	<2	–	–	–
Silver	mg/kg	2	1	3.7	–	–	<0.2	–	–	–
Vanadium	mg/kg	5	N/A	N/A	–	–	31	–	–	–
Zinc	mg/kg	5	200	410	40	145	170	70	115	91
Other parameters										
Moisture content	%	1.0	N/A	N/A	46.2	67.6	88.8	66.7	42.4	60.7
pH value	pH unit	0.1	N/A	N/A	–	–	7.4	–	–	–
TOC	%	0.5	N/A	N/A	–	–	18.3	–	–	–

Results highlighted in **orange bold** exceed the low ISQGs (ANZECC, 2000).

D.2 Newstan Colliery Services Site

D.2.1 Freshwater sites

Table D-4 Results of laboratory sediment quality analysis at freshwater reference monitoring site WMP20 at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG values		WMP20		
			Low	High	Autumn 2011	Autumn 2014	Spring 2014
Acid extractable metals							
Aluminium	mg/kg	50	N/A	N/A	820	–	–
Antimony	mg/kg	1.0	2	25	<1.0	–	–
Arsenic	mg/kg	1.0	20	70	1.6	–	–
Barium	mg/kg	1.0	N/A	N/A	69.5	–	–
Beryllium	mg/kg	1.0	N/A	N/A	<1.0	–	–
Boron	mg/kg	1	N/A	N/A	2	–	–
Cadmium	mg/kg	0.1	1.5	10	0.1	–	–
Chromium	mg/kg	1.0	80	370	<1.0	–	–
Cobalt	mg/kg	0.5	N/A	N/A	1.9	–	–
Copper	mg/kg	1.0	65	270	9.5	–	–
Iron	mg/kg	50.0	N/A	N/A	1,910	–	–
Lead	mg/kg	1.0	50	220	27.6	–	–

Parameter	Units	LOR	ISQG values		WMP20		
			Low	High	Autumn 2011	Autumn 2014	Spring 2014
Manganese	mg/kg	10.0	N/A	N/A	127	–	–
Molybdenum	mg/kg	1	N/A	N/A	<1	–	–
Nickel	mg/kg	1.0	21	52	1.8	–	–
Selenium	mg/kg	1	N/A	N/A	<1	–	–
Silver	mg/kg	1.0	1	3.7	<1.0	–	–
Tin	mg/kg	1	N/A	N/A	<1	–	–
Titanium	mg/kg	1	N/A	N/A	5	–	–
Vanadium	mg/kg	2.0	N/A	N/A	2.8	–	–
Zinc	mg/kg	1.0	200	410	48.1	–	–
Total metals							
Aluminium	mg/kg	50	N/A	N/A	3,750	–	–
Antimony	mg/kg	5	2	25	<5	<5	<5
Arsenic	mg/kg	5	20	70	5	–	–
Barium	mg/kg	10	N/A	N/A	90	–	–
Beryllium	mg/kg	1	N/A	N/A	<1	–	–
Boron	mg/kg	50	N/A	N/A	<50	–	–

Parameter	Units	LOR	ISQG values		WMP20		
			Low	High	Autumn 2011	Autumn 2014	Spring 2014
Cadmium	mg/kg	1	1.5	10	<1	<1	<1
Chromium	mg/kg	2	80	370	4	7	5
Cobalt	mg/kg	2	N/A	N/A	4	–	–
Copper	mg/kg	5	65	270	15	24	8
Iron	mg/kg	50	N/A	N/A	9,880	–	–
Lead	mg/kg	5	50	220	35	37	15
Lithium	mg/kg	0.1	N/A	N/A	1.8	–	–
Manganese	mg/kg	5	N/A	N/A	221	–	–
Mercury	mg/kg	0.1	0.15	1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	<2	–	–
Nickel	mg/kg	2	21	52	5	5	4
Selenium	mg/kg	5	N/A	N/A	<5	–	–
Silver	mg/kg	2	1	3.7	<2	<2	<2
Tin	mg/kg	10	N/A	N/A	50	–	–
Titanium	mg/kg	5	N/A	N/A	<5	–	–
Vanadium	mg/kg	5	N/A	N/A	16	–	–

Parameter	Units	LOR	ISQG values		WMP20		
			Low	High	Autumn 2011	Autumn 2014	Spring 2014
Zinc	mg/kg	5	200	410	83	57	99
Other parameters							
Moisture content	%	1.0	N/A	N/A	36.0	49.7	51.4
Organic matter	%	0.5	N/A	N/A	–	5.8	–
pH value	pH unit	0.1	N/A	N/A	6.1	–	–
TOC	%	0.5	N/A	N/A	3.77	3.4	9.2

Table D-5 Results of laboratory sediment quality analysis at freshwater on-site impact monitoring site By-Wash at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG values		By-Wash									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Acid extractable metals														
Aluminium	mg/kg	50	N/A	N/A	1,450	3,000	1,480	–	–	–	–	–	–	–
Antimony	mg/kg	1.0	2	25	<1.0	–	–	**5.6**	–	–	–	–	–	–
Arsenic	mg/kg	1.0	20	70	18.1	<1.0	4.6	–	–	–	–	–	–	–
Barium	mg/kg	1.0	N/A	N/A	961	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1.0	N/A	N/A	1.3	<1.0	<1.0	–	–	–	–	–	–	–
Boron	mg/kg	1	N/A	N/A	18	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	0.1	1.5	10	0.7	<0.1	0.4	0.2	–	–	–	–	–	–
Chromium	mg/kg	1.0	80	370	1.5	1.9	<1.0	<1.0	–	–	–	–	–	–
Cobalt	mg/kg	0.5	N/A	N/A	29.3	1.9	2.0	2.8	–	–	–	–	–	–
Copper	mg/kg	1.0	65	270	28.9	1.9	15.2	–	–	–	–	–	–	–
Iron	mg/kg	50.0	N/A	N/A	12,700	10,500	8,170	–	–	–	–	–	–	–
Lead	mg/kg	1.0	50	220	**492**	**58.4**	46.0	**95.3**	–	–	–	–	–	–
Manganese	mg/kg	10.0	N/A	N/A	8,790	376	88	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		By-Wash									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Mercury	mg/kg	0.10	0.15	1	–	<0.10	<0.1	–	–	–	–	–	–	–
Molybdenum	mg/kg	1	N/A	N/A	3	–	–	–	–	–	–	–	–	–
Nickel	mg/kg	1.0	21	52	20.4	3.8	4.2	2.2	–	–	–	–	–	–
Selenium	mg/kg	1	N/A	N/A	<1	<0.5	<0.5	–	–	–	–	–	–	–
Silver	mg/kg	1.0	1	3.7	<1.0	<1.0	<1.0	<1.0	–	–	–	–	–	–
Tin	mg/kg	1	N/A	N/A	4	–	–	–	–	–	–	–	–	–
Titanium	mg/kg	1	N/A	N/A	6	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	2.0	N/A	N/A	4.7	9.6	5.3	–	–	–	–	–	–	–
Zinc	mg/kg	1.0	200	410	**345**	48.8	26.4	54.3	–	–	–	–	–	–
Total metals														
Aluminium	mg/kg	50	N/A	N/A	6,010	–	–	–	–	–	–	–	–	–
Antimony	mg/kg	5	2	25	<5	–	–	<5	–	<5	<5	<5	<5	<5
Arsenic	mg/kg	5	20	70	**32**	–	–	–	–	–	–	–	–	–
Barium	mg/kg	10	N/A	N/A	850	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1	N/A	N/A	1	–	–	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		By-Wash									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Boron	mg/kg	50	N/A	N/A	<50	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	1	1.5	10	<1	–	–	<1	<1	1	<1	1	<1	<1
Chromium	mg/kg	2	80	370	4	–	–	4	5	11	6	7	7	5
Cobalt	mg/kg	2	N/A	N/A	48	–	–	–	–	–	–	–	–	–
Copper	mg/kg	5	65	270	20	–	–	8	52	33	23	19	29	9
Iron	mg/kg	50	N/A	N/A	13,600	–	–	–	–	–	–	–	–	–
Lead	mg/kg	5	50	220	**543**	–	–	**108**	**76**	**64**	50	**146**	**106**	30
Lithium	mg/kg	0.1	N/A	N/A	3.9	–	–	–	–	–	–	–	–	–
Manganese	mg/kg	5	N/A	N/A	9,770	–	–	–	–	–	–	–	–	–
Mercury	mg/kg	0.1	0.15	1	**0.2**	–	–	<0.1	**0.4**	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	16	–	–	–	–	–	–	–	–	–
Nickel	mg/kg	2	21	52	21	–	–	4	9	13	6	8	10	3
Selenium	mg/kg	5	N/A	N/A	11	–	–	–	–	–	–	–	–	–
Silver	mg/kg	2	1	3.7	<2	–	–	<2	–	<2	<2	<2	<2	<2
Tin	mg/kg	10	N/A	N/A	20	–	–	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		By-Wash									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Titanium	mg/kg	5	N/A	N/A	<5	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	5	N/A	N/A	8	–	–	–	–	–	–	–	–	–
Zinc	mg/kg	5	200	410	**285**	–	–	68	**207**	137	78	109	166	38
Other parameters														
Moisture content	%	1.0	N/A	N/A	75.4	75.3	–	78.5	84.3	70.6	59.7	74.2	79.9	54.0
Organic matter	%	0.5	N/A	N/A	–	–	56.6	–	–	–	19.2	8.1	14.8	–
pH value	pH unit	0.1	N/A	N/A	7.7	7.9	–	–	–	–	–	–	–	–
TOC	%	0.5	N/A	N/A	10.0	25.5	8.3	–	11.7	7.3	11.1	4.7	8.6	6.4

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Results highlighted in **green bold** exceed the high ISQGs (ANZECC, 2000).

(S) Surface sediment results

(D) Deep sediment results

Table D-6 Results of laboratory sediment quality analysis at freshwater on-site impact monitoring site WMP03 at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG values		WMP03									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012 (D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Acid extractable metals														
Aluminium	mg/kg	50	N/A	N/A	1,050	1,830	2,460	–	–	–	–	–	–	–
Antimony	mg/kg	1.0	2	25	<1.0	–	–	<1.0	–	–	–	–	–	–
Arsenic	mg/kg	1.0	20	70	2.7	<1.0	3.7	–	–	–	–	–	–	–
Barium	mg/kg	1.0	N/A	N/A	227	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1.0	N/A	N/A	<1.0	<1.0	<1.0	–	–	–	–	–	–	–
Boron	mg/kg	1	N/A	N/A	47	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	0.1	1.5	10	0.5	<0.1	0.4	<0.1	–	–	–	–	–	–
Chromium	mg/kg	1.0	80	370	<1.0	1.1	<1.0	<1.0	–	–	–	–	–	–
Cobalt	mg/kg	0.5	N/A	N/A	14.5	3.2	18.7	–	–	–	–	–	–	–
Copper	mg/kg	1.0	65	270	7.3	4.3	14.9	1.6	–	–	–	–	–	–
Iron	mg/kg	50.0	N/A	N/A	2,680	2,630	2,270	–	–	–	–	–	–	–
Lead	mg/kg	1.0	50	220	**167**	**87.6**	**118**	19.7	–	–	–	–	–	–
Manganese	mg/kg	10.0	N/A	N/A	884	2,290	3,570	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		WMP03									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012 (D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Mercury	mg/kg	0.10	0.15	1	–	<0.10	<0.1	–	–	–	–	–	–	–
Molybdenum	mg/kg	1	N/A	N/A	2	–	–	–	–	–	–	–	–	–
Nickel	mg/kg	1.0	21	52	7.3	3.2	6.7	<1.0	–	–	–	–	–	–
Selenium	mg/kg	1	N/A	N/A	3	<0.5	<0.5	–	–	–	–	–	–	–
Silver	mg/kg	1.0	1	3.7	<1.0	<1.0	<1.0	<1.0	–	–	–	–	–	–
Tin	mg/kg	1	N/A	N/A	1	–	–	–	–	–	–	–	–	–
Titanium	mg/kg	1	N/A	N/A	9	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	2.0	N/A	N/A	5.8	8.6	5	–	–	–	–	–	–	–
Zinc	mg/kg	1.0	200	410	112	82.2	90.8	14.8	–	–	–	–	–	–
Total metals														
Aluminium	mg/kg	50	N/A	N/A	9,530	–	–	–	–	–	–	–	–	–
Antimony	mg/kg	5	2	25	<5	–	–	<5		<5	<5	<5	<5	<5
Arsenic	mg/kg	5	20	70	7	–	–	–	5	–	–	–	–	–
Barium	mg/kg	10	N/A	N/A	250	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1	N/A	N/A	<1	–	–	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		WMP03									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012 (D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Boron	mg/kg	50	N/A	N/A	<50	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	1	1.5	10	<1	–	–	<1	<1	<1	<1	2	<1	<1
Chromium	mg/kg	2	80	370	5	–	–	11	10	3	5	11	8	10
Cobalt	mg/kg	2	N/A	N/A	36	–	–	–	–	–	–	–	–	–
Copper	mg/kg	5	65	270	22	–	–	<5	25	10	10	33	32	27
Iron	mg/kg	50	N/A	N/A	6,390	–	–	–	–	–	–	–	–	–
Lead	mg/kg	5	50	220	**192**	–	–	21	**186**	**110**	**146**	**70**	**126**	**150**
Lithium	mg/kg	0.1	N/A	N/A	10.9	–	–	–	–	–	–	–	–	–
Manganese	mg/kg	5	N/A	N/A	835	–	–	–	–	–	–	–	–	–
Mercury	mg/kg	0.1	0.15	1	<0.1	–	–	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	39	–	–	–	–	–	–	–	–	–
Nickel	mg/kg	2	21	52	12	–	–	2	10	6	5	19	14	15
Selenium	mg/kg	5	N/A	N/A	<5	–	–	–	–	–	–	–	–	–
Silver	mg/kg	2	1	3.7	<2	–	–	<2	–	<2	<2	<2	<2	<2
Tin	mg/kg	10	N/A	N/A	30	–	–	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		WMP03									
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012 (D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Titanium	mg/kg	5	N/A	N/A	<5	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	5	N/A	N/A	11	–	–	–	–	–	–	–	–	–
Zinc	mg/kg	5	200	410	140	–	–	22	131	75	106	**379**	176	**285**
Other parameters														
Moisture content	%	1.0	N/A	N/A	86.4	77.7	64.2	34.2	80.4	74.4	72.0	72.4	77.8	78.8
Organic matter	%	0.5	N/A	N/A	–	–	–	–	–	–	5.4	7.3	10.8	–
pH value	pH unit	0.1	N/A	N/A	8.8	8.1	8.1	–	–	–	–	–	–	–
TOC	%	0.5	N/A	N/A	22.2	12.4	7.7	–	7.5	4.4	3.2	4.2	6.2	9.5

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Results highlighted in **green bold** exceed the high ISQGs (ANZECC, 2000).

(S) Surface sediment results

(D) Deep sediment results

Table D-7 Results of laboratory sediment quality analysis at freshwater downstream impact monitoring sites at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG values		SP003			SP004								
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Acid extractable metals																
Aluminium	mg/kg	50	N/A	N/A	480	1,060	1,440	3,470	1,040	–	–	–	–	–	–	–
Antimony	mg/kg	1.0	2	25	<1.0	–	–	–	–	<5	–	–	–	–	–	–
Arsenic	mg/kg	1.0	20	70	1.9	<1.0	3.0	<1.0	1.3	–	–	–	–	–	–	–
Barium	mg/kg	1.0	N/A	N/A	68.9	–	–	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	–	–	–	–	–	–	–
Boron	mg/kg	1	N/A	N/A	5	–	–	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	0.1	1.5	10	<0.1	<0.1	0.2	0.5	0.2	<1	–	–	–	–	–	–
Chromium	mg/kg	1.0	80	370	<1.0	1.2	1.6	2.1	<1.0	11	–	–	–	–	–	–
Cobalt	mg/kg	0.5	N/A	N/A	2.2	3.4	4	3.7	1.2	–	–	–	–	–	–	–
Copper	mg/kg	1.0	65	270	4.3	6.3	11.8	2.1	7.3	21	–	–	–	–	–	–
Iron	mg/kg	50.0	N/A	N/A	3,170	6,970	9,160	11,200	5,420	–	–	–	–	–	–	–
Lead	mg/kg	1.0	50	220	14.4	13.0	25.8	38.1	21.2	38.0	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		SP003			SP004								
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Manganese	mg/kg	10.0	N/A	N/A	534	260	572	388	100	–	–	–	–	–	–	–
Mercury	mg/kg	0.10	0.15	1	–	<0.10	<0.1	<0.10	<0.1	–	–	–	–	–	–	–
Molybdenum	mg/kg	1	N/A	N/A	<1	–	–	–	–	<0.1	–	–	–	–	–	–
Nickel	mg/kg	1.0	21	52	1.6	2.9	3.5	3.2	1.3	–	–	–	–	–	–	–
Selenium	mg/kg	1	N/A	N/A	<1	<0.5	<0.5	<0.5	<0.5	11	–	–	–	–	–	–
Silver	mg/kg	1.0	1	3.7	<1.0	<1.0	<1.0	<1.0	<1.0	–	–	–	–	–	–	–
Tin	mg/kg	1	N/A	N/A	<1	–	–	–	–	<2	–	–	–	–	–	–
Titanium	mg/kg	1	N/A	N/A	5	–	–	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	2.0	N/A	N/A	4.0	7.6	8.0	10.6	8.0	–	–	–	–	–	–	–
Zinc	mg/kg	1.0	200	410	27.4	38.2	51	124	78.2	–	–	–	–	–	–	–
Total metals																
Aluminium	mg/kg	50	N/A	N/A	7,700	–	–	–	–	–	–	–	–	–	–	–
Antimony	mg/kg	5	2	25	<5	–	–	–	–	<1.0		<5	<5	<5	<5	<5
Arsenic	mg/kg	5	20	70	11	–	–	–	–	–	8	–	–	–	–	–

Parameter	Units	LOR	ISQG values		SP003			SP004								
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Barium	mg/kg	10	N/A	N/A	80	–	–	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1	N/A	N/A	<1	–	–	–	–	–	–	–	–	–	–	–
Boron	mg/kg	50	N/A	N/A	<50	–	–	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	1	1.5	10	<1	–	–	–	–	0.3	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2	80	370	16	–	–	–	–	<1.0	11	12	14	9	12	10
Cobalt	mg/kg	2	N/A	N/A	6	–	–	–	–	–	–	–	–	–	–	–
Copper	mg/kg	5	65	270	10	–	–	–	–	<1.0	22	19	28	20	28	22
Iron	mg/kg	50	N/A	N/A	22200	–	–	–	–	–	–	–	–	–	–	–
Lead	mg/kg	5	50	220	18	–	–	–	–	28.8	43	**68**	**60**	36	40	39
Lithium	mg/kg	0.1	N/A	N/A	8.4	–	–	–	–	–	–	–	–	–	–	–
Manganese	mg/kg	5	N/A	N/A	682	–	–	–	–	–	–	–	–	–	–	–
Mercury	mg/kg	0.1	0.15	1	<0.1	–	–	–	–	–	0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Molybdenum	mg/kg	2	N/A	N/A	2	–	–	–	–	2.7	–	–	–	–	–	–
Nickel	mg/kg	2	21	52	6	–	–	–	–	–	12	9	12	**25**	12	9

Parameter	Units	LOR	ISQG values		SP003			SP004								
			Low	High	Autumn 2011	Summer 2012(S)	Summer 2012(D)	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Selenium	mg/kg	5	N/A	N/A	<5	–	–	–	–	<1.0	–	–	–	–	–	–
Silver	mg/kg	2	1	3.7	<2	–	–	–	–	–	–	<2	<2	<2	<2	<2
Tin	mg/kg	10	N/A	N/A	50	–	–	–	–	–	–	–	–	–	–	–
Titanium	mg/kg	5	N/A	N/A	<5	–	–	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	5	N/A	N/A	46	–	–	–	–	107	–	–	–	–	–	–
Zinc	mg/kg	5	200	410	51	–	–	–	–	–	**561**	162	**210**	**398**	190	173
Other parameters																
Moisture content	%	1.0	N/A	N/A	43.8	40.7	7.7	55.3	44.7	42.5	71.2	74.3	76.1	53.5	68.3	56.9
Organic matter	%	0.5	N/A	N/A	–	–	–	–	–	–	–	–	11.4	11.1	14.1	–
pH value	pH unit	0.1	N/A	N/A	8.1	7.4	8.1	7.8	7.2	–	–	–	–	–	–	–
TOC	%	0.5	N/A	N/A	12.4	28.4	9.94	10.4	9.24	–	6.5	4.1	6.6	6.4	8.2	12.9

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Results highlighted in **green bold** exceed the high ISQGs (ANZECC, 2000).

(S) Surface sediment results

(D) Deep sediment results

Table D-8 Results of laboratory sediment quality analysis at freshwater downstream recovery monitoring site Weir at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG values		Weir								
			Low	High	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Acid extractable metals													
Aluminium	mg/kg	50	N/A	N/A	140	180	–	–	–	–	–	–	–
Antimony	mg/kg	1.0	2	25	–	–	<1.0	–	–	–	–	–	–
Arsenic	mg/kg	1.0	20	70	<1.0	<1.0	–	–	–	–	–	–	–
Barium	mg/kg	1.0	N/A	N/A	–	–	–	–	–	–	–	–	–
Beryllium	mg/kg	1.0	N/A	N/A	<1.0	<1.0	–	–	–	–	–	–	–
Boron	mg/kg	1	N/A	N/A	–	–	–	–	–	–	–	–	–
Cadmium	mg/kg	0.1	1.5	10	<0.1	<0.1	<0.1	–	–	–	–	–	–
Chromium	mg/kg	1.0	80	370	<1.0	<1.0	<1.0	–	–	–	–	–	–
Cobalt	mg/kg	0.5	N/A	N/A	<0.5	<0.5	–	–	–	–	–	–	–
Copper	mg/kg	1.0	65	270	<1.0	<1.0	1.2	–	–	–	–	–	–
Iron	mg/kg	50.0	N/A	N/A	440	230	–	–	–	–	–	–	–
Lead	mg/kg	1.0	50	220	2.7	8.0	4.9	–	–	–	–	–	–
Manganese	mg/kg	10.0	N/A	N/A	25	<10	–	–	–	–	–	–	–

Parameter	Units	LOR	ISQG values		Weir								
			Low	High	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Mercury	mg/kg	0.10	0.15	1	<0.10	<0.1	–	–	–	–	–	–	–
Molybdenum	mg/kg	1	N/A	N/A	–	–	–	–	–	–	–	–	–
Nickel	mg/kg	1.0	21	52	<1.0	<1.0	<1.0	–	–	–	–	–	–
Selenium	mg/kg	1	N/A	N/A	<0.5	<0.5	–	–	–	–	–	–	–
Silver	mg/kg	1.0	1	3.7	<1.0	<1.0	<1.0	–	–	–	–	–	–
Tin	mg/kg	1	N/A	N/A	–	–	–	–	–	–	–	–	–
Titanium	mg/kg	1	N/A	N/A	–	–	–	–	–	–	–	–	–
Vanadium	mg/kg	2.0	N/A	N/A	<2.0	<2.0	–	–	–	–	–	–	–
Zinc	mg/kg	1.0	200	410	7.5	7.5	22.7	–	–	–	–	–	–
Total metals													
Antimony	mg/kg	5	2	25	–	–	<5	–	<5	<5	<5	<5	<5
Arsenic	mg/kg	5	20	70	–	–	–	7	–	–	–	–	–
Cadmium	mg/kg	1	1.5	10	–	–	<1	<1	<1	<1	<1	<1	<1
Chromium	mg/kg	2	80	370	–	–	3	13	6	5	6	5	6
Copper	mg/kg	5	65	270	–	–	<5	32	10	9	13	<5	<5
Lead	mg/kg	5	50	220	–	–	<5	**70**	23	23	28	9	17

Parameter	Units	LOR	ISQG values		Weir								
			Low	High	Summer 2012(S)	Summer 2012(D)	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Mercury	mg/kg	0.1	0.15	1	–	–	<0.1	<0.1	<0.1	<0.1	**0.2**	<0.1	<0.1
Nickel	mg/kg	2	21	52	–	–	<2	7	4	4	5	<2	4
Silver	mg/kg	2	1	3.7	–	–	<2	–	<2	<2	<2	<2	<2
Zinc	mg/kg	5	200	410	–	–	49	**490**	74	50	223	6	36
Other parameters													
Moisture content	%	1.0	N/A	N/A	19.3	5.4	16.7	40.2	48.3	46.4	54.2	32.2	32.4
Organic matter	%	0.5	N/A	N/A	–	–	–	–	–	13.3	13.0	2.7	–
pH value	pH unit	0.1	N/A	N/A	8.4	7.7	–	–	–	–	–	–	–
TOC	%	0.5	N/A	N/A	0.26	0.18	–	3.6	3.2	7.7	7.5	1.5	4.6

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Results highlighted in **green bold** exceed the high ISQGs (ANZECC, 2000).

(S) Surface sediment results

(D) Deep sediment results

D.2.2 Estuarine sites

Table D-9 Results of laboratory sediment quality analysis at estuarine reference monitoring site SSCIZ at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG		SSCIZ	
			Low	High	Autumn 2014	Spring 2014
Total metals						
Antimony	mg/kg	5	2	25	<5	<5
Cadmium	mg/kg	1	1.5	10	**3**	**2**
Chromium	mg/kg	2	80	370	13	7
Copper	mg/kg	5	65	270	**81**	41
Lead	mg/kg	5	50	220	**67**	48
Mercury	mg/kg	0.1	0.15	1	<0.1	<0.1
Nickel	mg/kg	2	21	52	7	4
Silver	mg/kg	2	1	3.7	<2	<2
Zinc	mg/kg	5	200	410	**308**	**259**
Other parameters						
Moisture content	%	1.0	N/A	N/A	65.5	42.8
Organic matter	%	0.5	N/A	N/A	9.7	–
TOC	%	0.5	N/A	N/A	5.6	1.6

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Table D-10 Results of laboratory water quality analysis at estuarine downstream recovery monitoring site IZ at Newstan Colliery Surface Site

Parameter	Units	LOR	ISQG values		IZ						
			Low	High	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Acid extractable metals											
Antimony	mg/kg	1.0	2	25	<1.0	–	–	–	–	–	–
Cadmium	mg/kg	0.1	1.5	10	1.4	–	–	–	–	–	–
Chromium	mg/kg	1.0	80	370	<1.0	–	–	–	–	–	–
Copper	mg/kg	1.0	65	270	5.2	–	–	–	–	–	–
Lead	mg/kg	1.0	50	220	28.0	–	–	–	–	–	–
Nickel	mg/kg	1.0	21	52	<1.0	–	–	–	–	–	–
Silver	mg/kg	1.0	1	3.7	<1.0	–	–	–	–	–	–
Zinc	mg/kg	1.0	200	410	117	–	–	–	–	–	–
Total metals											
Antimony	mg/kg	5	2	25	**21**	–	<5	<5	<5	<5	<5
Arsenic	mg/kg	5	20	70	–	11	–	–	–	–	–
Cadmium	mg/kg	1	1.5	10	**2**	**2**	**3**	**2**	**2**	**2**	**2**
Chromium	mg/kg	2	80	370	10	8	16	9	12	13	8

Parameter	Units	LOR	ISQG values		IZ						
			Low	High	Summer 2013	Autumn 2013	Winter 2013	Spring 2013	Summer 2014	Autumn 2014	Spring 2014
Copper	mg/kg	5	65	270	43	53	**72**	38	35	44	39
Lead	mg/kg	5	50	220	46	48	**64**	40	44	**52**	41
Mercury	mg/kg	0.1	0.15	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	mg/kg	2	21	52	5	5	10	6	5	6	5
Silver	mg/kg	2	1	3.7	<2	–	<2	<2	<2	<2	<2
Zinc	mg/kg	5	200	410	**268**	**295**	**314**	176	**242**	197	178
Other parameters											
Moisture content	%	1.0	N/A	N/A	51.7	50.2	58.6	50.3	44.6	49.2	35.0
Organic matter	%	0.5	N/A	N/A	–	–	–	6.1	3.6	5.1	–
TOC	%	0.5	N/A	N/A	–	4.9	5.0	3.5	2.1	3.0	4.2

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Table D-11 Results of laboratory sediment quality analysis at other estuarine downstream recovery monitoring sites at Newstan Colliery Surface Site (surface sediment results)

Parameter	Units	LOR	ISQG values		LT1	LT2	LT3	LT4	LT5	LT6	LT7	Ref1
			Low	High	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)
Acid extractable metals												
Aluminium	mg/kg	50	N/A	N/A	760	220	630	370	820	1490	700	760
Arsenic	mg/kg	1.0	20	70	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Beryllium	mg/kg	1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	mg/kg	0.1	1.5	10	1.4	0.3	**1.9**	0.7	**2.2**	1.5	**2.0**	**5.2**
Chromium	mg/kg	1.0	80	370	<1.0	<1.0	<1.0	<1.0	1.1	<1.0	<1.0	1.3
Cobalt	mg/kg	0.5	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	mg/kg	1.0	65	270	<1.0	<1.0	3.2	<1.0	8.6	<1.0	2.8	1.7
Iron	mg/kg	50.0	N/A	N/A	530	250	1090	300	1540	580	1600	3750
Lead	mg/kg	1.0	50	220	14.4	2.8	16.2	5.1	23.9	16.2	34.2	**50.9**
Manganese	mg/kg	10.0	N/A	N/A	<10	<10	<10	<10	10	<10	61	16
Mercury	mg/kg	0.10	0.15	1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nickel	mg/kg	1.0	21	52	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Selenium	mg/kg	1	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	Units	LOR	ISQG values		LT1	LT2	LT3	LT4	LT5	LT6	LT7	Ref1
			Low	High	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)	Summer 2012(S)
Silver	mg/kg	1.0	1	3.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium	mg/kg	2.0	N/A	N/A	8.8	<2.0	6.4	4.8	8.2	14.8	4.9	7.0
Zinc	mg/kg	1.0	200	410	86.0	16.7	76.4	25.9	119	96.9	234	160
Other parameters												
Moisture content	%	1.0	N/A	N/A	32.7	23.5	27.0	28.4	33.1	46.9	36.6	45.4
pH value	pH unit	0.1	N/A	N/A	8.2	8.2	8.6	8.6	8.4	8.0	8.5	8.6

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

(S) Surface sediment results

Table D-12 Results of laboratory sediment quality analysis at other estuarine downstream recovery monitoring sites at Newstan Colliery Surface Site (deep sediment results)

Parameter	Units	LOR	ISQG values		LT1	LT2	LT3	LT4	LT5	LT6	LT7	Ref1
			Low	High	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)
Acid extractable metals												
Aluminium	mg/kg	50	N/A	N/A	710	220	600	690	500	1,410	670	1,040
Arsenic	mg/kg	1.0	20	70	3.6	<1.0	1.2	2.6	<1.0	<1.0	2.4	<1.0
Beryllium	mg/kg	1.0	N/A	N/A	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	mg/kg	0.1	1.5	10	**3.2**	0.4	1.1	0.2	1.1	1.1	0.6	**13.8**
Chromium	mg/kg	1.0	80	370	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.4
Cobalt	mg/kg	0.5	N/A	N/A	0.9	<0.5	<0.5	<0.5	<0.5	<0.5	0.9	0.5
Copper	mg/kg	1.0	65	270	10.5	1.1	1.4	1.1	2.2	1.1	6.2	3
Iron	mg/kg	50.0	N/A	N/A	1,940	260	490	1,050	770	690	1,330	3,990
Lead	mg/kg	1.0	50	220	25.3	2.7	11.0	4.4	11.7	20.1	24.6	111
Manganese	mg/kg	10.0	N/A	N/A	11	<10	<10	<10	<10	<10	67	23
Mercury	mg/kg	0.10	0.15	1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	–	<0.1
Nickel	mg/kg	1.0	21	52	1.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Selenium	mg/kg	1	N/A	N/A	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Parameter	Units	LOR	ISQG values		LT1	LT2	LT3	LT4	LT5	LT6	LT7	Ref1
			Low	High	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)	Summer 2012(D)
Silver	mg/kg	1.0	1	3.7	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Vanadium	mg/kg	2.0	N/A	N/A	8.9	<2.0	6.6	14.1	5.8	15.5	2.6	12.8
Zinc	mg/kg	1.0	200	410	132	16.8	40.6	10.0	61.3	92.7	200	**396**
Other parameters												
Moisture content	%	1.0	N/A	N/A	32.8	<1.0	25.8	27.4	20.6	47.2	–	40.7
pH value	pH unit	0.1	N/A	N/A	7.7	7.7	8.1	7.2	7.7	7.3	7.7	7.8
TOC	%	0.5	N/A	N/A	4.16	0.07	1.23	1.84	1.88	3.90	0.68	3.68

Results highlighted in **orange bold** exceed the low ISQG (ANZECC, 2000).

Results highlighted in **green bold** exceed the high ISQGs (ANZECC, 2000).

(D) Deep sediment results

Appendix E – Aquatic ecology relative richness plots

E.1 Cooranbong Services Site

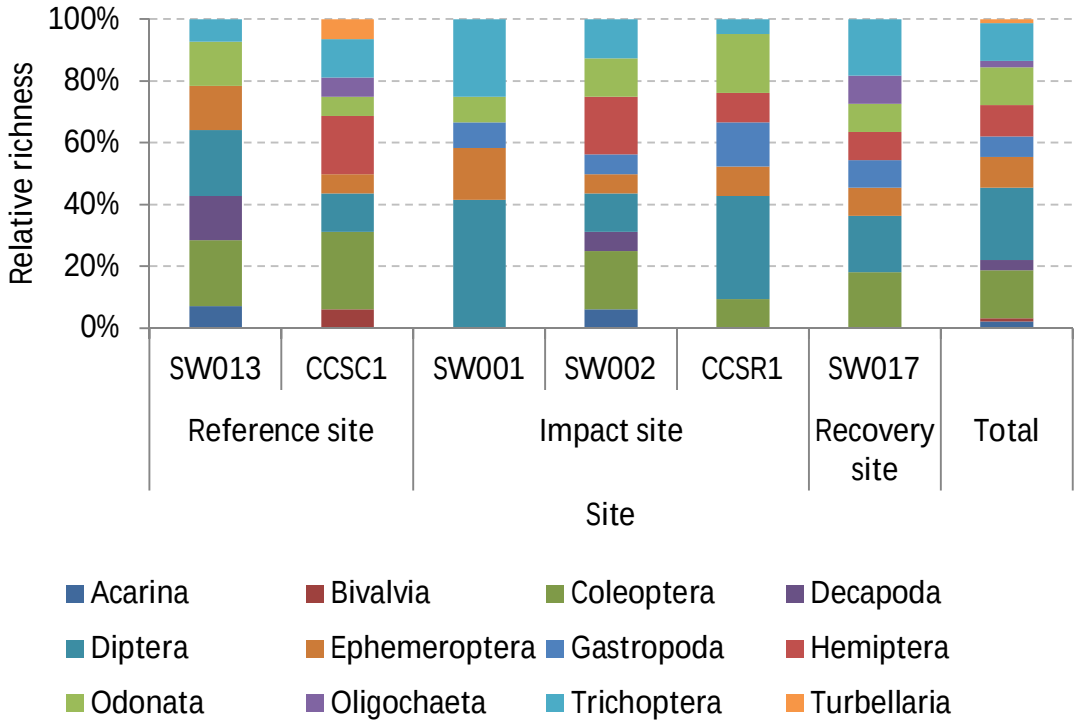


Figure E-1 Relative richness for sites surveyed in winter 2012 at Cooranbong Services Site

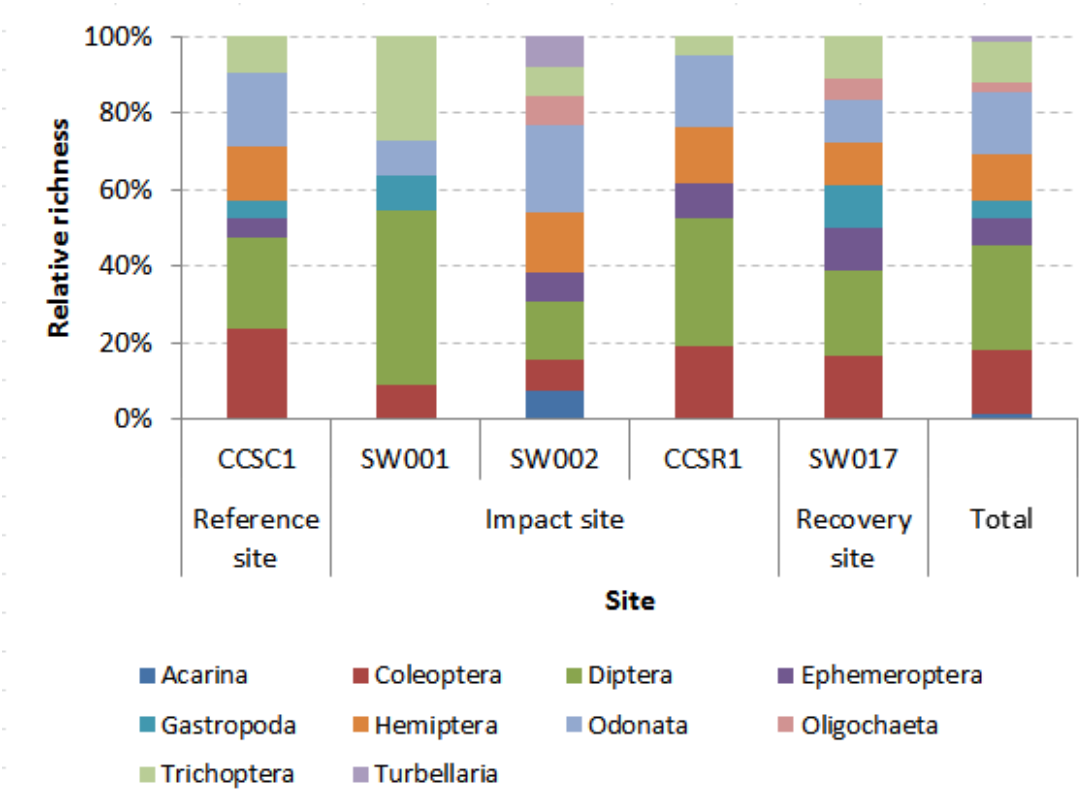


Figure E-2 Relative richness for sites surveyed in spring 2013 at Cooranbong Services Site

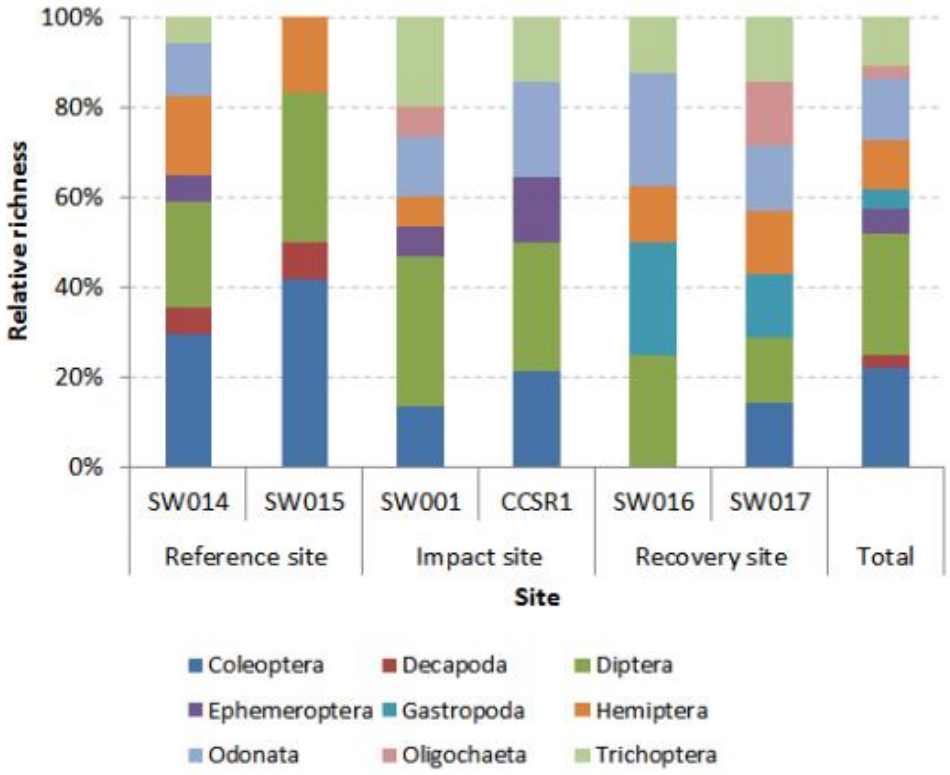


Figure E-3 Relative richness for sites surveyed in autumn 2014 at Cooranbong Services Site

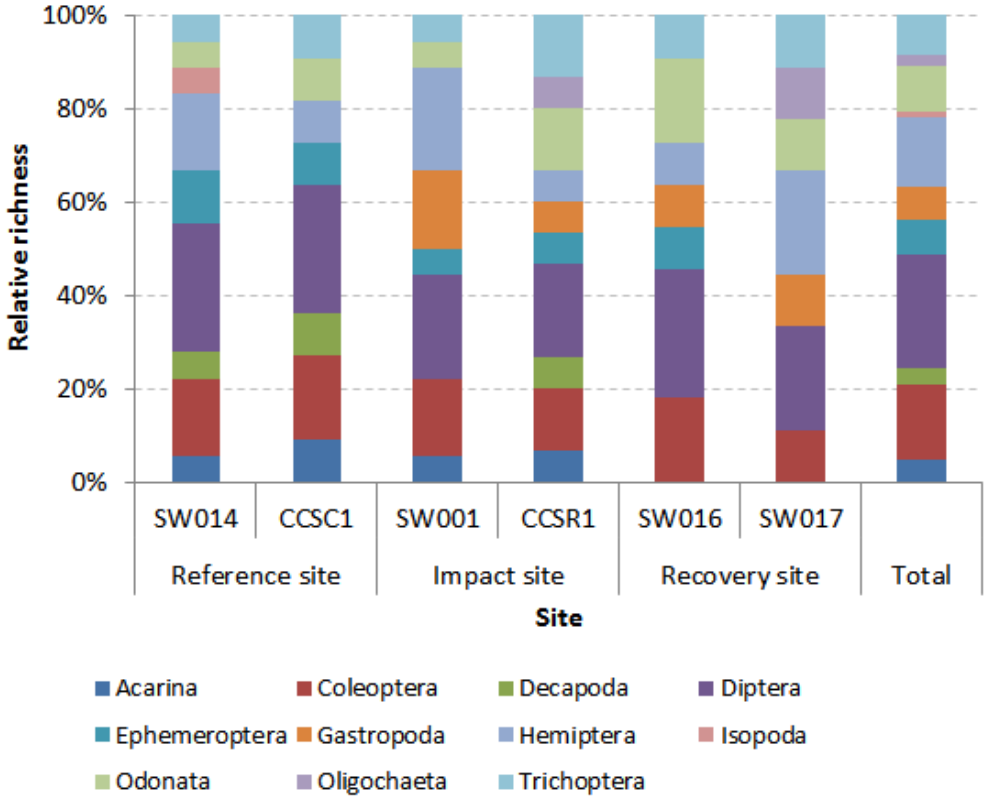


Figure E-4 Relative richness for sites surveyed in spring 2014 at Cooranbong Services Site

E.2 Newstan Colliery Surface Site

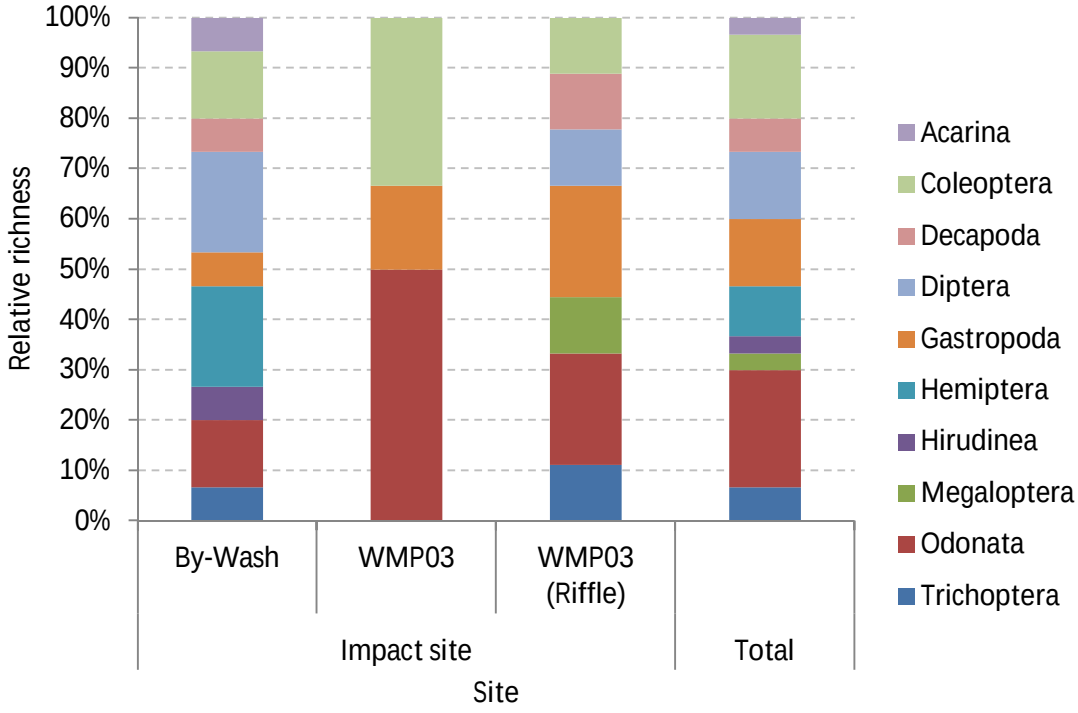


Figure E-5 Relative richness for sites surveyed in autumn 2011 at Newstan Colliery Surface Site

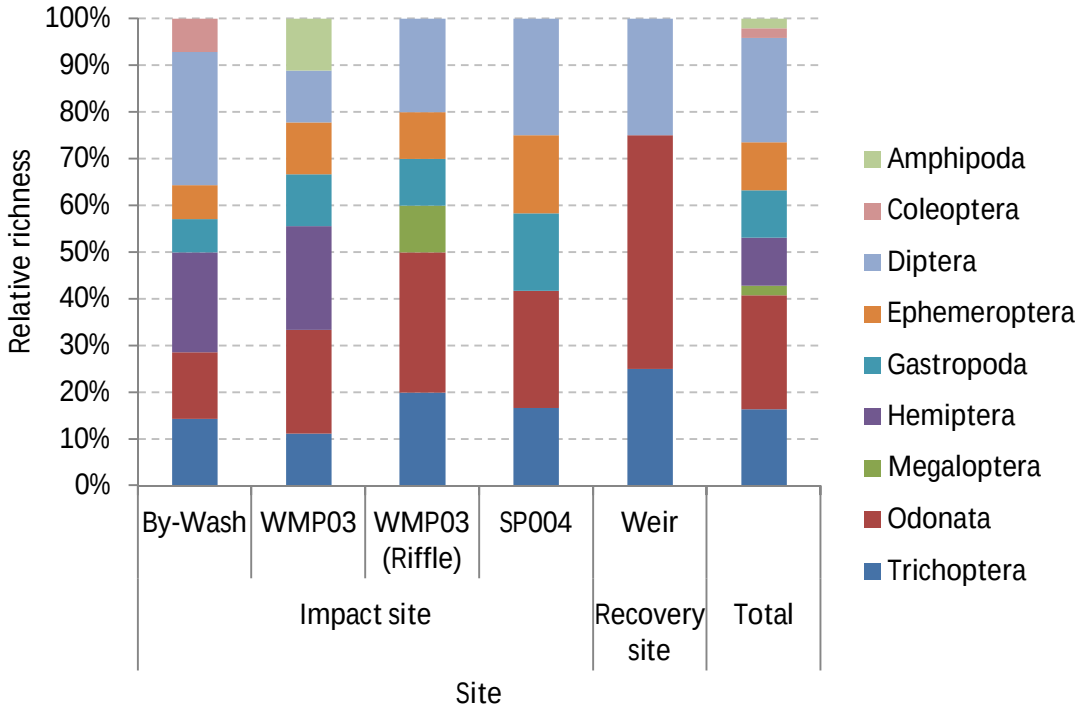


Figure E-6 Relative richness for sites surveyed in summer 2012 at Newstan Colliery Surface Site

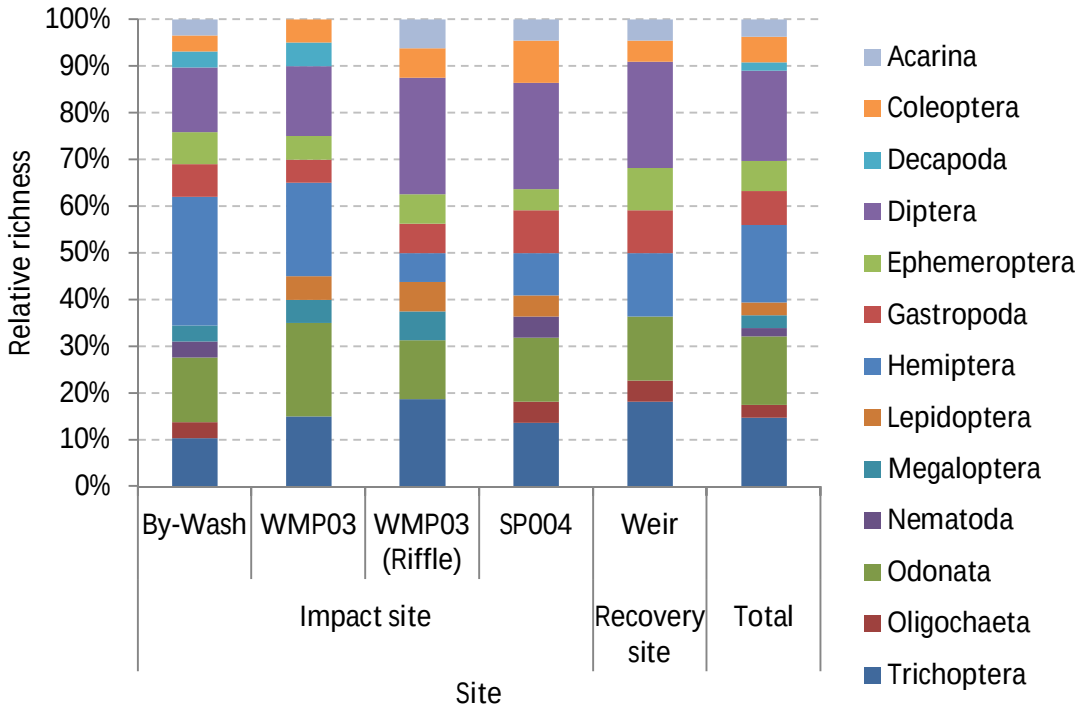


Figure E-7 Relative richness for sites surveyed in summer 2013 at Newstan Colliery Surface Site

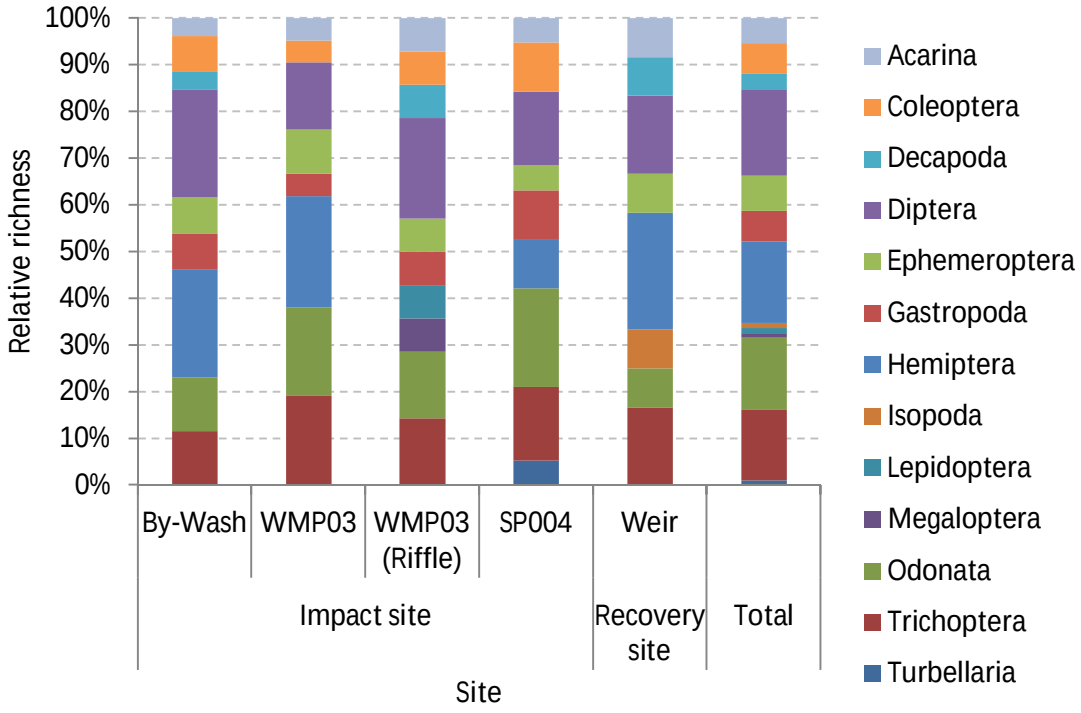


Figure E-8 Relative richness for sites surveyed in autumn 2013 at Newstan Colliery Surface Site

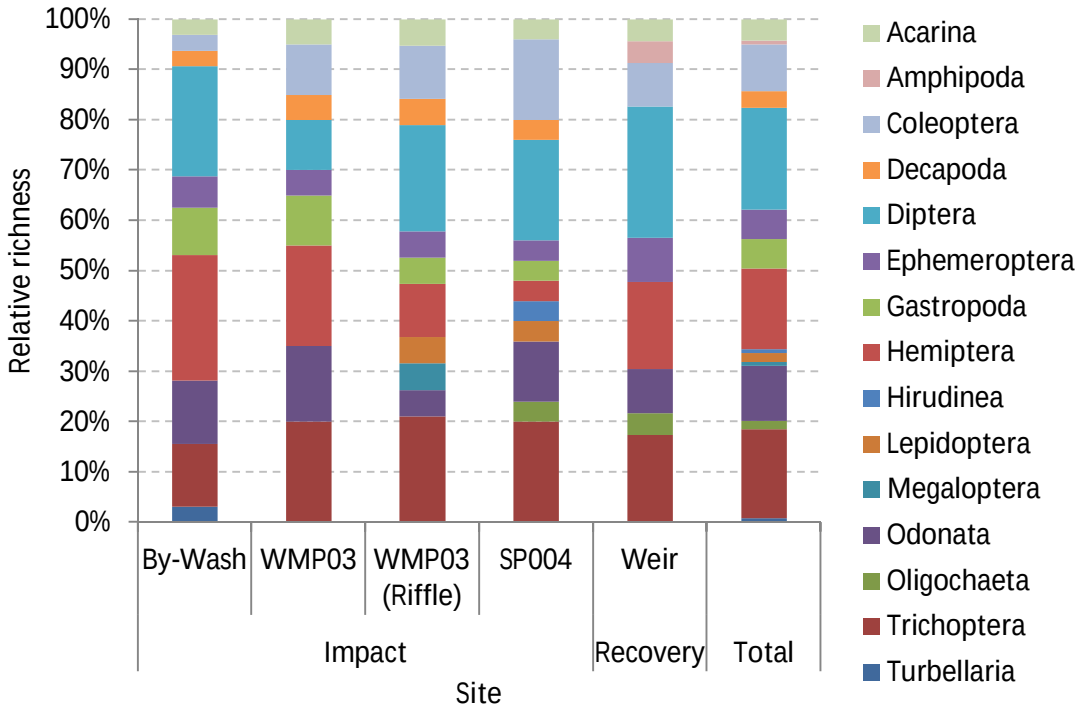


Figure E-9 Relative richness for sites surveyed in spring 2013 at Newstan Colliery Surface Site

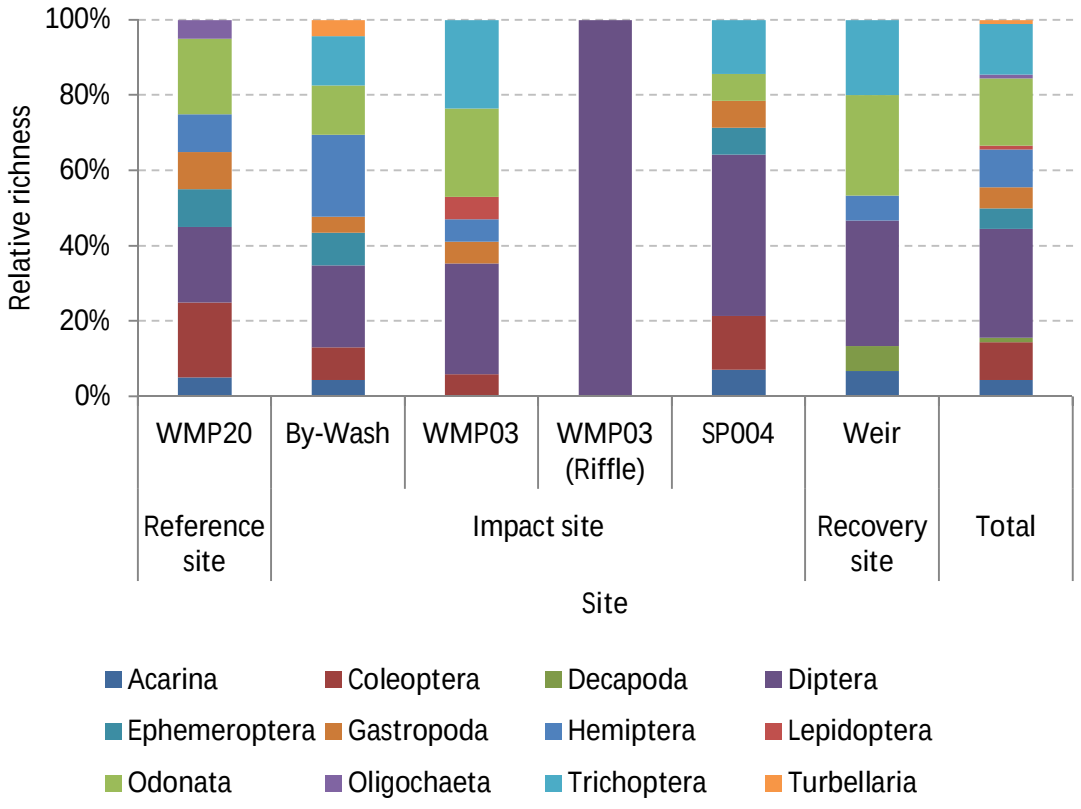


Figure E-10 Relative richness for sites surveyed in autumn 2014 at Newstan Colliery Surface Site

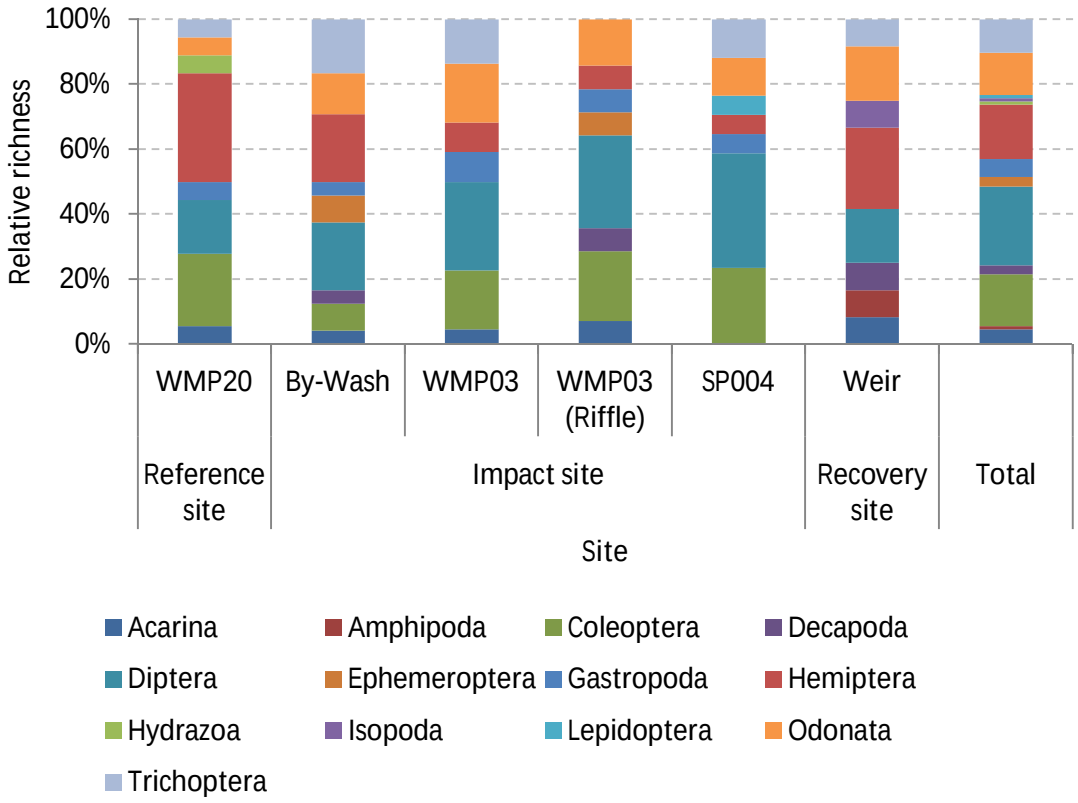


Figure E-11 Relative richness for sites surveyed in spring 2014 at Newstan Colliery Surface Site

Appendix F – Ecotoxicology assessment water quality results

F.1 Cooranbong Services Site

Table F-1 Summary of water quality results for Cooranbong LDP001 ecotoxicology assessment

Parameter	Units	LOR	SSTVs (GHD, 2013a)	LDP001 discharge
Physicochemical parameters				
pH	pH unit	0.01	6.5–9.0	8.17
Electrical conductivity	µS/cm	1	2,200	**4,130**
TDS	mg/L	10	N/A	2,430
TSS	mg/L	5	50	10
Turbidity	NTU	0.1	56	9.4
Nutrients				
Nitrite + nitrate as N	mg/L	0.01	N/A	0.64
TKN	mg/L	0.1	N/A	0.4
Total nitrogen	mg/L	0.1	1.3	1.0
Total phosphorus	mg/L	0.01	0.1	<0.01
Anions				
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	973
Total alkalinity $CaCO_3$	mg/L	1	N/A	973
Chloride	mg/L	1	N/A	198
Sulfate	mg/L	1	N/A	786
Cations				
Calcium	mg/L	1	N/A	26
Magnesium	mg/L	1	N/A	47
Potassium	mg/L	1	N/A	868
Sodium	mg/L	1	N/A	23
Dissolved metals				
Aluminium	mg/L	0.01	1.97	<0.01
Arsenic	mg/L	0.001	0.024	<0.001
Beryllium	mg/L	0.001	N/A	<0.001
Boron	mg/L	0.05	0.37	0.25

Parameter	Units	LOR	SSTVs (GHD, 2013a)	LDP001 discharge
Cadmium	mg/L	0.0001	0.0008	<0.0001
Chromium	mg/L	0.001	0.0037	<0.001
Cobalt	mg/L	0.001	0.001	**0.005**
Copper	mg/L	0.001	0.00546	<0.001
Iron	mg/L	0.05	2.58	0.15
Lead	mg/L	0.001	0.02584	<0.001
Lithium	mg/L	0.001	N/A	0.171
Manganese	mg/L	0.001	1.9	0.007
Mercury	mg/L	0.0001	0.0006	<0.0001
Molybdenum	mg/L	0.001	N/A	0.027
Nickel	mg/L	0.001	0.0429	**0.059**
Selenium	mg/L	0.01	0.011	<0.01
Silver	mg/L	0.001	0.001	<0.001
Vanadium	mg/L	0.01	N/A	<0.01
Zinc	mg/L	0.005	0.0312	0.006
Other parameters				
Silica	mg/L	0.1	N/A	12.4
TOC	mg/L	1	N/A	<1

Results highlighted in **orange bold** exceed the GHD (2013a) SSTVs.

F.2 Newstan Colliery Surface Site

Table F-2 Summary of water quality results for Newstan LDP001 ecotoxicology assessments

Parameter	Units	LOR	SSTVs (GHD, 2011)	Untreated discharge	Laboratory treated discharge	Clean Water Plant discharge		
				May 2011	April 2012	May 2014	November 2014(A)	November 2014(B)
Physicochemical parameters								
pH	pH unit	0.01	6.5–8.5	7.01^	7.87	8.1^	8.06	8.06
Electrical conductivity	µS/cm	1	2,200	**2,540^**	2,200	1,452^	**2,600**	**2,610**
TDS	mg/L	10.0	N/A	1,730	–	1,220	1,690	1,700
TSS	mg/L	5	50	6	–	8	<5	<5
Turbidity	NTU	–	50	9.4	–	0.0^	0.0^	0.0^
Total hardness as $CaCO_3$	mg/L	1	N/A	–	–	–	–	–
Nutrients								
Ammonia as N	mg/L	0.01	0.9	0.12	–	<0.01	–	–
Nitrite + nitrate as N	mg/L	0.01	N/A	0.02	0.04	0.22	0.21	0.22
TKN	mg/L	0.1	N/A	0.2	<0.5	0.2	<0.1	0.1
Total nitrogen	mg/L	0.1	0.5	0.2	<0.5	0.4	0.2	0.3
Total phosphorus	mg/L	0.01	0.05	<0.01	<0.05	0.02	<0.01	<0.01

Parameter	Units	LOR	SSTVs (GHD, 2011)	Untreated discharge	Laboratory treated discharge	Clean Water Plant discharge		
				May 2011	April 2012	May 2014	November 2014(A)	November 2014(B)
Anions								
Bicarbonate alkalinity as $CaCO_3$	mg/L	1	N/A	652	–	534	575	582
Total alkalinity $CaCO_3$	mg/L	1	N/A	652	662	534	575	582
Chloride	mg/L	1	N/A	440	235	313	454	455
Sulfate	mg/L	1	N/A	132	190	114	137	133
Cations								
Calcium	mg/L	1	N/A	26	33.4	18	32	34
Magnesium	mg/L	1	N/A	9	9.9	7.0	9	10
Potassium	mg/L	1	N/A	4	9.9	3	4	4
Sodium	mg/L	1	N/A	621	483	427	575	578
Dissolved metals								
Aluminium	mg/L	0.01	0.68	0.16	<0.010	<0.01	<0.01	<0.01
Antimony	mg/L	0.001	N/A	<0.001	–	–	<0.001	<0.001
Arsenic	mg/L	0.001	0.024	**0.029**	<0.0005	<0.001	<0.001	<0.001
Barium	mg/L	0.001	N/A	0.173	–	0.109	0.106	0.108

Parameter	Units	LOR	SSTVs (GHD, 2011)	Untreated discharge	Laboratory treated discharge	Clean Water Plant discharge		
				May 2011	April 2012	May 2014	November 2014(A)	November 2014(B)
Beryllium	mg/L	0.001	N/A	<0.001	<0.001	–	<0.001	<0.001
Boron	mg/L	0.05	0.37	0.24	0.182	–	0.21	0.21
Cadmium	mg/L	0.0001	0.00054	<0.0001	<0.001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.0025	<0.001	<0.002	<0.001	<0.001	<0.001
Cobalt	mg/L	0.001	N/A	0.003	<0.002	<0.001	<0.001	<0.001
Copper	mg/L	0.001	0.0035	<0.001	<0.002	0.003	0.002	0.002
Iron	mg/L	0.05	0.30	0.05	<0.01	<0.05	<0.05	<0.05
Lead	mg/L	0.001	0.0136	0.007	0.003	0.003	0.005	0.005
Lithium	mg/L	0.001	N/A	0.160	0.144	–	0.138	0.134
Manganese	mg/L	0.001	1.9	0.105	0.138	<0.001	<0.001	<0.001
Mercury	mg/L	0.0001	0.0006	<0.0001	<0.0005	<0.0001	<0.0001	<0.0001
Molybdenum	mg/L	0.001	N/A	0.039	0.017	–	0.015	0.016
Nickel	mg/L	0.001	0.0275	0.016	0.009	0.010	0.009	0.009
Selenium	mg/L	0.01	0.03	**0.12**	<0.0005	–	<0.01	<0.01
Silver	mg/L	0.001	0.00005	<0.001	<0.001	–	<0.001	<0.001

Parameter	Units	LOR	SSTVs (GHD, 2011)	Untreated discharge	Laboratory treated discharge	Clean Water Plant discharge		
				May 2011	April 2012	May 2014	November 2014(A)	November 2014(B)
Strontium	mg/L	0.001	N/A	–	–	–	1.97	1.95
Tin	mg/L	0.001	N/A	<0.001	–	–	<0.001	<0.001
Titanium	mg/L	0.01	N/A	<0.01	–	–	<0.01	<0.01
Vanadium	mg/L	0.01	N/A	<0.01	<0.01	–	<0.01	<0.01
Zinc	mg/L	0.005	0.02	0.012	0.002	–	0.006	<0.005
Other parameters								
Oil and grease	mg/L	5	N/A	<5	–	–	<5	<5
Silica	mg/L	0.1	N/A	14.2	13.0	–	11.8	12.0

Results highlighted in **orange bold** exceed the GHD (2011) SSTVs.

(A) LDP001-A sample results

(B) LDP001-B sample results

^ *In situ* field measurement.

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Appendix 5 – Revised Air Quality Impact Assessment

global environmental solutions

Northern Coal Logistics Project

Air Quality Impact Assessment

Report Number 630.10123-R1

11 December 2014

Northern Coal Services Pty Ltd
PO BOX 1000
Toronto NSW 2283

Version: Revision 3

Northern Coal Logistics Project

Air Quality Impact Assessment

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Executive Summary

Introduction

SLR Consulting was commissioned by Northern Coal Services Pty Limited (Northern Coal Services) to conduct an Air Quality Impact Assessment (AQIA) for the Northern Coal Logistics Project located between Fassifern and Dora Creek on the western side of Lake Macquarie, New South Wales.

The Northern Coal Logistics Project (the Project) comprises of the operations at Newstan Colliery Surface Site, Hawkmount Quarry, Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site) and the private haul roads. As part of the Project, various upgrades have been proposed to the operations at Newstan Colliery Surface Site. The aim of this AQIA was to assess the air quality impacts on surrounding sensitive receivers associated with the Project and the upgrades at Newstan Colliery Surface Site.

Methodology

This assessment has been completed in accordance with the "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (DEC, 2005) (the Approved Methods) issued by the New South Wales Environment Protection Authority (NSW EPA). Air quality criteria specified by the NSW EPA were adopted as stipulated in the Approved Methods. In the absence of criteria applicable to $PM_{2.5}$ in the Approved Methods, the NEPM advisory reporting standard (2003) was adopted.

Dispersion modelling was conducted for the identified sources at Newstan Colliery Surface Site, Hawkmount Quarry, Cooranbong Entry Site and the private haul roads for particulates (TSP, PM_{10} and $PM_{2.5}$) and odour for ten scenarios:

- eight scenarios associated with the operations at the Newstan Colliery Surface Site; and
- two scenarios associated with the operations at the Cooranbong Entry Site.

In order to assess the background air quality of the region a number of industrial facilities with the potential to have a cumulative impact on the local airshed were identified. A dispersion modelling exercise was performed to determine suitable background levels of pollutants in order to assess the cumulative impacts.

Results

The dispersion modelling exercise for the Project indicates that:

- The annual average deposited dust concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The annual average TSP concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The annual average PM_{10} concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The annual average $PM_{2.5}$ concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.

Executive Summary

- The 24-hour average PM_{10} concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site. The 24-hour average PM_{10} concentrations were likely to exceed the relevant criterion for three scenarios at the receptor 'NC6' surrounding the Newstan Colliery Surface Site. To achieve the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site, it was recommended that:
  - Train loading operations are automated once it is proposed to export 6 Mtpa from the Newstan Colliery Surface Site; and
  - Coal transfers between the CPP and the rail loop stockpile are automated once it is proposed to export 6 Mtpa AND train loading operations are automated once it is proposed to export 8 Mtpa from the Newstan Colliery Surface Site.
- The 24-hour average $PM_{2.5}$ concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The 99th percentile odour concentrations were predicted to be below the relevant criterion at all the identified sensitive receptors during Project operations for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.

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APPENDICES

Appendix A Detailed Emissions Inventory (CLP)
Appendix B Contour Plots

ABBREVIATIONS

%	percent
°C	degrees Celsius
µg	Microgram
µg/m^3	microgram per cubic metre of air
µg/Nm^3	microgram per normalised cubic metre of air (273K, 101.3kPa)
µm	micrometre or micron
AGL	above ground level
AHD	Australian Height Datum
AP-42	US EPA Emission Factor Handbook
AQIA	air quality impact assessment
AWS	automatic weather station
Centennial Mandalong	Centennial Mandalong Pty Ltd
Centennial Newstan	Centennial Newstan Pty Ltd
CH_4	methane
CO	carbon monoxide
CO_2	carbon dioxide
CSIRO	Australian Commonwealth Scientific and Industrial Research Organisation

DECC	Former NSW Department of Environment and Climate Change (see OEH and EPA)
DECCW	Former NSW Department of Environment, Climate Change and Water (see OEH and EPA)
DDG	dust deposition gauge
DP&I	Department of Planning and Infrastructure
DGRs	Director General's Requirements
EETM	Emission Estimation Technique Manual
EF	Emission Factor
EIS	Environmental Impact Statement
EHS	Environmental Health and Safety
EPA	Environment Protection Authority
EPS	Eraring Power Station
FEL	front-end loader
g	Gram
$g/m^2/month$	grams per square metre per month
HVAS	High Volume Air Sampler
ha	hectare
J	joule
K	degrees Kelvin
kg	kilogram
kg/hr	kilogram per hour
km	kilometre
km E	kilometres east
km N	kilometres north
L	litre
m	metre
M	million
m/s	metre per second
m^2	square metre
m^3	cubic metre
min	minute
mm	millimetre
Mt	million tonnes
Mtpa	million tonnes per annum
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NO	nitric oxide
NO_2	nitrogen dioxide
NO_X	oxides of nitrogen
NPI	National Pollutant Inventory (Australia)
NSW	New South Wales
OEH	NSW Office of Environment and Heritage
Pa	Pascal
PM	Particulate Matter
PM_{10}	particular matter with an equivalent aerodynamic diameter of 10 microns or less
$PM_{2.5}$	particular matter with an equivalent aerodynamic diameter of 2.5 microns or less
ppb	parts per billion (10^9)
ppm	parts per million (10^6)
ROM	run of mine
SI	Système International
SO_2	sulfur dioxide
t	tonne
TEOM	tapered element oscillating microbalance
tpa	tonnes per annum
TSP	total suspended particulate matter
US EPA	United States Environmental Protection Agency

UTM	Universal Transverse Mercator
VOC	volatile organic compound
W	watt
WGS	World Geodetic System

GLOSSARY

air dispersion model	A computer-based software program which provides a mathematical prediction of how pollutants from a source will be distributed in the surrounding area under specific conditions of wind, temperature, humidity and other environmental factors
airshed	The geographical area associated with a given air supply
algorithms	A step-by-step problem-solving procedure, especially an established, recursive computational procedure for solving a problem in a finite number of steps
ambient	Pertaining to the surrounding environment or prevailing conditions
anemometer	An instrument for measuring wind force and velocity
atmosphere	A gaseous mass surrounding the planet Earth that is retained by Earth's gravity. It is divided into five layers. Most of the weather and clouds are found in the first layer
atmospheric stability	The tendency of the atmosphere to resist or enhance vertical motion
atmospheric pressure	The force per unit area exerted against a surface by the weight of air above that surface in the Earth's atmosphere
background	The existing air quality in the Project area excluding the impacts from the proposed development
baseline monitoring program	A monitoring program designed to measure the ambient concentration levels which currently exist prior to the proposed development
CALMET	A meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain
CALPOST	A post-processor used to process CALPUFF files, producing tabulations that summarize results of the simulation for user-selected averaging periods
CALPUFF	A transport and dispersion model that advects “puffs” of material emitted from modelled sources, simulating dispersion and transformation processes
climatological	The science dealing with climate and climatic phenomena
combustion	The process of thermal oxidation. A chemical change, especially oxidation, accompanied by the production of heat and light
commissioning	A systematic process of ensuring that a new facility performs according to the documented design intent and the owner’s operational needs, and that specified system documentation and training are provided to the facility staff
crushers	A machine designed to reduce large rocks into smaller rocks, gravel, or rock dust
decommissioning	Planned shut-down or removal of a building, equipment, plant, etc., from operation or usage
dust deposition	Settling of particulate matter out of the air through gravitational effects (dry deposition) and scavenging by rain and snow (wet deposition)
dispersion	The spreading and dilution of substances emitted in a medium (e.g. air or water) through turbulence and mixing effects
diurnal	Relating to or occurring in a 24-hour period; daily
downwash	The grounding of an air pollution plume as it flows over nearby buildings or other structures due to turbulent eddies being formed in the downwind side of the building, resulting in elevated ground level concentrations.
downwind	The direction in which the wind is blowing

emission factor	A measure of the amount of a specific pollutant or material emitted by a specific process, fuel, equipment, or source based on activity data such as the quantity of fuel burnt, hours of operation or quantity of raw material consumed.
emissions inventory	A database that lists, by source, the amount of air pollutants discharged into the atmosphere from a facility over a set period of time (e.g. per annum, per hour)
erodible	A term used to describe a soil that is vulnerable to erosion by the agents of wind, water, ice
evapotranspiration	The process by which water is transferred from the land to the atmosphere by evaporation from the soil and other surfaces
epidemiological	The branch of medicine that deals with the study of the causes, distribution, and control of disease in populations
fossil fuel	A natural fuel such as coal, diesel or gas, formed in the geological past from the remains of living organisms
fugitive emissions	Pollutants which escape from an industrial process due to leakage, materials handling, transfer, or storage
guideline	A general rule, principle, or piece of advice. A statement or other indication of policy or procedure by which to determine a course of action.
materiality threshold	Represents the amount of insignificant emissions allowed which do not need to be quantified and accounted for.
meteorological	The science that deals with the phenomena of the atmosphere, especially weather and weather conditions
mixing height	The height to which the lower atmosphere will undergo mechanical or turbulent mixing, producing a nearly homogeneous air mass
modelling domain	The area over which the model is making predictions
particulate	Of, relating to, or formed of minute separate particles. A minute separate particle, as of a granular substance or powder
plume	A space in air, water, or soil containing pollutants released from a point source
point source	A pollution source that is fixed and/or uniquely identifiable, such as a stack, chimney, outlet pipe or vent
pollutant	A substance or energy introduced into the environment that has undesired effects, or adversely affects the usefulness of a resource
prognostic	A prediction of the value of variables for some time in the future on the basis of the values at the current or previous times
qualitative assessment	An assessment of impacts based on a subjective, non-statistical oriented analysis
quantitative assessment	An assessment of impacts based on estimates of emission rates and air dispersion modelling techniques to provide estimate values of ground level pollutant concentrations.
receptor	Coordinate locations specified in an air dispersion model where ground level pollutant concentrations are calculated by the model
sensitive receptor	Locations such as residential dwellings, hospitals, churches, schools, recreation areas etc where people (particularly the young and elderly) may often be present, or locations with sensitive vegetation and crops.
spatial variation	Pertaining to variations across an area
standard	The prescribed level of a pollutant in the outside air that should not be exceeded during a specific time period to protect public health

standard deviation of wind direction	A measure of the variation in wind direction
synoptic meteorological data	A surface weather observation, made at periodic times (usually at 3-hourly and 6-hourly intervals), of sky cover, state of the sky, cloud height, atmospheric pressure reduced to sea level, temperature, dew point, wind speed and direction, amount of precipitation, hydrometeors and lithometeors, and special phenomena that prevail at the time of the observation or have been observed since the previous specified observation
temporal variation	Pertaining to variations with time
topography	Detailed mapping or charting of the features of a relatively small area, district, or locality
volatile organic compounds	All organic compounds (substances made up of predominantly carbon and hydrogen) with boiling temperatures in the range of 50-260°C, excluding pesticides. This means that they are likely to be present as a vapour or gas in normal ambient temperatures.
wind direction	The direction from which the wind is blowing
wind erosion	Detachment and transportation of loose topsoil or sand due to action by the wind
wind rose	A meteorological diagram depicting the distribution of wind direction and speed at a location over a period of time

1 INTRODUCTION

SLR Consulting has been commissioned by Centennial Northern Coal Services Pty Ltd (Northern Coal Services) to conduct an Air Quality Impact Assessment (AQIA) for the Northern Coal Logistics Project (the Project) located between Fassifern and Dora Creek on the western side of Lake Macquarie, New South Wales.

The Project comprises of the operations at Newstan Colliery Surface Site, Hawkmount Quarry, Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site) and the private haul roads linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station and the Cooranbong Entry Site.

This AQIA assesses the incremental and cumulative impacts from the Project. The aim of this AQIA is to assess the air quality impacts on surrounding sensitive receptors associated with the Project.

The NSW Office of Environment and Heritage (OEH) [formerly NSW Department of Environment, Climate Change and Water (DECCW)] have issued 'Action for Air' (DECCW 2009) as a key strategy for implementing the State Plan's cleaner air goals. Originally published in 1998, the 'Action for Air' is the NSW government's 25-year plan for managing air quality in Sydney, the Illawarra and the Lower Hunter regions. The 'Action for Air' outlines the key objectives and actions in order to achieve the wider air quality goals. This assessment aims to assess the air quality impacts against the wider air quality goals set out in the 'Action for Air'.

The New South Wales Environment Protection Authority (NSW EPA) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (DEC, 2005) (the Approved Methods) outline the requirements for conducting an AQIA (and the Sections of this report where the requirements are met), as follows:

- Description of local topographic features and sensitive receptor locations (**Section 3.1** and **Section 3.2** respectively).
- Establishment of air quality assessment criteria (**Section 4**).
- Analysis of climate and dispersion meteorology for the region (**Sections 6.2**).
- Description of existing air quality environment (**Section 7**).
- Compilation of a comprehensive emissions inventory for the existing and proposed activities (**Section 5**).
- Completion of atmospheric dispersion modelling and analysis of results (**Section 6)**.
- Preparation of an air quality impact assessment report comprising the above.

The scope for this AQIA has been designed to address the Director General's Requirements (DGR's) with regard to the assessment of air quality impacts. A summary of the DGR's is provided in **Section 2.2**.

2 PROJECT OVERVIEW

The Project is part of a long term strategy developed by Centennial for its future operations in the Newcastle Coalfield to provide the infrastructure and flexibility required to meet future opportunities in both the domestic and export coal markets. The other parts of the long term strategy include the Newstan Extension of Mining Project and Mandalong Southern Extension Project (refer **Figure 5**).

The Project comprises both a continuation of existing operations and an upgrade to the surface coal handling and processing infrastructure at the Newstan Colliery Surface Site and Cooranbong Entry Site, along with the existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Colliery Extension of Mining Project and Mandalong Southern Extension Project) into domestic and export markets.

The project Application Area comprises:

Newstan Colliery Surface Site - Newstan Colliery Surface Site comprises coal handling and processing infrastructure, the Southern Reject Emplacement Area (SREA), Northern Reject Emplacement Area (NREA), water management infrastructure and rail loading infrastructure. The exceptions are the mine ventilation shafts and ventilation fans, which form part of the Newstan Extension of Mining Project (see **Section 2.4.1**).

The Project proposes to extend and redevelop the Newstan Colliery Surface Site to accommodate new coal handling and processing infrastructure.

Cooranbong Entry Site - Cooranbong Entry Site comprises a coal handling plant (CHP), coal stockpiles, workshop building and water management infrastructure. The exceptions are the mine ventilation shaft, ventilation fan and the Borehole Dam, which form part of the Mandalong Southern Extension Project (see **Section 2.4.4**).

Private Haul Roads - The Cooranbong Private Haul Road owned by Centennial Mandalong links the Newstan Colliery Surface Site and the Cooranbong Entry Site via the Newstan-Eraring Private Haul Road. The Newstan-Eraring Private Haul Road links the Newstan Colliery Surface Site to the Eraring Power Station and is owned by Eraring Energy. The Awaba Private Haul Road links the Awaba Colliery Surface Site to the Newstan-Eraring Private Haul Road and is owned by Centennial Newstan Pty Limited.

Hawkmount Quarry – Hawkmount Quarry is an abandoned gravel quarry (Crown land under permissive occupancy held by Lake Macquarie City Council). Hawkmount Quarry has not been used for extraction purposes for several years but is proposed to be used as coarse rejects emplacement area for the Northern Coal Logistics Project.

2.1 Project Location

The Project Application Area is located between Fassifern and Dora Creek on the western side of Lake Macquarie, New South Wales.

The existing Newstan Colliery Surface Site is located approximately 19 kilometres (km) southwest of Newcastle, within the Newcastle Coalfield of NSW.

The existing Cooranbong Entry Site is located approximately 30 kilometres (km) southwest of Newcastle.

The private haul roads link the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Hawkmount Quarry and Cooranbong Entry Site.

The regional location of the Project application area is shown in **Figure 1**.

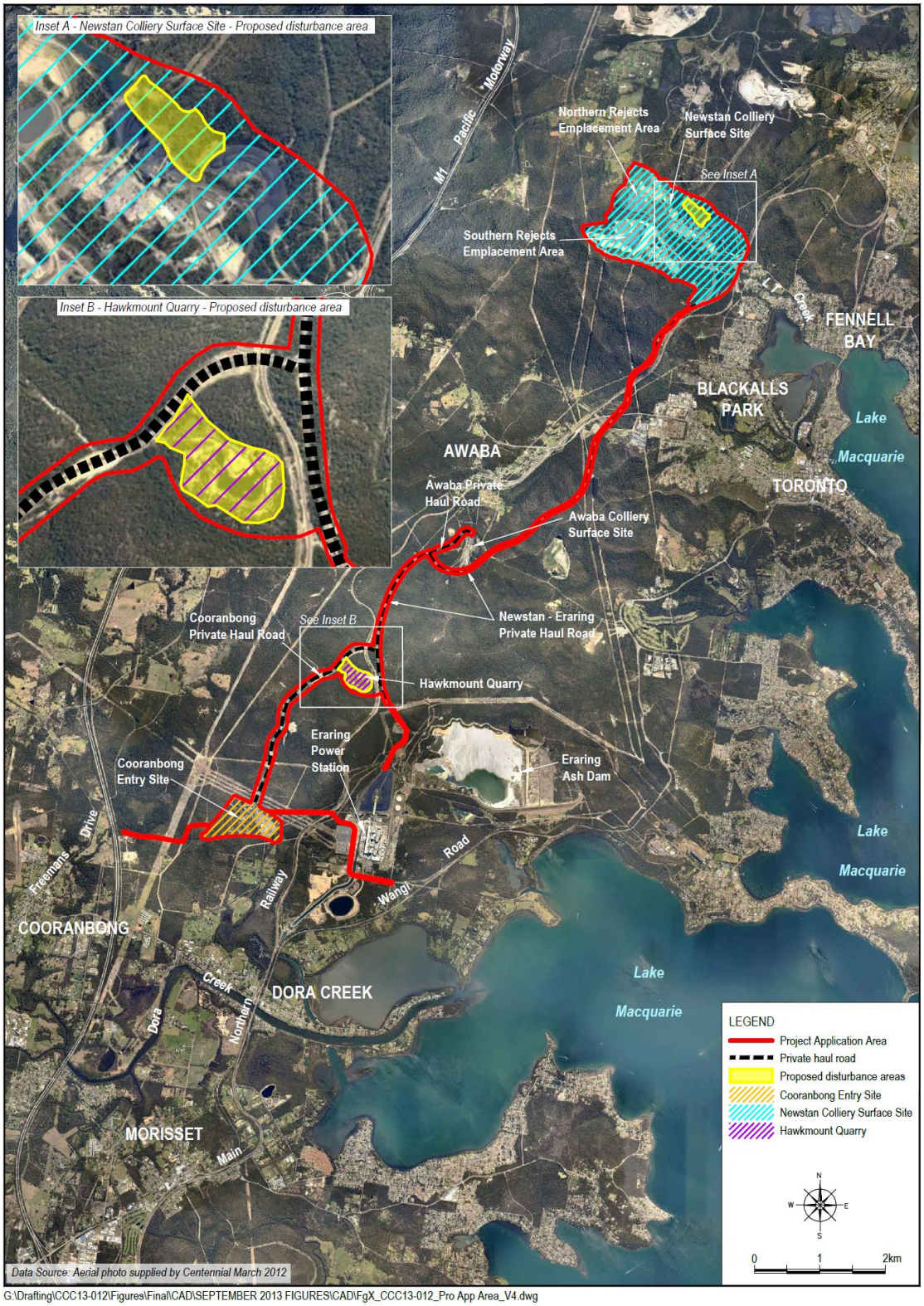
Figure 1 Regional Setting of the Project



Source: Centennial 2012

The local setting of the Project Application Area is shown in **Figure 2**.

Figure 2 Local Setting of the Project



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Source: Centennial 2012

2.2 Director General's Requirements

The Director General of the Department of Planning and Infrastructure (DP&I) issued the Director General's Requirements (DGRs) for the Project on 20 March 2012, with revised DGRs issued on 7 August 2013. **Table 1** below identifies the DGRs relevant to this AQIA and where they have been addressed.

Table 1 Director General's Requirements – Northern Coal Logistics Project (Application number SSD - 5145)

Key Issue	Assessment Requirement	Addressed in Section
Air Quality	Construction and operational impacts, with a particular focus on dust emissions including $PM_{2.5}$ and PM_{10} emissions	**Section 2.4.1, Section 8.5** and **Section 8.3** and **Section 8.4**
	Reasonable and feasible mitigation measures to minimise dust emissions, including evidence that there are no such measures available other than those proposed; and	**Section 8.9**
	Monitoring and management measures, in particular real-time air quality monitoring.	**Section 8.9.3**

Issued: 7 August 2013; Department of Planning & Infrastructure, NSW Government, File Reference: SSD - 5145.

The DGR's also require that the assessment be performed in accordance with relevant policies, guidelines and plans including:

- Protection of Environment Operations (Clean Air) Regulation 2002;
- Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (2005); and,
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (2006).

This assessment addresses the key issues raised within the DGR's and is performed in accordance with the relevant policies and guidelines.

2.3 Process Description

In summary (and of relevance to this AQIA) the Project proposes to:

- Re-develop and upgrade the existing coal preparation and handling infrastructure at the Newstan Colliery Surface Site to enable continued utilisation for the receipt, handling and processing of up to 8 million tonnes per annum (Mtpa) run-of-mine (ROM) coal from the Newstan Colliery (up to 4.5 Mtpa), the Awaba Colliery (up to 0.88 Mtpa) and Mandalong Mine (up to 6 Mtpa);
- Continue to utilise the existing coal handling infrastructure at the Cooranbong Entry Site to enable the receipt, handling and processing of up to 6 Mtpa of ROM coal from Mandalong Mine;
- Increase the volume of coal transported from the Cooranbong Entry Site to Newstan Colliery Surface Site, via truck using existing private haul roads, from 4 Mtpa to up to 6 Mtpa;
- Increase the volume of coal transported from the Cooranbong Entry Site to Eraring Power Station, using the existing dedicated overland conveyor, from 4 Mtpa to up to 6 Mtpa;
- Increase the volume of coal transported from the Newstan Colliery Surface Site to Eraring Power Station, via truck using existing private haul roads, from 2 Mtpa to up to 4.5 Mtpa;

- Increase the volume of coal transported from the Newstan Colliery Surface Site rail loading facilities by train to the Port of Newcastle, Port Kembla or Vales Point Power Station for export from 3 Mtpa to up to 8 Mtpa;
- Continue to transport up to 0.5 Mtpa of middlings by truck via private haul roads from Newstan Colliery Surface Site to Cooranbong Entry Site for subsequent supply to the Eraring Power Station via a dedicated overland conveyor;
- Continue to transport up to 0.88 Mtpa of material (including coal and stone from construction activities undertaken as part of the Newstan Colliery Extension of Mining Project) by truck via private haul roads from the Awaba Colliery Surface Site to the reject emplacement areas at the Newstan Colliery Surface Site;
- Transport reject material from the Newstan Colliery Surface Site to the Newstan Colliery Northern Reject Emplacement Area (NREA), the Newstan Colliery Southern Reject Emplacement Area (SREA) and/or Hawkmount Quarry via existing private haul roads;
- Increase the volume of water discharged via licenced discharge points at the Newstan Colliery Surface Site and Cooranbong Entry Site;
- Provide employment for up to 120 full-time personnel;
- Provide a life of operation of 30 years from the granting of development consent; and
- Operate 24 hours per day, seven days per week.

2.4 Identification of Emission Sources

2.4.1 Newstan Colliery Surface Site

In regards to the activities identified in **Section 2.3**, the following emission sources have been identified at the Newstan Colliery Surface Site:

- Construction and installation of equipment to enable the handling and preparation of coal;
- Handling, processing and transportation of ROM coal and product coal;
- Handling and transportation of coal rejects; and
- Wind erosion from open and exposed areas such as coal stockpiles and rejects emplacement areas.

Atmospheric pollutants likely to be generated by the potential activities include fugitive emissions of particulates (TSP, PM_{10}, $PM_{2.5}$[1]) in addition to those generated through the combustion of fuel in vehicle engines (NO_X, SO_2, VOCs, CO, PM_{10}) [2].

It is considered appropriate to assume that the emissions due to combustion of fuel in vehicle engines on site will be negligible compared to the existing background levels. Hence, the emission products of combustion from vehicle engines are not considered further in this assessment.

Also, it is considered that emissions of particulate matter during the construction and installation of project infrastructure will be minor when compared to the Project operation and therefore has not been considered further within this assessment.

[1] PM_{10} is used to describe particulate matter with an aerodynamic diameter of 10 microns (µm) or less. Correspondingly, $PM_{2.5}$ describes particulates with aerodynamic diameters of 2.5 µm or less. TSP (Total Suspended Particulate) describes particulate matter which is less than 30 µm diameter.

[2] Oxides of Nitrogen (NO_X), Sulfur dioxide (SO_2), Volatile Organic Compounds (VOCs), Carbon monoxide (CO).

There are two ventilation fans located at the Newstan Colliery Surface Site which are owned and operated by Centennial Newstan Pty Ltd to ventilate the underground workings of the Newstan Colliery. Although the operation of these ventilation fans do not form part of this Project (given they will become part of Centennial's Newstan Extension of Mining Project), their continued operation has been considered in this assessment to provide a comprehensive cumulative assessment of air quality impacts as a result of the operations at the Newstan Colliery Surface Site. Emissions from the ventilation fans include TSP, PM_{10}, $PM_{2.5}$ and odour.

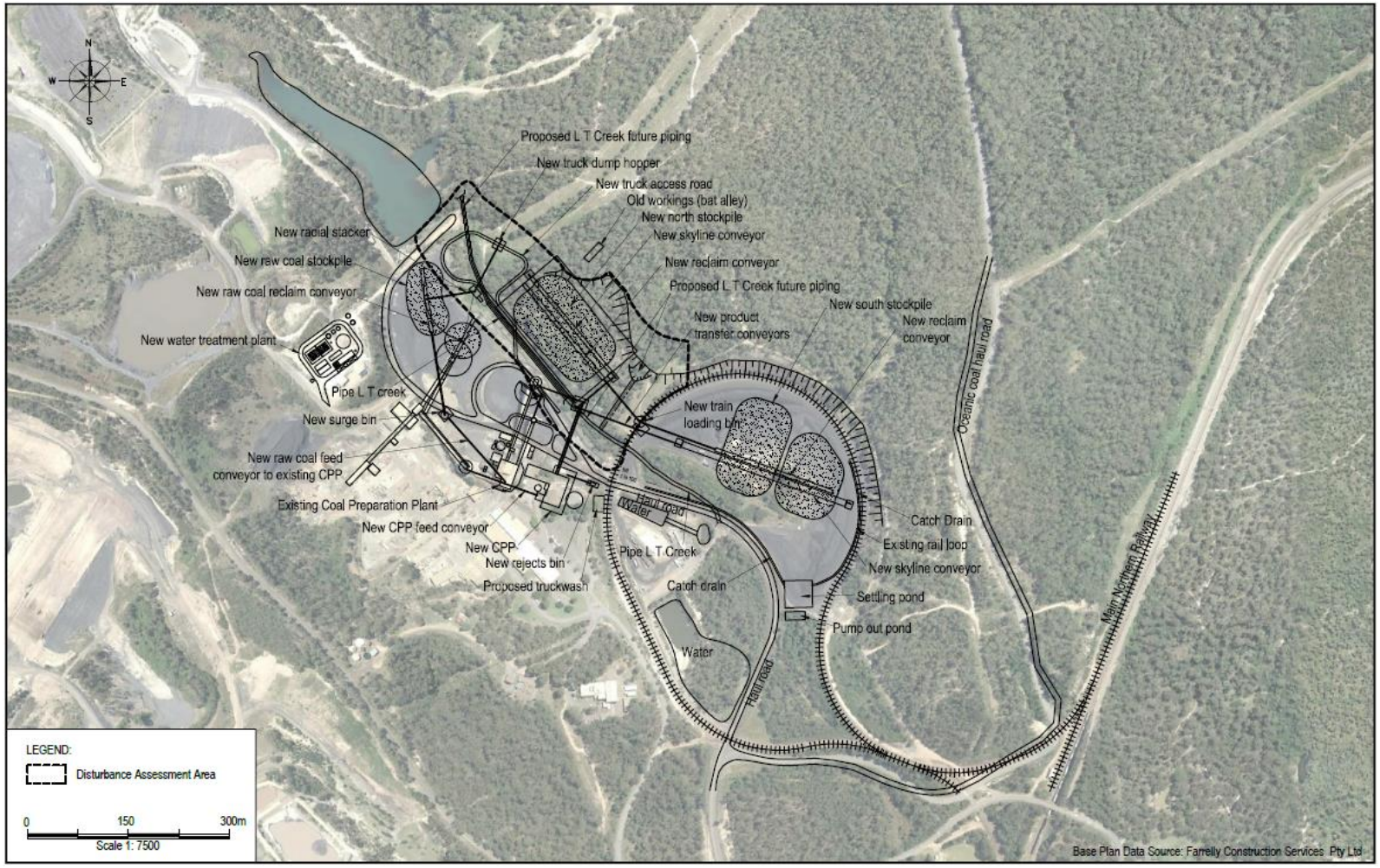
The emission sources and major pollutants identified at the Newstan Colliery Surface Site are summarised in **Table 2**.

Table 2 Summary of Potential Emission Sources – Newstan Colliery Surface Site

Emission Source	Emission Type	Pollutants
Haul roads	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$
Excavator	Material handling	TSP, PM_{10}, $PM_{2.5}$
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$
Coal stockpiles	Wind erosion	TSP, PM_{10}, $PM_{2.5}$
Coal bins	Material handling	TSP, PM_{10}, $PM_{2.5}$
Loading stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$
Unloading from stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$
Miscellaneous transfer points (including conveying)	Material handling	TSP, PM_{10}, $PM_{2.5}$
Coal processing plant	Process emissions	TSP, PM_{10}, $PM_{2.5}$
Northern rejects emplacement area (NREA)	Wind erosion	TSP, PM_{10}, $PM_{2.5}$
Reject dumping at NREA	Material handling	TSP, PM_{10}, $PM_{2.5}$
Southern rejects emplacement area (SREA)	Wind erosion	TSP, PM_{10}, $PM_{2.5}$
Reject dumping at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$
Ventilation shafts	Process emissions	TSP, PM_{10}, $PM_{2.5}$ Odour

A conceptual layout of the proposed re-developed Newstan Colliery Surface Site is shown in **Figure 3**.

Figure 3 Conceptual Layout of Newstan Colliery Surface Site



Source: Centennial 2012

2.4.2 Private Haul Roads

In addition to the operations at Newstan Colliery Surface Site and Cooranbong Entry Site, private haul roads between Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Hawkmount Quarry and Cooranbong Entry Site will be used to transport product coal and rejects.

It has been advised by Centennial that the private haul roads are all sealed and regularly maintained using best management practices.

It is considered appropriate to include private haul roads as potential particulate emission sources as these will be in continuous operation.

2.4.3 Hawkmount Quarry

The Project's production waste management strategy incorporates the emplacement of coarse rejects at the existing Hawkmount Quarry (together with the NREA and SREA). The quarry has not been used for extraction purposes for several years, and there is no evidence of any closure or rehabilitation activities. It is estimated it will provide an additional 400,000 cubic metres (m^3) of capacity for coarse rejects emplacement (Centennial 2012).

The major identified sources of emissions and respective pollutants are shown in **Table 3**.

Table 3 Summary of Potential Emission Sources – Hawkmount Quarry

Emission Source	Emission Type	Pollutants
Reject dumping	Material handling	TSP, PM_{10}, $PM_{2.5}$
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$
Open Area	Wind erosion	TSP, PM_{10}, $PM_{2.5}$

2.4.4 Cooranbong Entry Site

The Cooranbong Entry Site currently processes up to 4 Mtpa of coal each year. The coal is brought in from the underground workings of the Mandalong Mine using the south drift conveyor located at the north-western end of the site. The coal is then screened and crushed before it is transported to the Newstan Colliery Surface Site via the sealed private haul roads and to Eraring Power Station (EPS) via an enclosed overland conveyor.

Centennial Mandalong is approved to deliver up to 4 Mtpa of coal from the Cooranbong Entry Site to Centennial's Newstan Colliery Surface Site via private haul roads for further processing and up to 4 Mtpa of coal directly to EPS via Eraring Energy's overland conveyor.

As part of the Northern Coal Logistics Project, it is proposed to increase the amount of coal delivered from the Cooranbong Entry Site to the EPS and Newstan Colliery Surface Site from the current limit of 4 Mtpa to up to 6 Mtpa. It is noted that the amount of coal transported to Newstan Colliery Surface Site and EPS will vary according to the respective demands and other site specific factors. However, to assess the worst case impacts from the operations at the Cooranbong Entry Site, two scenarios are assessed and are discussed in detail in **Section 5.2**.

Atmospheric pollutants likely to be generated by the activities at the Cooranbong Entry Site include fugitive emissions of particulates (PM_{10}, $PM_{2.5}$ and TSP and deposited dust) in addition to those generated through the combustion of fuel in vehicles (NOx, SO_2, VOCs, CO, PM_{10}).

There is one ventilation fan located at the Cooranbong Entry Site which is owned and operated by Centennial Mandalong Pty Ltd to ventilate the underground workings of the Cooranbong Colliery. Although the operation of this ventilation fan does not form part of this Project (given it will become part of Centennial's Mandalong Southern Extension Project), its continued operation has been considered in this assessment to provide a comprehensive cumulative assessment of air quality impacts as a result of the operations at the Cooranbong Entry Site. Emissions from the ventilation fan include TSP, PM_{10}, $PM_{2.5}$ and odour.

The presence of EPS in the vicinity of the Project Site will have a significant impact on the air quality in the region. The methodology used to account for the cumulative impacts of EPS emissions with those from the Project Site is presented in **Section 7.4**.

It is considered appropriate to assume that the concentration of pollutants generated due to combustion of fuel is likely to be negligible compared to the impacts from EPS. Therefore, the impacts from combustion of fuel in vehicles at Cooranbong Entry Site are not considered further in this assessment.

The emission sources and major pollutants identified at the Cooranbong Entry Site are summarised in **Table 4**.

Table 4 Summary of Potential Emission Sources – Cooranbong Entry Site

Emission Source	Emission Type	Pollutants
Haul roads	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$
Haul trucks	Wind erosion	TSP, PM_{10}, $PM_{2.5}$
Front end loader (FEL)	Material handling	TSP, PM_{10}, $PM_{2.5}$
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$
Coal stockpiles	Wind erosion	TSP, PM_{10}, $PM_{2.5}$
Coal bins	Material handling	TSP, PM_{10}, $PM_{2.5}$
Loading stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$
Unloading from stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$
Miscellaneous transfer points (including conveying)	Material handling	TSP, PM_{10}, $PM_{2.5}$
Coal screening	Process emissions	TSP, PM_{10}, $PM_{2.5}$
Coal crushing	Process emissions	TSP, PM_{10}, $PM_{2.5}$
Ventilation fans	Process emissions	TSP, PM_{10}, $PM_{2.5}$, Odour

A conceptual layout of the Cooranbong Entry Site is shown in **Figure 4**.

Figure 4 Conceptual Layout of Cooranbong Entry Site



Source: Centennial 2012

2.5 Emission Controls

2.5.1 Newstan Colliery Surface Site

A comprehensive AQIA was completed for the Newstan Colliery Surface Site in September 2011, which assessed the incremental and cumulative impacts from the existing operations

Additionally, a best practice assessment was completed by SLR Consulting in September 2012 (as part of a widespread NSW EPA Pollution Reduction Program [PRP] aimed at the coal mining industry), to assess the major sources of particulates from site operations and the emissions reductions realised through the implementation of a number of implemented control measures, for the current and proposed operations. It was concluded from the best practice measures assessment that the particulate control measures to be implemented as part of the site upgrade (e.g. truck wheel wash, skyline stackers, ROM dump hopper) would represent best practice particulate control, once installed.

Furthermore, the PRP showed that PM_{10} emissions per tonne of coal handled reduced by 12% following the implementation of the proposed measures.

A summary of the emissions sources along with the associated pollutants evaluated in this assessment and the respective emission controls applied is shown in **Table 5**. The estimation of these emissions and the subsequent emissions inventory are discussed in detail in **Section 5**.

Table 5 Summary of Potential Emission Sources – Newstan Colliery

Emission Source	Emission Type	Pollutants	Control (Efficiency)
Paved haul roads	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control
Front end loader (FEL) on Coal	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer on Coal	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Coal stockpiles	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Coal bins	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed (70%)
Loading trains	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed (70%)
Loading stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Unloading from stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Miscellaneous transfer points (including conveying)	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed (70%)
Coal processing plant	Process emissions	TSP, PM_{10}, $PM_{2.5}$	Enclosed (100%)
Northern rejects emplacement area (NREA)	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer at NREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Reject dumping at NREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Southern rejects emplacement area (SREA)	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Excavators at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Reject dumping at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Ventilation shafts	Process emissions	TSP, PM_{10}, $PM_{2.5}$ Odour	No Control

2.5.2 Private Haul Roads

It has been advised by Northern Coal Services that the private haul roads are all sealed and regularly maintained using best management practices. The estimation of these emissions and the subsequent emissions inventory are discussed in detail in **Section 5**.

The coal haulage trucks operating on the private haul roads linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and the Eraring Power Station operate with E5 European standard engines. However it is beyond the scope of this assessment to quantify the control efficiency provided by the E5 European standard engines compared to Australian standard engines.

2.5.3 Hawkmount Quarry

A summary of the emissions sources along with the associated pollutants evaluated in this assessment and the respective controls applied is shown in **Table 6**. The estimation of these emissions and the subsequent emissions inventory are discussed in detail in **Section 5**.

Table 6 Summary of Potential Emission Sources – Hawkmount Quarry

Emission Source	Emission Type	Pollutants	Control
Reject dumping	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Open Area	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control

2.5.4 Cooranbong Entry Site

A summary of the emissions sources along with the associated pollutants evaluated in this assessment and the respective controls applied is shown in **Table 7**. The estimation of these emissions and the subsequent emissions inventory are discussed in detail in **Section 5**.

SLR has been informed by Centennial Mandalong that the mine has already commenced the implementation of the use of Tier 3 standard engines for its underground fleet to reduce particulate emissions. All machines are fitted with particulate filter assembly units.

Table 7 Summary of Project Emission Sources – Cooranbong Entry Site

Emission Source	Emission Type	Pollutants	Control
Front end loader (FEL)	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Coal stockpiles	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Loading stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Paved Haul Roads	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control
Unloading from Stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water Sprays at 100,000 t stockpile – 50%
Miscellaneous Transfer Points (including conveying)	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed – 70%
Ventilation shafts	Process emissions	TSP, PM_{10}, $PM_{2.5}$ Odour	No Control

In addition to the emission controls identified above, a wheel wash has been installed within the site.

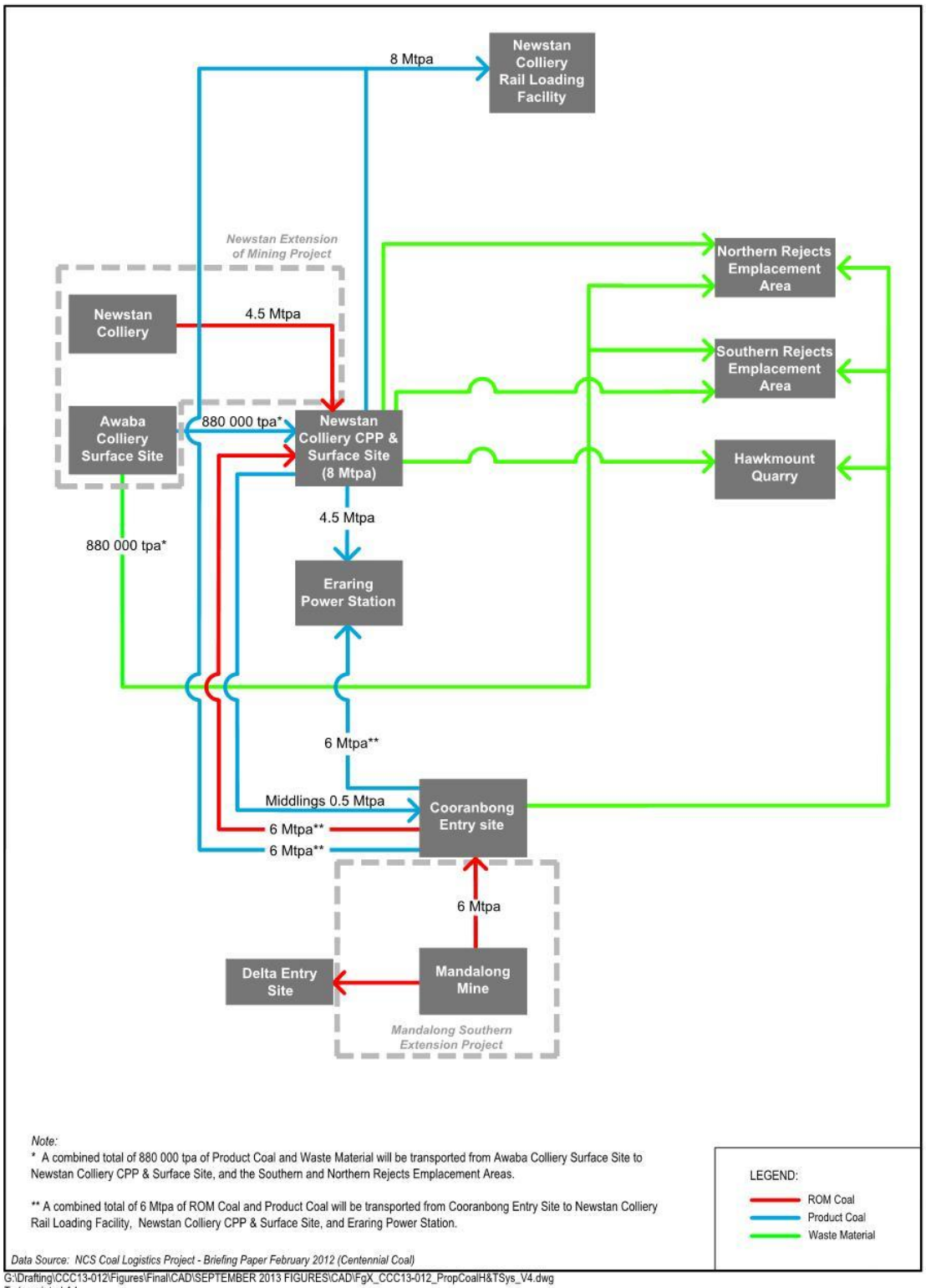
2.6 Hours of Operation

Northern Coal Services proposes to undertake the coal handling, processing and transportation operations of the Project 24 hours a day, seven days per week. This includes operations at the Newstan Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and private haul roads.

2.7 Coal Activity Rate

The coal activity rate and the movement of Coal for the Project is summarised in **Figure 5**.

Figure 5 Movement of Coal for Northern Coal Logistics Project (Source: Centennial 2012)



Note: The coal throughput shown above is the maximum throughput.

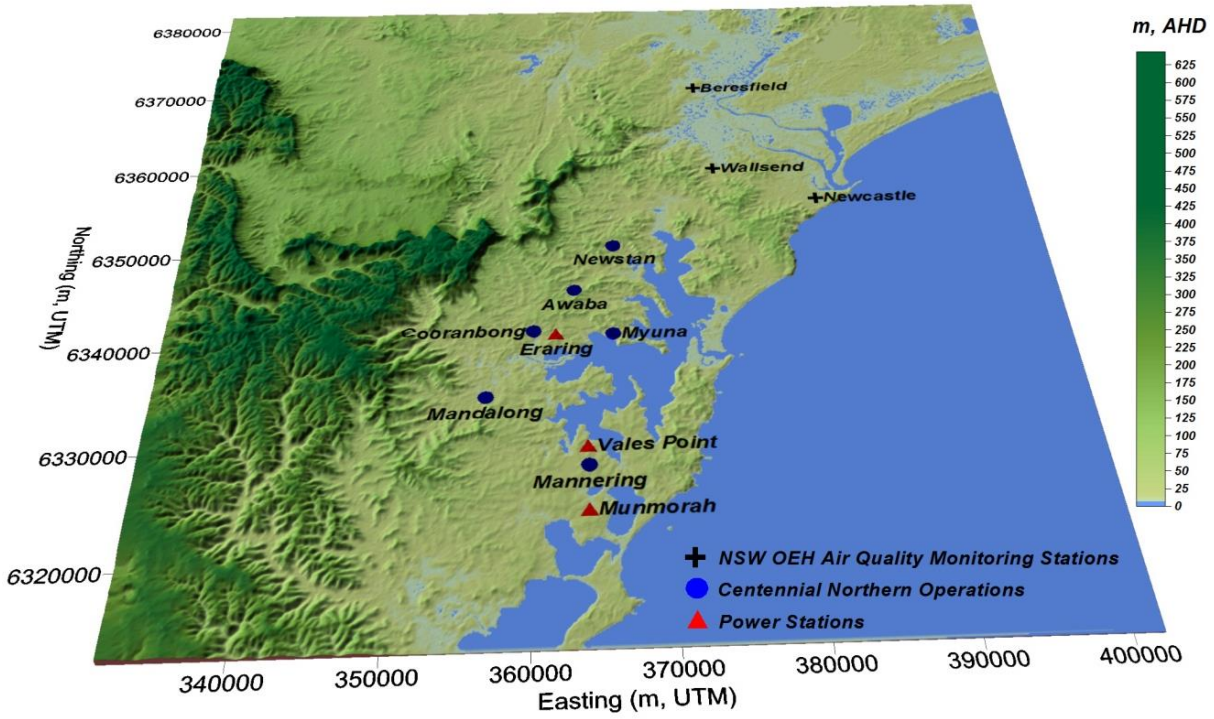
3 STUDY AREA

3.1 Local Topography

The topographical data used in the meteorological and dispersion modelling was sourced from the United States Geological Service's Shuttle Radar Topography Mission database that has recorded topography across Australia with a 3 arc second (~90 m) spacing.

The Newstan Colliery Surface Site, private haul roads, Hawkmount Quarry and Cooranbong Entry Site are located west of Lake Macquarie within undulating terrain. The topography of the local region surrounding the Project Application Area and surrounds is presented in **Figure 6**.

Figure 6 Local and Regional Topography



3.2 Sensitive Receptors

As discussed in **Section 2**, the main components of the Project are the Newstan Colliery Surface Site, Cooranbong Entry Site, private haul roads and Hawkmount Quarry. As the Project is spread over a large area, it is considered appropriate to assess the impacts at the sensitive receptors which are relevant to the main components of the Project separately.

The locations of the sensitive receptors identified in the vicinity of Newstan Colliery Surface Site, Cooranbong Entry Site and private haul roads are discussed in the following sections.

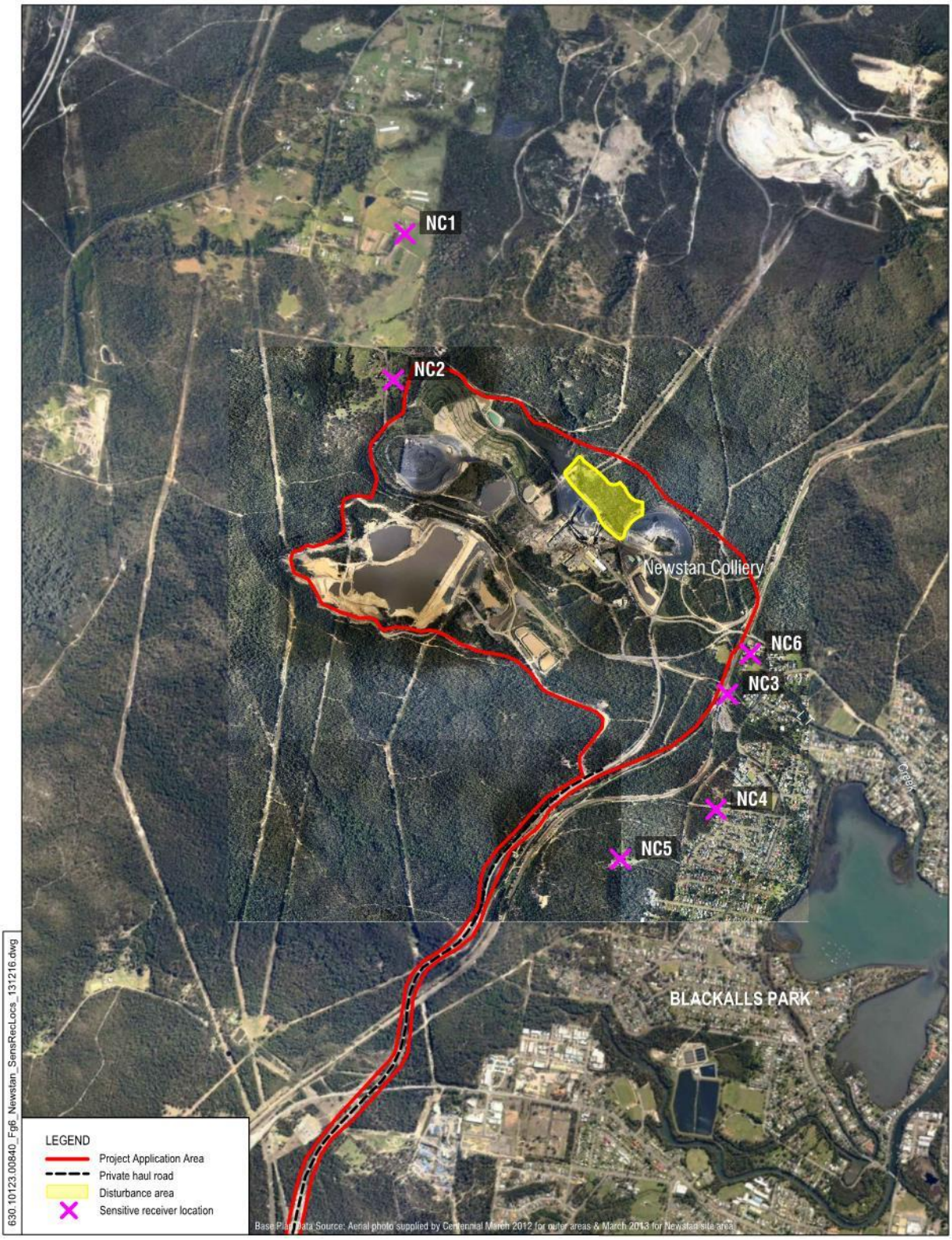
3.2.1 Newstan Colliery Surface Site

A number of residences/sensitive receptors are located in the area surrounding the Newstan Colliery Surface Site. A list of the nearest sensitive receptors identified in the vicinity of the site is presented in **Table 8** and **Figure 7**.

Table 8 Newstan Colliery Surface Site - Surrounding Sensitive Receptor Locations

Receiver ID	Location	Location (m, UTM)		Elevation (m, AHD)
		Easting	Northing	
NC1	Dwelling - Jefferson Road, Wakefield	365,779.7	6,351,882.4	40
NC2	Dwelling - Miller Road, Fassifern	365,720.1	6,351,115.5	58
NC3	Dwelling - Wallsend Road, Fassifern	367,462.9	6,349,487.1	12
NC4	Dwelling - Narara Street, Fassifern	367,399.3	6,348,880.4	27
NC5	Dwelling - Reynolds Street, Fassifern	366,904.1	6,348,625.7	72
NC6	Fassifern Primary School	367,580.8	6,349,693.9	11

Figure 7 Newstan Colliery Surface Site - Surrounding Sensitive Receptor Locations



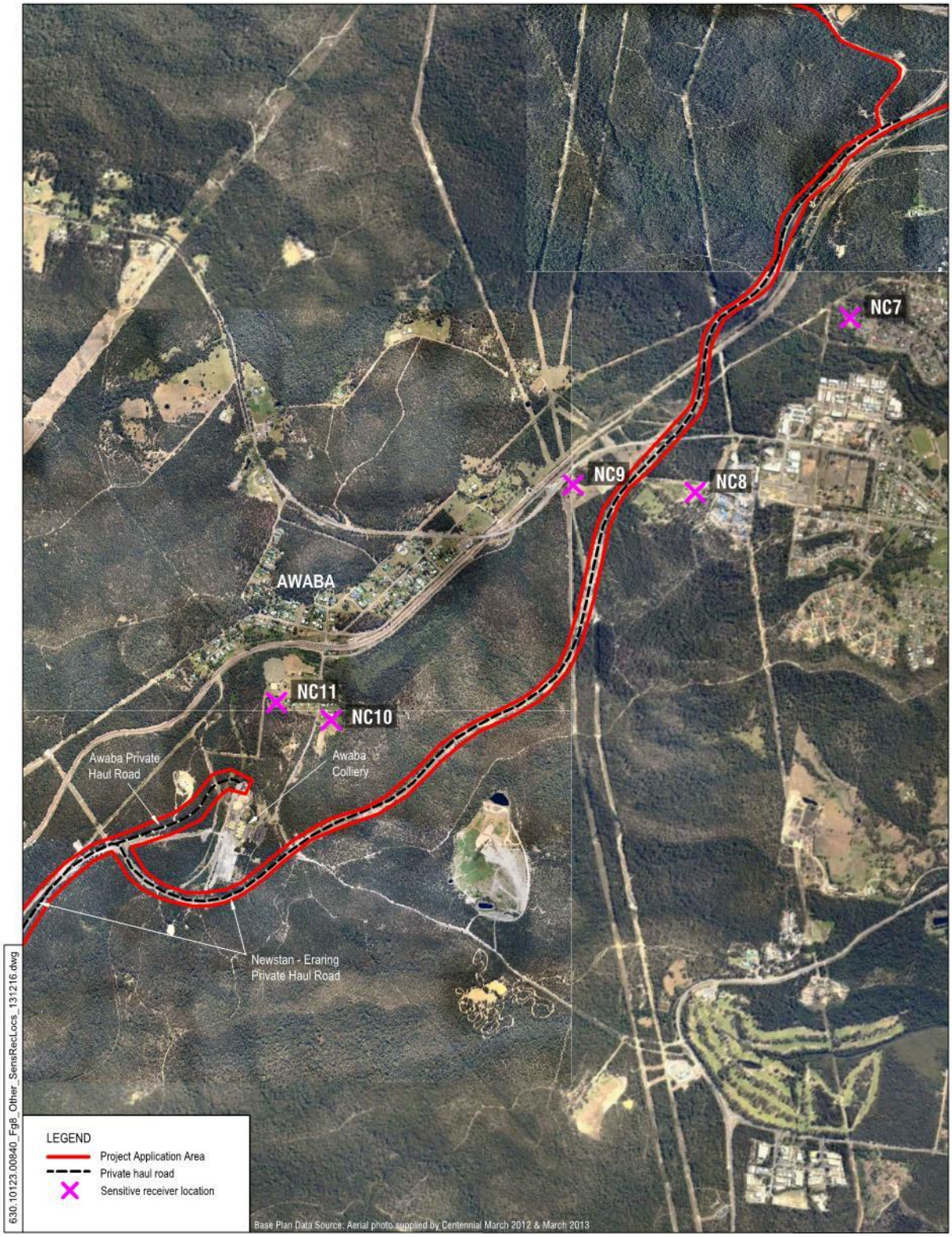
3.2.2 Private Haul Roads - Surrounding Sensitive Receptor Locations

For the purpose of assessing potential air quality impacts from the Newstan-Eraring Private Haul Road (no close residents along the other haul roads) the residential locations listed in **Table 9** and shown in **Figure 8** have been considered.

Table 9 Private Haul Roads - Surrounding Sensitive Receptor Locations

Receptor ID	Location	Location (m, UTM)		Elevation (m, AHD)
		Easting	Northing	
NC7	Dwelling - John Street, Blackalls Park	366,547.6	6,348,055.5	13
NC8	Dwelling - Toronto Street, Toronto	365,739.8	6,347,141.8	33
NC9	Dwelling - Awaba Road, Awaba	365,104.2	6,347,180.6	24
NC10	Dwelling - Sydney Street, Awaba	363,830.6	6,345,944.2	28
NC11	Dwelling - Olney Street, Awaba	363,548.3	6,346,041.9	33

Figure 8 Private Haul Roads – Surrounding Sensitive Receptor Locations



3.2.3 Cooranbong Entry Site

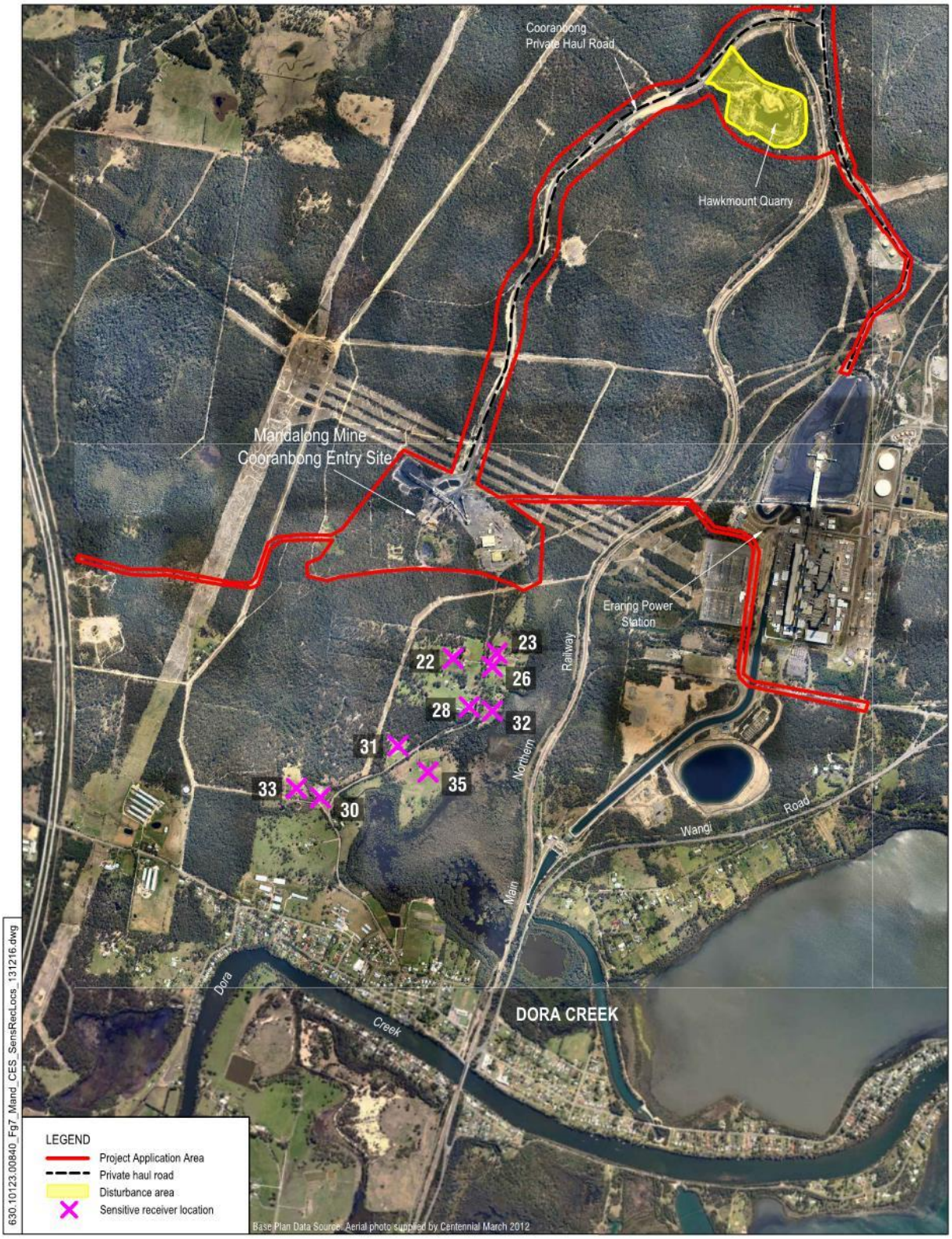
A number of residences/sensitive receptors are located in the area surrounding the Cooranbong Entry Site. A list of the nearest sensitive receptors identified in the vicinity of the Cooranbong Entry Site is presented in **Table 10** and **Figure 9**.

It is noted that the receptor numbers represent the respective house numbers close to Cooranbong Entry Site. Also, the receptor numbers are consistent with the AQIA completed for Cooranbong Entry Site in April 2012 (SLR 2012a).

Table 10 Cooranbong Entry Site - Surrounding Sensitive Receiver Locations

Receiver ID	Location	Location (m, UTM)		Elevation (m, AHD)
		Easting	Northing	
22	Residential Properties Gradwells Road, Cooranbong	359,999.6	6,340,497.4	26
23		360,226.8	6,340,525.2	14
26		360,202.1	6,340,460.8	12
28		360,077.6	6,340,254.9	15
30		359,299.0	6,339,788.6	7
31		359,721.6	6,340,039.6	12
32		360,189.7	6,340,230.2	6
33		359,181.8	6,339,820.8	12
35		359,869.7	6,339,907.7	8

Figure 9 Cooranbong Entry Site - Surrounding Sensitive Receptor Locations



4 AMBIENT AIR QUALITY CRITERIA

State air quality guidelines adopted by the NSW EPA are published in the *Approved Methods and Guidance For the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005) (hereafter 'The Approved Methods').

As specified within the DGR's, the Approved Methods has been consulted during the preparation of this assessment report. The Approved Methods lists the statutory methods that are to be used to model and assess emissions of air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the Project. The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, WHO and ANZEEC). The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW, and are considered to be appropriate for the setting.

4.1 Particulate Matter

Airborne contaminants that can be inhaled directly into the lungs can be classified on the basis of their physical properties as gases, vapours or particulate matter. In common usage, the terms "dust" and "particulates" are often used interchangeably. The term "particulate matter" refers to a category of airborne particles, typically less than 30 microns (µm) in diameter and ranging down to 0.1 µm and is termed total suspended particulate (TSP). The annual goal for TSP recommended by the NSW EPA is 90 micrograms per cubic metre of air (µg/m^3).

The TSP goal was developed before the more recent results of epidemiological studies which suggested a relationship between health impacts and exposure to concentrations of finer particulate matter.

Emissions of particulate matter less than 10 µm and 2.5 µm in diameter (referred to as PM_{10} and $PM_{2.5}$ respectively) are considered important pollutants due to their ability to penetrate into the respiratory system. In the case of the $PM_{2.5}$ category, recent health research has shown that this penetration can occur deep into the lungs. Potential adverse health impacts associated with exposure to PM_{10} and $PM_{2.5}$ include increased mortality from cardiovascular and respiratory diseases, chronic obstructive pulmonary disease and heart disease, and reduced lung capacity in asthmatic children.

The NSW EPA PM_{10} assessment goals set out in the Approved Methods are as follows:

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

The World Health Organisation (WHO) also set goals for PM_{10} which are as follows:

- a 24-hour maximum of 50 µg/m^3.
- an annual average of 20 µg/m^3.

It is noted that the annual average goal for PM_{10} set by the WHO is more stringent than that set by the NSW EPA. Both goals are assessed within this report even considering that the 30 µg/m^3 annual average PM_{10} goal is appropriate for the setting.

The Approved Methods do not set any assessment goals for $PM_{2.5}$. In December 2000, the National Environment Protection Council (NEPC) initiated a review to determine whether a national ambient air quality criterion for $PM_{2.5}$ was required in Australia, and the feasibility of developing such a criterion. The review found that:

- there are health effects associated with these fine particles.
- the health effects observed overseas are supported by Australian studies.

- fine particle standards have been set in Canada and the USA, and an interim criterion is proposed for New Zealand.

The review concluded that there is sufficient community concern regarding $PM_{2.5}$ to consider it an entity separate from PM_{10}.

As such, in July 2003, a variation to the Ambient Air Quality NEPM was made to extend its coverage to $PM_{2.5}$, setting the following Interim Advisory Reporting Standards for $PM_{2.5}$:

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

The World Health Organisation also set goals for $PM_{2.5}$ which are as follows:

- a 24-hour maximum of 25 µg/m^3.
- an annual average of 10 µg/m^3.

The WHO goals for $PM_{2.5}$ are either the same (24 hour maximum) or less stringent (annual average) than those advised within the NEPM.

It is noted that the Advisory Reporting Standards relating to $PM_{2.5}$ particles are reporting guidelines only at the present time and not intended to represent air quality criteria. A summary of the EPA particulate guidelines is shown in **Table 11**. A summary of the WHO guidelines is shown in **Table 12**.

Table 11 EPA Goals for Particulates

Pollutant	Averaging Time	Goal
TSP	Annual	90 µg/m^3
PM_{10}	24 Hours Annual	50 µg/m^3 30 µg/m^3
$PM_{2.5}$	24 Hours Annual	25 µg/m^3 (interim advisory reporting standard only) 8 µg/m^3 (interim advisory reporting standard only)

Table 12 WHO Goals for Particulates

Pollutant	Averaging Time	Goal
PM_{10}	24 Hours Annual	50 µg/m^3 20 µg/m^3
$PM_{2.5}$	24 Hours Annual	25 µg/m^3 10 µg/m^3

4.2 Nuisance Impacts of Fugitive Emissions

The preceding section is concerned in large part with the health impacts of airborne particulate matter. Nuisance impacts need also to be considered, mainly in relation to deposited dust. In NSW, accepted practice regarding the nuisance impact of dust is that dust-related nuisance can be expected to impact on residential areas when annual average dust deposition levels exceed 4 grams per square metre per month (g/m^2/month).

Table 13 presents the impact assessment goals set out in the Approved Methods for dust deposition, showing the allowable increase in dust deposition level over the ambient (background) level to avoid dust nuisance.

Table 13 EPA Goals for Allowable Dust Deposition

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

Source: Approved Methods, NSW DEC 2005.

4.2.1 Odour

According to NSW EPA, impact assessment criteria for complex mixtures of odours have been designed to take into account the range of sensitivity to odours within the community and to provide additional protection for individuals with a heightened response to odours. Where a number of the factors simultaneously contribute to making an odour "offensive", an odour goal of 2 OU at the nearest residence (existing or any likely future residences) is appropriate, which generally occurs for affected populations equal or above 2,000 people.

The equation used by the NSW EPA to determine the appropriate impact assessment criteria for complex mixtures of odorous air pollutants, as specified in the Approved Methods, is expressed as follows:

$$\text{Impact assessment criterion (OU)} = (\log_{10}(\text{population})-4.5)/-0.6$$

A summary of appropriate impact assessment criteria for various population densities is provided in **Table 14**.

Table 14 Impact assessment criteria for complex mixtures of odorous air pollutants

Population of affected community	Impact assessment criteria for complex mixtures of odorous air pollutants (Odour Units, OU)
Urban (≥~2000) and/or schools and hospitals	2.0
~500	3.0
~125	4.0
~30	5.0
~10	6.0
Single rural residence (≤~2)	7.0

For this Project, the only odour sources are the ventilation fans located at Newstan Colliery Surface Site and the Cooranbong Entry Site and hence it is likely that the only sensitive receptors affected by Project odour sources will be the receptors around Newstan Colliery Surface Site and Cooranbong Entry Site.

A school has been identified as one of these sensitive receptors ('NC6', **Section 3.2.1**) around Newstan Colliery Surface Site and therefore it is appropriate to adopt a conservative odour criterion of 2 OU for the receptors around Newstan Colliery Surface Site.

Considering the small number of potentially affected residential residences around the Cooranbong Entry Site, it is considered appropriate to adopt a conservative odour criterion of 4 OU for the receptors around Cooranbong Entry Site.

4.3 Summary of Project Air Quality Goals

The air quality goals adopted for this assessment, which confirm to current EPA and Federal air quality criteria, are summarised in **Table 15**.

Table 15 Project Air Quality Goals

Pollutant	Averaging Time	Goal
TSP	Annual	90 µg/m^3 (NSW EPA)
PM_{10}	24 Hours Annual Annual	50 µg/m^3 (NSW EPA) 30 µg/m^3 (NSW EPA) 20 µg/m^3 (WHO)
$PM_{2.5}$	24 Hours Annual	25 µg/m^3 (NEPM interim advisory reporting standard only) 8 µg/m^3 (NEPM interim advisory reporting standard only) 10 µg/m^3 (WHO)
Dust Deposition	Annual	Maximum Incremental (Project only) increase of 2 g/m^2/month Maximum Total of 4 g/m^2/month (Project and other sources)
Odour	1-hour	2 OU (99th percentile) – receptors around Newstan Colliery Surface Site 4 OU (99th percentile) – receptors around Cooranbong Entry Site

Source: Approved Methods, NSW DEC 2005, WHO 2005.

5 EMISSIONS ESTIMATION

This section describes the various components of the Project (**Section 5.1**), the methodology used to estimate emissions (**Section 5.3**), the activity data used in the emissions estimation (**Section 5.4**) and the respective emissions inventory (**Section 5.5**).

5.1 Emission Sources

A summary of the emission sources assessed in this assessment is shown in **Table 16**.

Table 16 Summary of the Emission Sources Assessed

	Emission Sources	Pollutants	Controls (Efficiency)
Newstan Colliery Surface Site			
Paved haul roads	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control
Front end loader (FEL) on Coal	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer on Coal	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Coal stockpiles	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Coal bins	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed (70%)
Loading trains	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed (70%)
Loading stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Unloading from stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Miscellaneous transfer points (including conveying)	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed (70%)
Coal processing plant	Process emissions	TSP, PM_{10}, $PM_{2.5}$	Enclosed (100%)
Northern rejects emplacement area (NREA)	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer at NREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Reject dumping at NREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Southern rejects emplacement area (SREA)	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Excavators at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water sprays (50%)
Reject dumping at SREA	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Controls
Ventilation fans	Process emissions	TSP, PM_{10}, $PM_{2.5}$ Odour	No Control
Private Haul Roads (Paved)			
Newstan-Eraring private haul road	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control
Cooranbong private haul road	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control
Awaba private haul road	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control

	Emission Sources	Pollutants	Controls (Efficiency)
Hawkmount Quarry			
Reject dumping	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Open Area	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Cooranbong Entry Site			
Front end loader (FEL)	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Bulldozer	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Coal stockpiles	Wind erosion	TSP, PM_{10}, $PM_{2.5}$	No Control
Loading stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	No Control
Internal Paved Haul Roads	Wheel generated dust	TSP, PM_{10}, $PM_{2.5}$	No Control
Unloading from Stockpiles	Material handling	TSP, PM_{10}, $PM_{2.5}$	Water Sprays at Stockpile A – 50%
Miscellaneous Transfer Points (including conveying)	Material handling	TSP, PM_{10}, $PM_{2.5}$	Enclosed – 70%
Ventilation fans	Process emissions	TSP, PM_{10}, $PM_{2.5}$ Odour	No Control

5.2 Operational Scenarios Assessed

As discussed in **Section 2.4.4**, coal from Cooranbong Entry Site will be transported to either Newstan Colliery Surface Site or EPS depending on demand and other site specific factors.

In order to assess the worst case impacts from the Project, a total of ten modelling scenarios have been assessed in this study.

- eight scenarios associated with the operations at the Newstan Colliery Surface Site and
- two scenarios associated with the operations at the Cooranbong Entry Site.

A description of the eight scenarios assessed for the Newstan Colliery Surface Site as part of this study is shown in **Table 17**. A description of the two scenarios assessed for the Cooranbong Entry Site as part of this study is shown in **Table 18**.

Table 17 Summary of the Operational Scenarios Modelled – Newstan Colliery Surface Site

Scenario	Newstan Colliery Surface Site	Private Haul Roads	Hawkmount Quarry	Purpose of this Scenario
Scenario 1	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 4 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Trucks dumping coal at rail loop stockpile Manual train loading using FELs	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 4 Mtpa of coal using current infrastructure and handling operations at the Newstan Colliery Surface Site
Scenario 2a	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 6 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Trucks dumping coal at rail loop stockpile Manual train loading using FELs	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 6 Mtpa of coal using current infrastructure and handling operations at the Newstan Colliery Surface Site
Scenario 2b	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 6 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Automation of coal transfer from CPP to rail loop stockpile Manual train loading using FELs	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 6 Mtpa of coal using new infrastructure at the Newstan Colliery Surface Site: Automation of coal transfer from CPP to rail loop stockpile
Scenario 2c	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 6 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Trucks dumping coal at rail loop stockpile Automation of train loading operations	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 6 Mtpa of coal using new infrastructure at the Newstan Colliery Surface Site: Automation of train loading operations
Scenario 3a	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 8 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Trucks dumping coal at rail loop stockpile Manual train loading using FELs	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 8 Mtpa of coal using current infrastructure and handling operations at the Newstan Colliery Surface Site
Scenario 3b	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 8 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Automation of coal transfer from CPP to rail loop stockpile Manual train loading using FELs	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 8 Mtpa of coal using new infrastructure at Newstan Colliery Surface Site: Automation of coal transfer from CPP to rail loop stockpile
Scenario 3c	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 8 Mtpa of coal by rail Trucks dumping coal at ROM stockpile Trucks dumping coal at rail loop stockpile Automation of train loading operations	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 8 Mtpa of coal using new infrastructure at Newstan Colliery Surface Site: Automation of train loading operations
Scenario 4	Receipt of 6 Mtpa of coal from the Cooranbong Entry Site Export of 8 Mtpa of coal by rail Trucks dumping coal at ROM dump hopper Trucks dumping coal at rail loop stockpile Automation of train loading operations	32 truck trips per hour between Newstan Colliery, Cooranbong Entry Site, EPS and Hawkmount Quarry	Reject dumping Bulldozer operations Wind erosion	To assess the impacts due to export of 8 Mtpa of coal using new infrastructure at Newstan Colliery Surface Site: Coal dumping at ROM hopper

Table 18 Summary of the Operational Scenarios Modelled – Cooranbong Entry Site

Scenario	Purpose of this Scenario
Scenario 5a	To assess the impacts due to the receipt and handling of 6 Mtpa of coal from the Mandalong Mine and the export of 6 Mtpa of coal to Newstan Colliery Surface Site by trucks
Scenario 5b	To assess the impacts due to the receipt and handling of 6 Mtpa of coal from the Mandalong Mine and the export of 6 Mtpa of coal to EPS by overland conveyor

5.3 Methodology

Particulate emissions from the operational activities have been calculated using default or calculated emission factors for the relevant emission sources. Emission factors were sourced from the National Pollutant Inventory (NPI) *Emission Estimation Technique Manual (EETM) for Mining* version 3.1 (DSEWPC 2012), or from the US EPA AP-42 Emission Factor Handbook (US EPA, 2006) where suitable factors do not exist within the NPI documentation.

The NPI *EETM for Mining* (DSEWPC 2012) and US EPA AP 42 contain emission factors for TSP and PM_{10}. No emission factors for $PM_{2.5}$ are provided within the NPI *EETM for Mining* and only limited emission factors for $PM_{2.5}$ are provided in US EPA AP 42.

Limited research has been undertaken to assess the fraction of PM_{10} from the wide range of sources which would be emitted as $PM_{2.5}$. Research has been conducted by the Midwest Research Institute (MRI) on behalf of the Western Regional Air Partnership (WRAP) with findings published within the document entitled *'Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors'* (MRI 2006). This document provides six proposed $PM_{2.5}/PM_{10}$ ratios for fugitive dust source categories as presented in **Table 19**.

Table 19 Proposed Particle Size Ratios for AP-42

Fugitive Dust Source	AP-42 Section	Proposed $PM_{2.5}/PM_{10}$ Ratio
Paved roads	13.2.1	0.15
Unpaved roads (public & industrial)	13.2.2	0.1
Aggregate handling and storage piles	13.2.4	0.1
Industrial wind erosion	13.2.5	0.15
Agricultural tilling	-	0.2
Open area wind erosion	-	0.15

The $PM_{2.5}$ / PM_{10} ratios presented in **Table 19** have been used within this assessment to calculate the emissions of $PM_{2.5}$ attributable to the Project operations. The most appropriate ratio has been applied to each of the sources.

The emission factors used for the estimation of TSP, PM_{10} and $PM_{2.5}$ emissions from the operational activities are presented in **Table 20**.

Table 20 Summary of Emission Factors Used to Estimate Emissions

Activity	Emission Factor Equation	Units	Variables	Source of Emission Factor	Controls (Efficiency)
Newstan Colliery					
Trucks dumping coal	$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	kg/t	k = 0.74 (TSP) k = 0.35 (PM_{10}) k = 0.053 ($PM_{2.5}$) U = mean wind speed (m/s) M = Moisture content (%)	USEPA 2006	Hood (unknown) and Water sprays (50%)
FEL/Excavator on coal	$EF_{TSP} = \frac{0.580}{M^{1.2}}$ $EF_{PM_{10}} = \frac{0.0441}{M^{0.9}}$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	M = Moisture content (%)	DSEWPC 2012 MRI 2006	No controls
Bulldozer on coal	$EF_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}}$ $EF_{PM_{10}} = 6.33 \times \frac{s^{1.5}}{M^{1.4}}$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/h/vehicle	s=silt content (%) M=Moisture content (%)	DSEWPC 2012 MRI 2006	No controls
Coal stockpiles	$EF_{TSP} = 0.4$ $EF_{PM10} = 0.2$ $EF_{PM2.5} = 0.15 \times EF_{PM10}$	kg/ha/h	-	DSEWPC 2012 MRI 2006	Water sprays (50%)
Miscellaneous Transfer Points (including conveying)	$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	kg/t	k = 0.74 (TSP) k = 0.35 (PM_{10}) k = 0.053 ($PM_{2.5}$) U = mean wind speed (m/s) M = Moisture content (%)	DSEWPC 2012 USEPA 2006	Enclosed (70%)
Loading trains	EF_{TSP} = 0.0004 EF_{PM10} = 0.00017	kg/t	-	NPI EETM v3.1	Enclosed (70%)
Loading stockpiles	EF_{TSP} = 0.004 EF_{PM10} = 0.0017 $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	-	DSEWPC 2012 MRI 2006	Water sprays (50%)

Activity	Emission Factor Equation	Units	Variables	Source of Emission Factor	Controls (Efficiency)
Unloading from stockpiles	$EF_{TSP} = 0.004$ $EF_{PM10} = 0.0017$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	-	DSEWPC 2012 MRI 2006	Water sprays (50%)
Coal processing plant (primary crusher + screening)	$EF_{TSP} = 0.01$ $EF_{PM10} = 0.004$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	-	DSEWPC 2012 MRI 2006	Enclosed (100%)
Ventilation fans	$EF_{TSP} = 0.99$ $EF_{PM10} = 0.16$ $EF_{PM2.5} = 0.17$ $EF_{Odour} = 30{,}282$	g/s $OU.m^3/s$	-	SLR 2012c SLR 2012b	No controls
Cooranbong Entry Site-					
Excavator / Front End Loader on coal	$EF_{TSP} = \frac{0.580}{M^{1.2}}$ $EF_{PM_{10}} = \frac{0.0441}{M^{0.9}}$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	M = Moisture content (%)	DSEWPC 2012 MRI 2006	No controls
Bulldozer on coal	$EF_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}}$ $EF_{PM_{10}} = 6.33 \times \frac{s^{1.5}}{M^{1.4}}$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/h/vehicle	s=silt content (%) M=Moisture content (%)	DSEWPC 2012 MRI 2006	No controls
Loading Stockpiles	$EF_{TSP} = 0.004$ $EF_{PM10} = 0.0017$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	-	DSEWPC 2012 MRI 2006	No controls
Unloading from Stockpiles	$EF_{TSP} = 0.004$ $EF_{PM10} = 0.0017$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/t	-	DSEWPC 2012 MRI 2006	Water Sprays at Stockpile A – 50%
Miscellaneous Transfer Points	$EF = k \times 0.0016 \times \frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	kg/t	k = 0.74 (TSP) k = 0.35 (PM_{10}) k = 0.053 ($PM_{2.5}$) U = mean wind speed (m/s) M = Moisture content (%)	DSEWPC 2012 USEPA 2006	Enclosed (70%)

Activity	Emission Factor Equation	Units	Variables	Source of Emission Factor	Controls (Efficiency)
Wind Erosion	$EF_{TSP} = 0.4$ $EF_{PM10} = 0.2$ $EF_{PM2.5} = 0.15 \times EF_{PM10}$	kg/ha/h	-	DSEWPC 2012 MRI 2006	Water sprays (50%)
Ventilation fans	EF_{TSP} = 0.99 EF_{PM10} = 0.16 $EF_{PM2.5}$ = 0.17 EF_{Odour} = 30,282	g/s OU.m^3/s	-	SLR 2012c SLR 2012b	No controls
Hawkmount Quarry					
Trucks dumping rejects	$EF = k \times 0.0016 \times \frac{\frac{U}{2.2}^{1.3}}{\frac{M}{2}^{1.4}}$	kg/t	k = 0.74 (TSP) k = 0.35 (PM_{10}) k = 0.053 ($PM_{2.5}$) U = mean wind speed (m/s) M = Moisture content (%)	USEPA 2006	Hood (unknown) and Water sprays (50%)
Bulldozer on rejects	$EF_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}}$ $EF_{PM_{10}} = 6.33 \times \frac{s^{1.5}}{M^{1.4}}$ $EF_{PM2.5} = 0.1 \times EF_{PM10}$	kg/h/vehicle	s=silt content (%) M=Moisture content (%)	DSEWPC 2012 MRI 2006	No controls
Open areas	$EF_{TSP} = 0.4$ $EF_{PM10} = 0.2$ $EF_{PM2.5} = 0.15 \times EF_{PM10}$	kg/ha/h	-	DSEWPC 2012 MRI 2006	No controls
Private Haul Roads					
Wheel generated dust from paved roads	$EF = k \times sL^{0.91} \times W^{1.02}$	kg/VKT	UESPA 2011	k = 3.23 (TSP) k = 0.62 (PM_{10}) k = 0.15 ($PM_{2.5}$) sL = silt loading (g/m^2) W = average weight of the vehicles traveling the road (tonnes)	No controls

Note: The relevant sources are included/excluded as appropriate for each scenario discussed in **Section 5.2**.

5.4 Activity Rates

5.4.1 Ventilation Fans

Actual measurements of the particulate and odour emissions from the ventilation fans at Newstan Colliery Surface Site and Cooranbong Entry Site were not performed.

However, particulate and odour monitoring was conducted at the Mandalong Mine Access Site. For the purpose of this assessment, the results of the monitoring of the ventilation fans at the existing Mandalong Mine Access Site have been adopted to assess potential impacts from the existing ventilation fans at the Newstan Colliery Surface Site and Cooranbong Entry Site which will be operating under similar conditions, such as:

- proposed mining will be carried out in similar geological conditions to those currently experienced at the existing Mandalong Mine, and
- similar underground mining equipment will be used.

Specifically, to estimate emissions from the gas ventilation fans, a monitoring program was conducted by SLR Consulting at the existing Mandalong Mine Access Site in June 2012 and August 2012 (SLR 2012a and SLR 2012b respectively). The pollutant emissions that were monitored were:

- TSP;
- PM_{10};
- $PM_{2.5}$; and
- Odour.

5.4.2 Material Handling

Annual activity data for the proposed activities occurring as part of the Project are provided in **Table 21** for material handling operations.

Table 21 Proposed Annual Activity Data for Material Handling Operations – Scenario 1 to 4

	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 3a	Scenario 3b	Scenario 3c	Scenario 4		
Operation / Activity	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Units**	**Notes**
Newstan Colliery Surface Site – Incoming Coal from Mandalong Southern Extension Project										
Trucks dumping coal at ROM stockpile	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	0	tonnes	Maximum proposed rate
Trucks dumping coal at dump hopper	0	0	0	0	0	0	0	6,000,000		None
Newstan Colliery Surface Site – Incoming Coal from Newstan Underground Mine										
Conveyor from Newstan Drift to CPP module 2 (Newstan Coal)	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	tonnes	Assumed 90% of coal direct to CPP
Conveyor from Newstan Drift to Newstan Coal ROM Stockpile (Newstan Coal)	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	tonnes	Assumed 10% of coal to stockpile
Newstan Colliery Surface Site – Onsite Coal Movement for Mandalong Coal										
Dozer on ROM stockpile (push to reclaim tunnel)	876	876	876	876	876	876	876	876	hours	Assumed to be operating 10% of time during the year
ROM Coal from ROM Coal Stockpile to stacker	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	6,000,000	tonnes	Maximum proposed rate
ROM Coal from stacker to stockpile	600,000	600,000	600,000	600,000	600,000	600,000	600,000	600,000	tonnes	10% of coal going to stockpile
Conveyor to CPP Module 1	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	5,400,000	tonnes	90% of coal direct from stacker to CPP
Newstan Colliery Surface Site – Onsite Coal Movement for Underground Coal										
Conveyor drop onto Newstan ROM Stockpile (from underground)	450,000	450,000	450,000	450,000	450,000	450,000	450,000	450,000	tonnes	Assumed 10% of coal to stockpile
Conveyor drop to CPP Module 2	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	4,050,000	tonnes	Assumed 90% of coal direct to CPP
Newstan Colliery Surface Site – Onsite Coal Processing for Total Coal										
CPP Module 1 & CPP Module 2 & CHP-Crush/Screen/Wash	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	8,000,000	tonnes	Maximum proposed rate
Newstan Colliery Surface Site – Outgoing Product Coal										
Trucks dumping coal to Rail loop stockpile	4,000,000	6,000,000	0	6,000,000	8,000,000	0	8,000,000	8,000,000	tonnes	None
Conveyor drop to Rail Loop Stockpile	0	0	6,000,000	0	0	8,000,000	0	0	tonnes	None
Conveyor to train loading bin	0	0	0	6,000,000	0	0	0	0	tonnes	None
Conveyor loading trains/trucks	0	0	0	6,000,000	0	0	0	0	tonnes	None
Dozer at Product Stockpile (Rail Loop)	2,920	4,380	4,380	4,380	5,840	5,840	5,840	5,840	hours	Assumed to operating 8 hours per day for the full year
Front End Loader 1 at Product Stockpile (Rail Loop) loading trains	1,333,333	2,000,000	2,000,000	0	2,666,666	2,666,666	0	0	tonnes	Assumed to be 1/3rd of the total product coal
Front End Loader 2 at Product Stockpile (Rail Loop) loading trains	1,333,333	2,000,000	2,000,000	0	2,666,666	2,666,666	0	0	tonnes	Assumed to be 1/3rd of the total product coal
Front End Loader 3 at Product Stockpile (Rail Loop) loading trains	1,333,333	2,000,000	2,000,000	0	2,666,666	2,666,666	0	0	tonnes	Assumed to be 1/3rd of the total product coal
Newstan Colliery Surface Site – Reject Coal										
Reject from CPP loaded to bin	1,073,100	1,073,100	1,073,100	1,073,100	1,073,100	1,073,100	1,073,100	1,073,100	tonnes	Assumed 6 truckloads per hour, 35t truck payload and 14 hrs/day operation
Reject from CPP loaded to trucks	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum

	Scenario 1	Scenario 2a	Scenario 2b	Scenario 2c	Scenario 3a	Scenario 3b	Scenario 3c	Scenario 4		
Operation / Activity	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Activity Rate (Annual)**	**Units**	**Notes**
										total reject to SREA
Trucks dumping reject/stone material at SREA	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to SREA
Dozer at SREA	1,752	1,752	1,752	1,752	1,752	1,752	1,752	1,752	hours	Assumed to operating 20% of time throughout the year
Excavator at SREA	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to SREA
Excavator at SREA	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to SREA
Excavator at SREA	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to SREA
Traxcavator at SREA	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to SREA
Compactor at SREA	2,600	2,600	2,600	2,600	2,600	2,600	2,600	2,600	hours	Operating hours are from 6am to 5pm Monday to Friday 10 hrs/day on overburden.
Trucks dumping reject material at NREA	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to SREA
Dozer at NREA	1,752	1,752	1,752	1,752	1,752	1,752	1,752	1,752	hours	Assumed to be operating 20% of the time throughout the year
Hawkmount Quarry										
Trucks dumping rejects	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	1,000,000	tonnes	Assumed to be maximum total reject to Hawkmount Quarry
Dozer at Hawkmount Quarry	1,022	1,022	1,022	1,022	1,022	1,022	1,022	1,022	hours	Assumed to be operating 20% of the time throughout the year

Table 22 Proposed Annual Activity Data for Material Handling Operations – Scenario 5a and 5b

	Scenario 5a	Units	Notes	Scenario 5b	Units	Notes
Cooranbong Entry Site						
Coal handled by FEL 1 at 100,000 t stockpile	503,700	tonnes	Assumed to be 115 t/hr; 24 hrs/day; 50% of the time throughout the year	0	tonnes	All coal transported to EPS
Coal handled by FEL 2 at 100,000 t stockpile	192,720	tonnes	Assumed to be 110 t/hr; 24 hrs/day; 20% of the time throughout the year	0	tonnes	All coal transported to EPS
Coal handled by FEL at stockpile 3000 t stockpile	876,000	tonnes	Assumed to be 400 t/hr; 24 hrs/day; 25% of the time throughout the year	876,000	tonnes	All coal transported to EPS
Bulldozer on 100,000 t stockpile	208	hours	Assumed to be operating 4 hours/week, 52 weeks per year	0	hours	All coal transported to EPS
Loading 100,000 t stockpile	1,740,000	tonnes	Assumed to be total 29% loaded from stockpile A	0	tonnes	All coal transported to EPS
Loading 3000 t stockpile	876,000	tonnes	Assumed to be 400 t/hr; 24 hrs/day; 25% of the time throughout the year	876,000	tonnes	All coal transported to EPS
Unloading 100,000 t stockpile	1,740,000	tonnes	Assumed to be 29% loaded from stockpile A	0	tonnes	All coal transported to EPS
Unloading 3000 t stockpile	876,000	tonnes	Assumed to be 400 t/hr; 24hrs/day; 25% of the time throughout the year	876,000	tonnes	All coal transported to EPS
South drift conveyor	6,000,000	tonnes	Maximum proposed production from Mandalong Mine	6,000,000	tonnes	All coal transported to EPS
2000t ROM Coal bin	0	tonnes	Maximum proposed production from Mandalong Mine	6,000,000	tonnes	All coal transported to EPS
250t Raw coal bin	0	tonnes	Maximum proposed production from Mandalong Mine	6,000,000	tonnes	All coal transported to EPS
1200t truck loading bin	4,260,000	tonnes	Assumed to be 71% of the coal loaded from truck loading bin	0	tonnes	All coal transported to EPS

	Scenario 5a	Units	Notes	Scenario 5b	Units	Notes
Cooranbong Entry Site						
Final product bin	0	tonnes	Maximum proposed production from Mandalong Mine	6,000,000	tonnes	All coal transported to EPS
Screen/rotary breakers	0	tonnes	Maximum proposed production from Mandalong Mine	6,000,000	tonnes	All coal transported to EPS
Crushing plant	0	tonnes	Maximum proposed production from Mandalong Mine	6,000,000	tonnes	All coal transported to EPS

5.4.3 Wheel Generated Dust

The Project proposes the continued use of the existing private haul roads that link Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and Eraring Power Station.

The length of each haul road is presented in **Table 23** with information on the haul road width, annual use and mean vehicle weight.

Table 23 Details of Haul Roads

Haul Road	Length (m)	Width (m)	One Way Trips per Hour	Vehicle Kilometres Travelled (VKT) per Year[1]	Mean Vehicle Weight (tonnes)
Newstan Colliery Surface Site					
Not Applicable[2]					
Cooranbong Entry Site					
Haul roads within the site	800	8	16	224,256	50
Hawkmount Quarry					
Not Applicable					
Private Haul Roads					
Cooranbong private haul road	3,400	8	16	953,088	50
Newstan-Eraring private haul road	13,000	8	16	3,644,160	50
Awaba private haul road	700	8	16	196,224	50

[1] The calculated VKTs are based on 16 trucks per hour, operating for 24 hours per day and 365 days per year.
[2] The haul roads within the Newstan Colliery have been incorporated as part of the Newstan – Eraring private haul road

5.4.4 Wind Erosion

Several areas at Newstan Colliery Surface Site, Cooranbong Entry Site and Hawkmount Quarry are considered as potential wind erosion sources following upgrade and are presented in **Table 24**.

Table 24 Annual Activity Data for Wind Erosion Sources

Open Area	Total Area (ha)	Active Area (ha)
Newstan Colliery Surface Site		
ROM coal stockpile	0.8	0.8
Proposed Product stockpile (North)	2.2	2.2
Proposed Product stockpile (South)	2.4	2.4
Train wagon surface	0.4	0.4
Southern Reject Emplacement Area (SREA)	57	45
Northern Reject Emplacement Area (NREA)	37	8

Cooranbong Entry Site		
100,000 tonne stockpile	0.65	0.65
3,000 tonne stockpile)	0.09	0.09
1,500 tonne stockiple)	0.05	0.05
Hawkmount Quarry		
Hawkmount Quarry open area	2.8	2.8

5.5 Emissions Inventory

A summary of the emissions inventory for all scenarios at Newstan Colliery Surface Site and Cooranbong Entry Site is shown in **Figure 10** and **Figure 11** respectively.

A summary of the emissions inventory for the private haul roads and Hawkmount Quarry is shown in **Figure 12**.

A detailed emission inventory can be found in **Appendix A**.

Figure 10 A Summary of the Particulate Emissions from All Scenarios – Newstan Colliery Surface Site

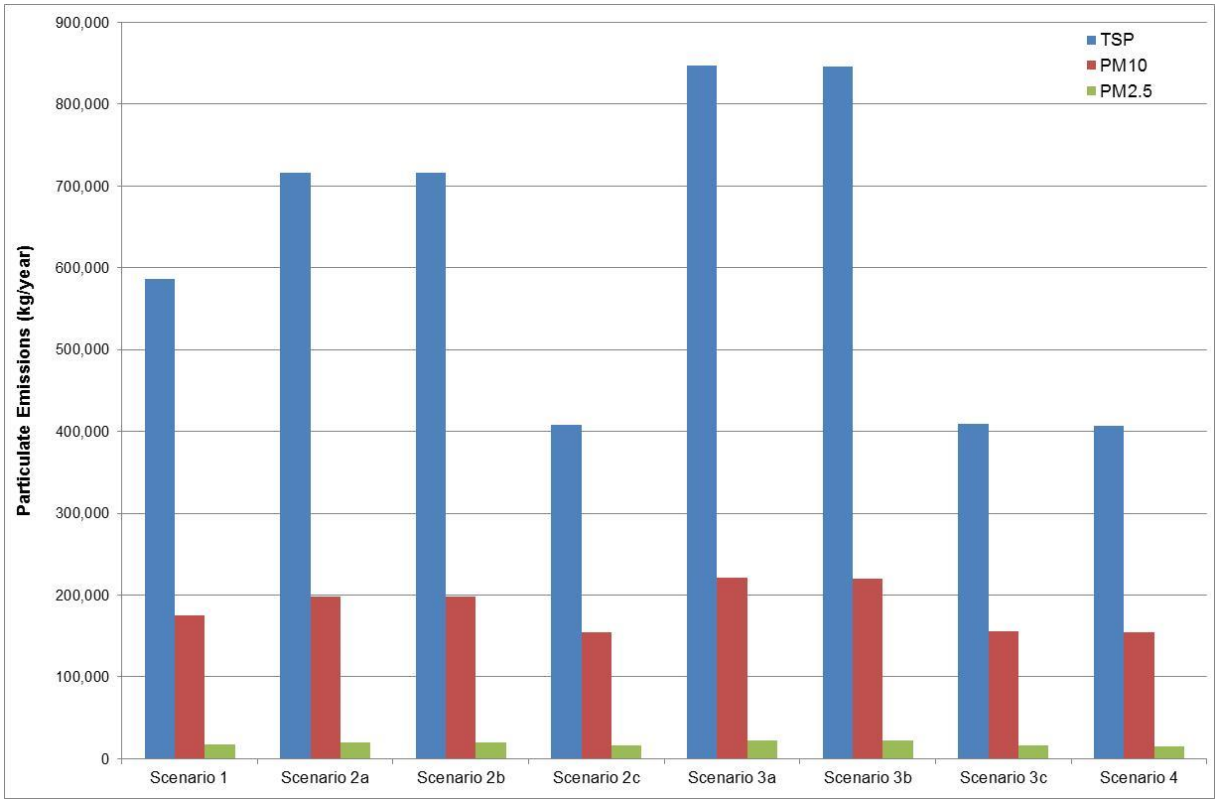


Figure 11 A Summary of the Particulate Emissions from All Scenarios – Cooranbong Entry Site

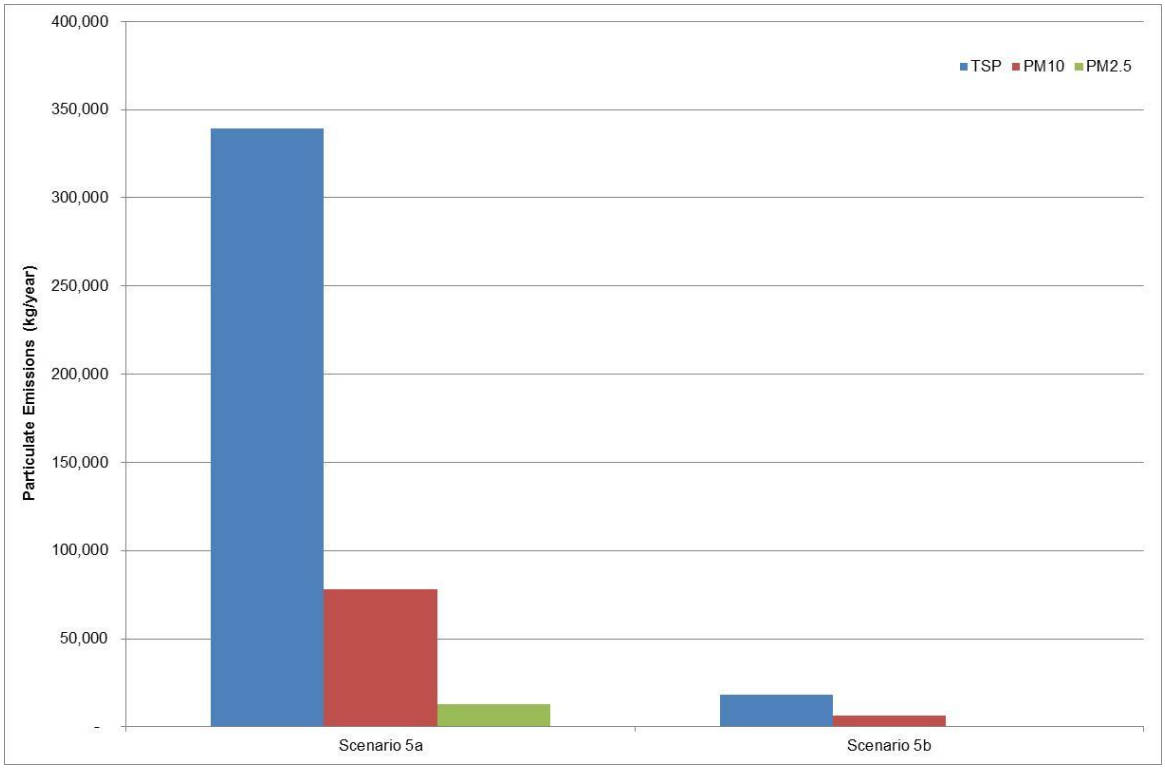
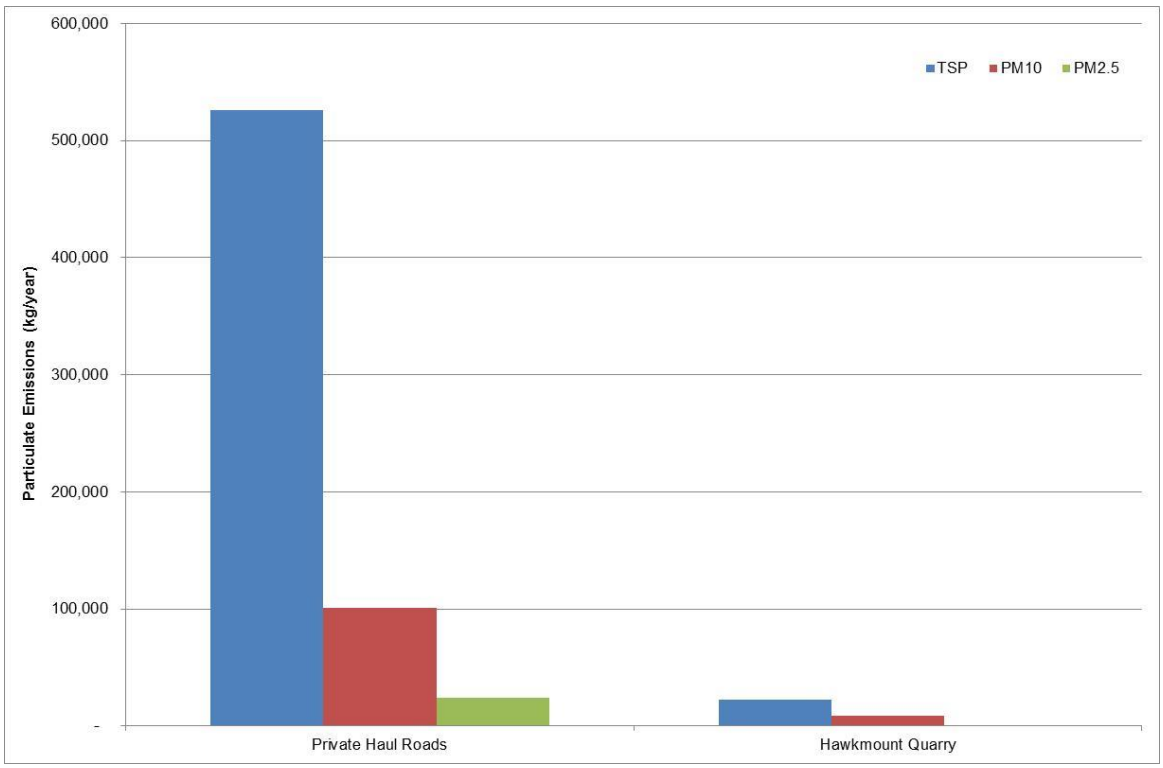


Figure 12 A Summary of the Particulate Emissions from Private Haul Roads and Hawkmount Quarry



Ventilation Fans

The monitored emissions from ventilation fans (SLR 2012b) are shown in **Table 25**. It is noted that the emissions from the existing Mandalong Mine Access Site are adopted for the emissions from the ventilation fans at the Newstan Colliery Surface Site and the Cooranbong Entry Site. .

Table 25 Monitored Pollutant Emissions from the Ventilation Fans at existing MMAS

Pollutant	Emission Rate	Units
TSP[1]	0.99	g/s
PM_{10}[1]	0.16	g/s
$PM_{2.5}$[1]	0.17	g/s
Odour[2]	30,282	$OU.m^3/s$

[1] Source: SLR 2012b

[2] Source: SLR 2012a, the average of three samples is adopted as the odour emission rate.

6 AIR DISPERSION MODELLING METHODOLOGY

6.1 Model Selection

Emissions from the Project operations have been modelled using the US EPA's CALPUFF (Version 6.267) modelling system. CALPUFF is a transport and dispersion model that ejects "puffs" of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so it typically uses the fields generated by a meteorological pre-processor CALMET, discussed further below. Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period. The primary output files from CALPUFF contain either hourly concentration or hourly deposition fluxes evaluated at selected receptor locations. The CALPOST post-processor is then used to process these files, producing tabulations that summarise results of the simulation for user-selected averaging periods.

The advantages of using CALPUFF (rather than using a steady state Gaussian dispersion model such as AUSPLUME) is its ability to handle calm wind speeds (<0.5 m/s) and the effects of complicated terrain on plume dispersion. Steady state models assume that meteorology is unchanged by topography over the modelling domain and may result in significant over or under estimation of air quality impacts.

More advanced dispersion models (such as CALPUFF) are approved for use by many regulatory authorities in situations where these models may be more appropriate than use of the AUSPLUME model. Such situations include those noted above (i.e. high frequency of calm wind conditions and/or complicated terrain).

6.2 Meteorological Modelling

6.2.1 Meteorological Modelling Approach

To adequately characterise the dispersion meteorology of the Project Application Area, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability. The meteorology of the study area was characterised based on a 3-Dimensional prognostic meteorological dataset for the region surrounding the Project Application Area.

MM5

The three dimensional prognostic dataset generated by the Pennsylvania State University/National Centre for Atmospheric Research, or MM5, model was created and assimilated in the CALMET modelling process. The MM5 model is a prognostic mesoscale wind field model with four-dimensional data assimilation. CALMET's wind model allows MM5 generated data to be used as initial pseudo-observations (Scire *et al.*, 2006).

For this study, an MM5 meteorological dataset was obtained for a 120 km x 120 km domain for the 2006, 2007, 2008, 2009 and 2010 calendar years, centred over the study area, with a spatial grid resolution of 12 km. The model has 40 vertical levels, with the lowest level beginning at 11 m above ground level ranging to 3,500 m. The MM5 dataset contains the two-dimensional and three-dimensional parameters listed in **Table 26**.

Table 26 MM5 Dataset Parameters

Hourly 3-Dimensional Parameters	Hourly 2-Dimensional Parameters
Wind speed and direction	Sea-level pressure
Temperature	Rainfall amount
Pressure	Snow cover
Geopotential height	Short wave and long wave radiation at the surface
Vertical velocity	Air temperature and specific humidity at 2m
Relative humidity	Wind speed and direction at 10m
Mixing ratios for water vapour, cloud water, rain and other precipitation	Sea surface temperature

CALMET

CALMET is a meteorological model that develops wind and temperature fields on a three-dimensional gridded modelling domain. Associated two-dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The interpolated wind field is then modified within the model to account for the influences of topography, as well as differential heating and surface roughness associated with different land uses across the modelling domain. These modifications are applied to the winds at each grid point to develop a final wind field. The final wind field thus reflects the influences of local topography and land uses.

Table 27 details the parameters used in the meteorological modelling. No surface, upper air or buoy observations were used in the CALMET model ('No-Obs Mode' hereafter). This approach is recommended by NSW EPA (2010) as:

- No-Obs mode allows the important benefits of the non-steady-state approach in CALPUFF to be included in the dispersion modelling (e.g., spatially varying meteorology and dispersion, causality, recirculation, stagnation, pollutant build-up, fumigation, etc.);
- No-Obs mode makes use of three-dimensional, hourly prognostic meteorological data often available at high resolution to drive CALMET and CALPUFF;
- No-Obs mode greatly simplifies the preparation of the CALMET inputs because a large number of input variables dealing with observational data are not required and the difficulties of dealing with potentially incomplete observational datasets are eliminated;
- No-Obs mode provides a relatively straightforward approach that facilitates agency review and approval of the CALMET/CALPUFF simulations;

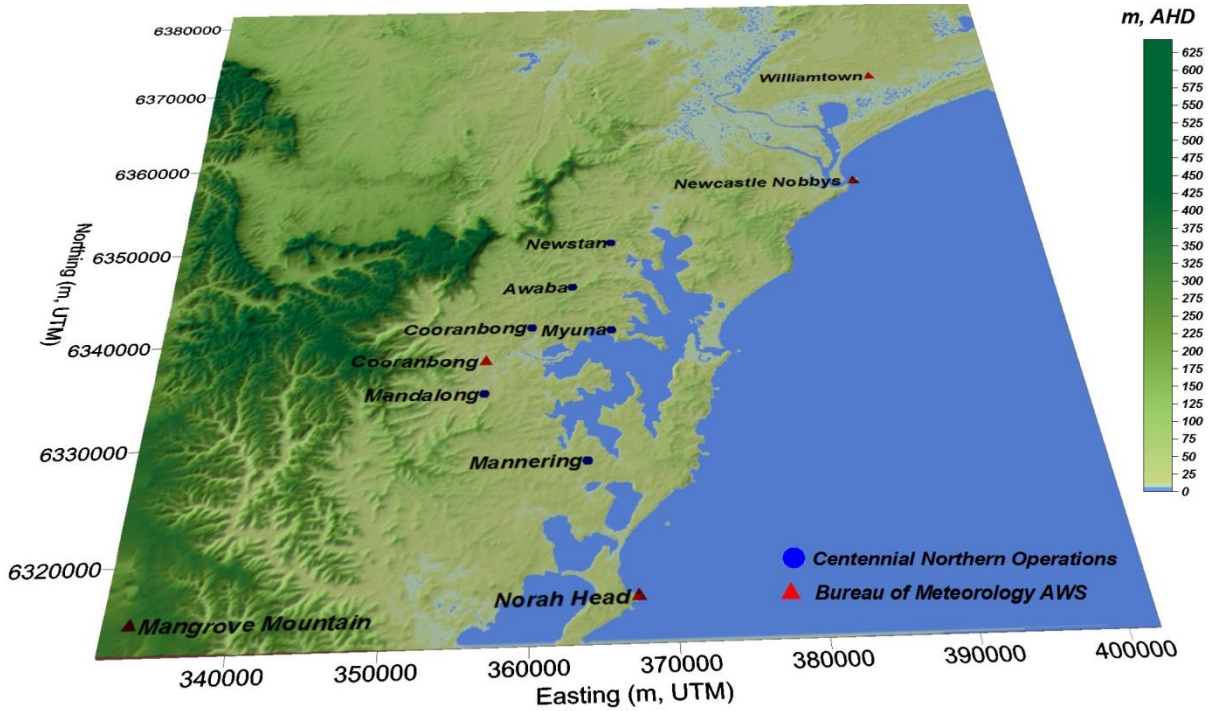
Table 27 CALMET Configuration Used for this Study

Meteorological grid domain	40 km x 40 km
Meteorological grid resolution	0.3 km
TERRAD Value	1.5 km
Vertical Resolution (Cell Heights)	10 (0 m, 20 m, 40 m, 80 m, 160 m, 320 m, 640 m, 1,200 m, 2,000 m, 3,000 m and 4,000m)
Modelling Years	2006, 2007, 2008, 2009 and 2010

6.2.2 Validation of Meteorological Modelling Approach

A validation of the meteorological modelling has been performed using data from the Bureau of Meteorology's (BoM's) Williamtown Automatic Weather Station (AWS), which is considered to be in a similar meteorological and topographical environment to the Centennial Northern Operations. The AWS at Williamtown (when compared to the coastal AWS of Newcastle Nobbys and Norah Head, and the inland Mangrove Mountain) is at a distance from the coast similar to that of the Centennial's northern operations. On this basis it is concluded that increased confidence in the ability of the CALMET model to represent the meteorology at Centennial's Northern Operations may be obtained if suitably accurate predictions can be shown to be made at the Williamtown RAAF AWS.

Figure 13 Locations of Centennial Northern Operations and Surrounding Bureau of Meteorology Automatic Weather Stations



A CALMET file has been generated for an area within a radius of 10 km from the BoM Williamtown RAAF AWS. All required inputs to CALMET including grid spacing, and switches including TERRAD, were set so as to be consistent between this validation run and those used in the generation of the meteorological field covering the operations of the Northern Coal Logistics Project. CALMET was run in 'No-Obs mode' with observational data from the BoM Williamtown RAAF AWS used as validation data.

It was concluded from the validation study that the CALMET model performed very well in representing the observed meteorological fields at Williamtown. Based on these findings it was concluded that, using the same parameters in modelling, it can be expected that the CALMET model would perform equally as well in predicting the meteorological fields over the area of the Project Site (and other Centennial Northern Operations).

6.2.3 Meteorological Data Used in Modelling

The Newstan Colliery Surface Site and Cooranbong Entry Site are separated by a distance of approximately 13 km. Even though the meteorological modelling domain provides an area sufficient to cover these sites, and it is acknowledged that the meteorological conditions experienced at both of these sites may be different, it is difficult to quantify both the 'meteorological sets' within this report. However, to provide an estimate of the predicted meteorological conditions which may be experienced at both sites, the modelled meteorological data 'extracted' at a point midway between the two sites (at Awaba Colliery Surface Site) is presented in this section.

It is noted that the meteorological dataset developed for use in this assessment has been compiled to provide a robust and conservative assessment of potential downwind impacts due to particulate and other pollutant emissions from activities occurring within the Project Application Area.

The factors considered in selecting the meteorological data for use in an air quality impact assessment can be considerably different to those that need to be considered when compiling data for a noise impact assessment. A full description of the differences between requirements for air quality and noise impact assessments is provided in **Section 6.2.5**.

Wind Speed and Direction

A summary of the annual wind behaviour predicted by CALMET for the Project for the years 2006, 2007, 2008, 2009 and 2010 are presented as wind roses in **Figure 14**, **Figure 15** and **Figure 16**, **Figure 17** and **Figure 18** respectively.

These wind roses indicate that the region predominantly experiences light to moderate (between 1.5 m/s and 8 m/s) winds with high speed winds (> 8m/s) prevailing for a low fraction of time during certain seasons and that the wind direction is seasonally dependent. Winds occur reasonably evenly from all quadrants except the west-northwest quadrant, from which winds occur infrequently. During autumn and winter, the region experiences a high percentage of winds from the west-northwest quadrant.

Calm wind conditions (wind speed less than 0.5 m/s) were predicted to occur just over 1% of the time during years 2006, 2007 and 2008, and less than 1% during years 2009 and 2010.

Figure 14 Annual Wind Roses for –Northern Coal Logistics Project (CALMET predictions, 2006)

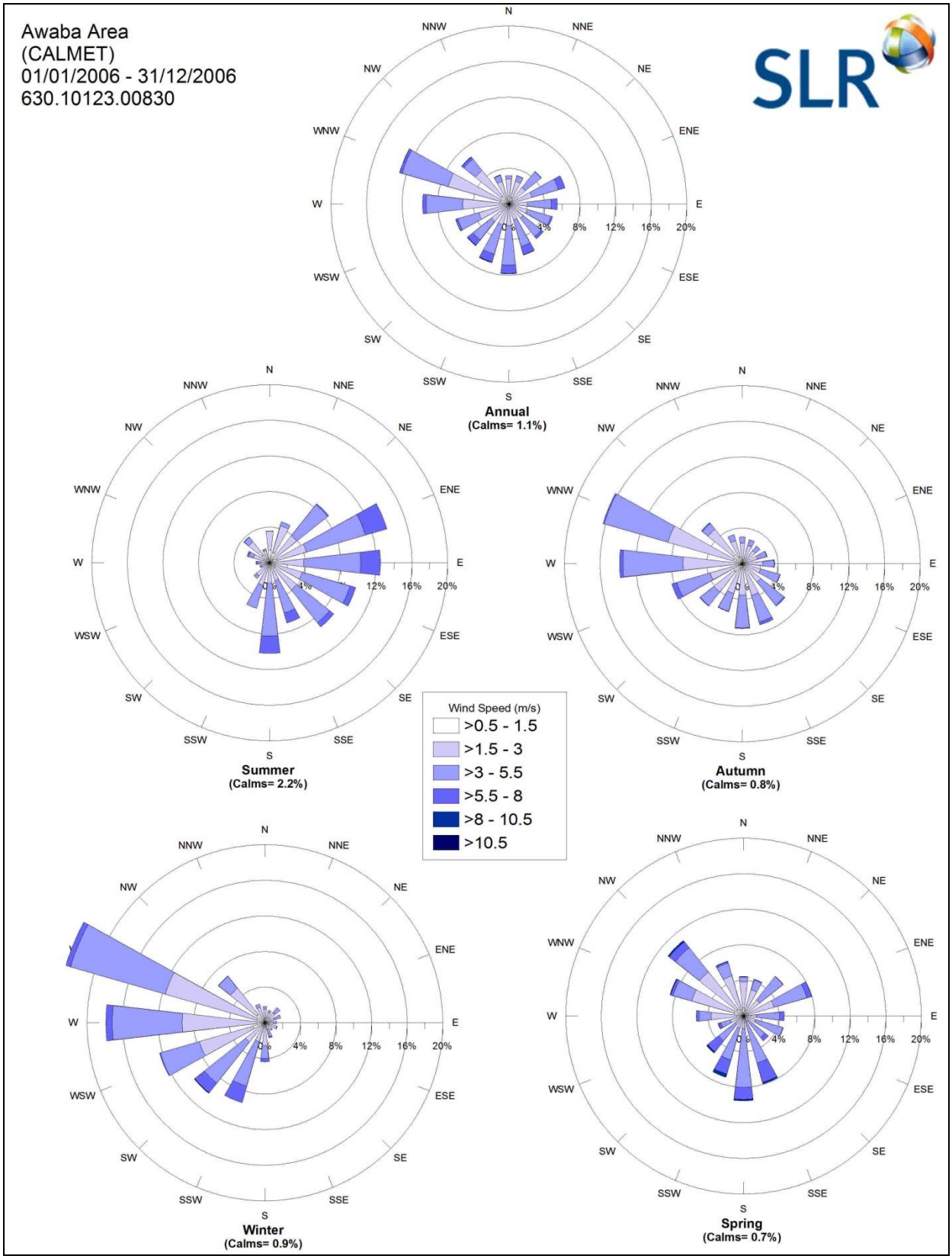


Figure 15 Annual Wind Roses for Northern Coal Logistics Project (CALMET predictions, 2007)

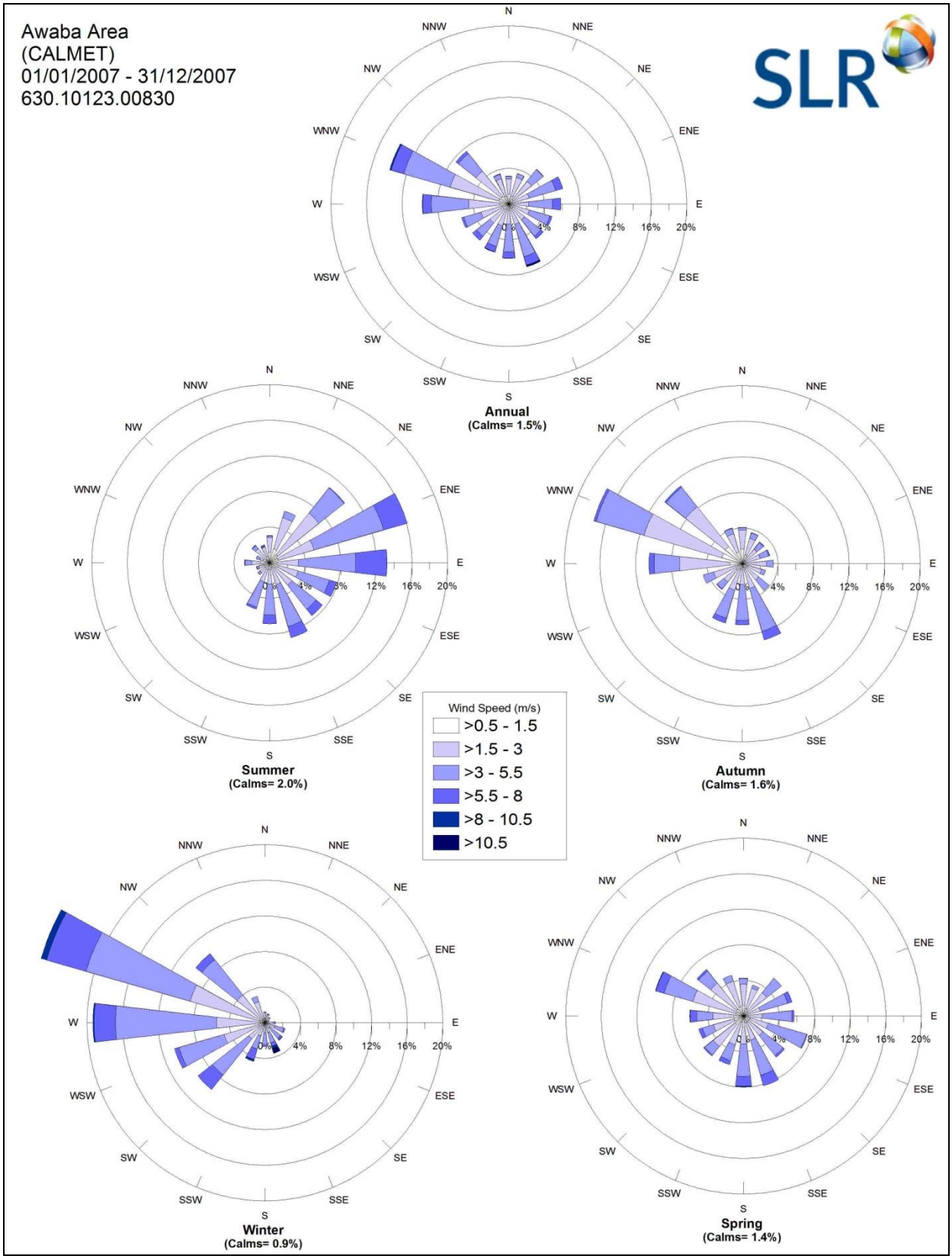


Figure 16 Annual Wind Roses for Northern Coal Logistics Project (CALMET predictions, 2008)

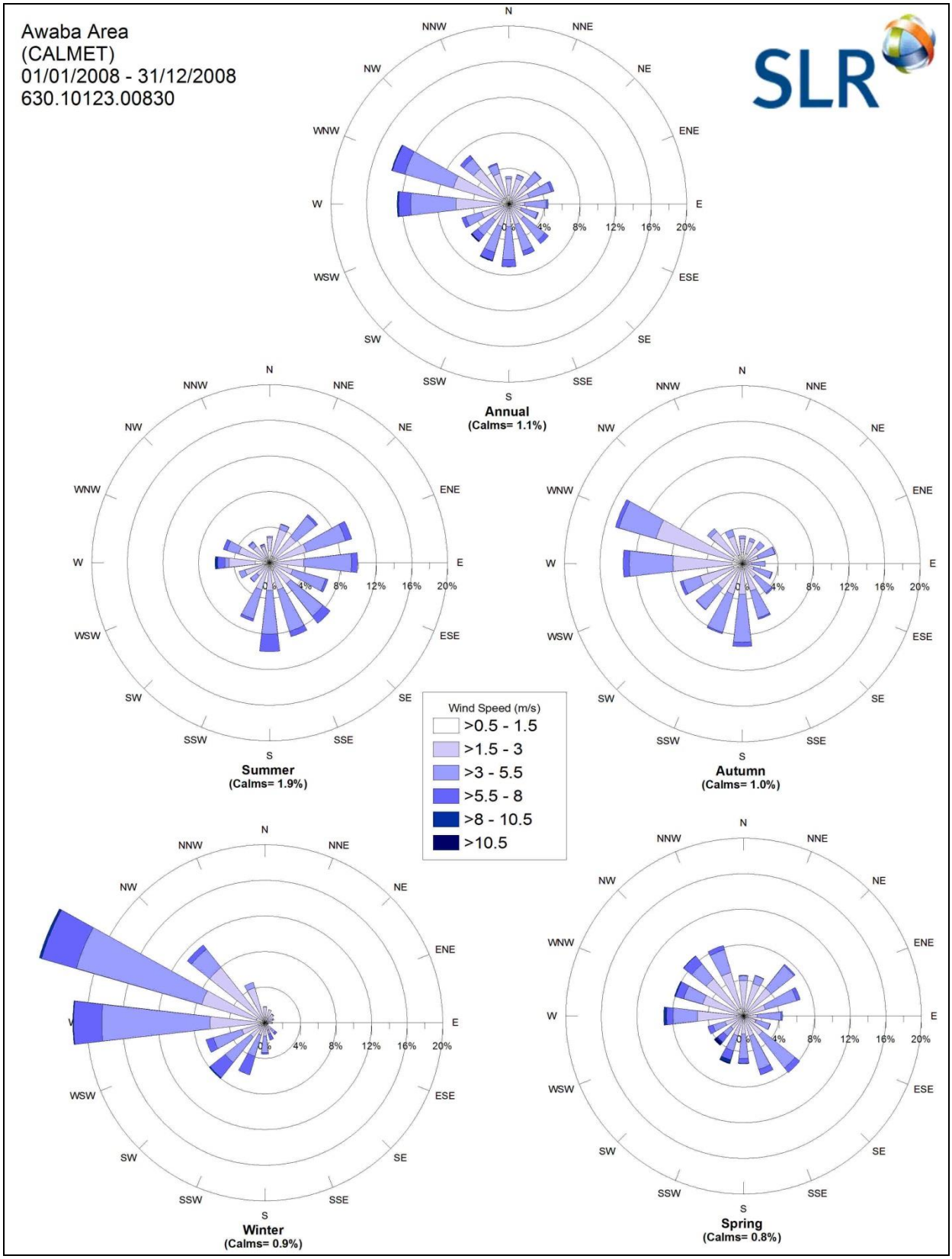


Figure 17 Annual Wind Roses for Northern Coal Logistics Project (CALMET predictions, 2009)

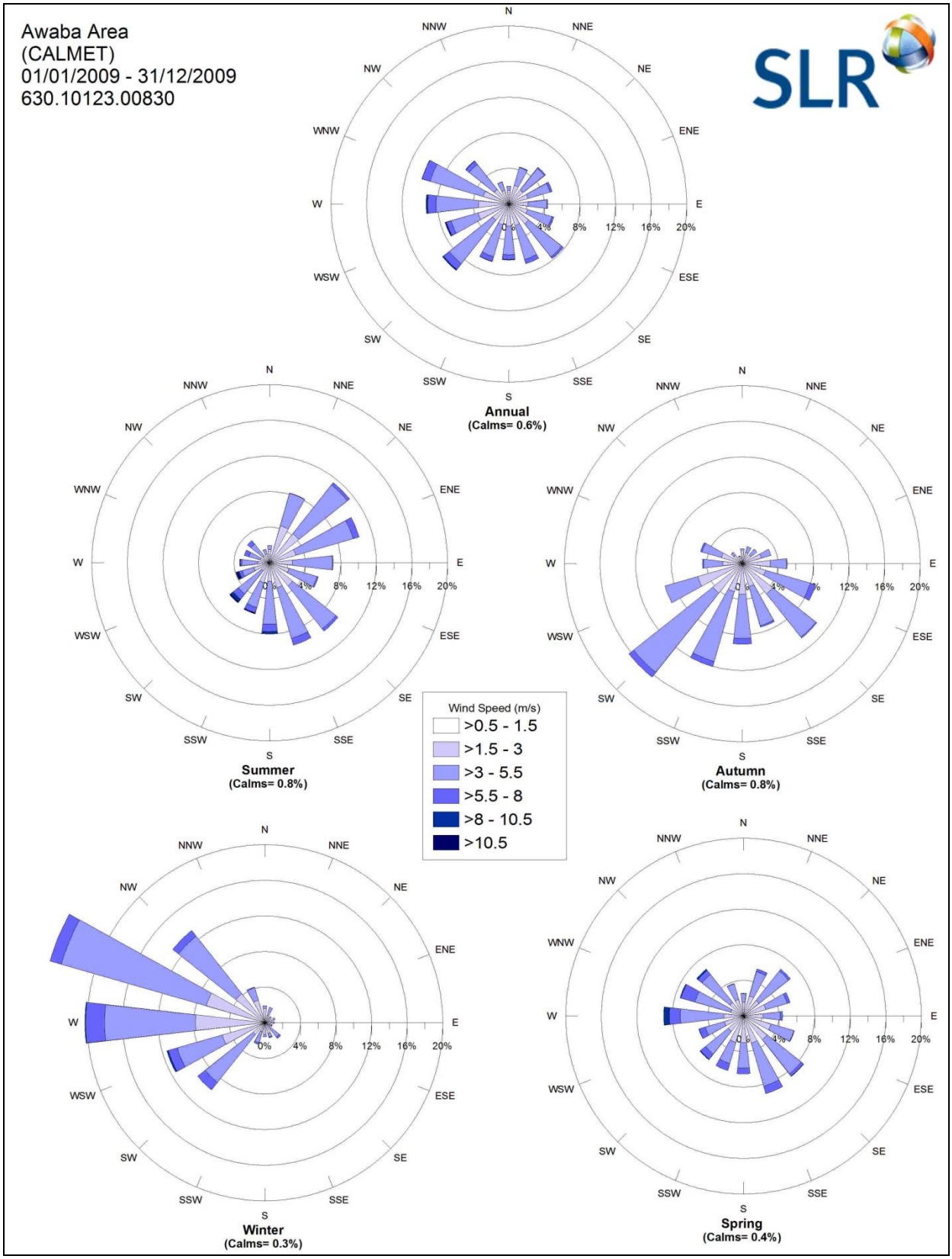


Figure 18 Annual Wind Roses for Northern Coal Logistics Project (CALMET predictions, 2010)



Atmospheric Stability

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes, A to F, to categorise the degree of atmospheric stability (see **Table 28**). These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models.

The frequency of each stability class predicted by CALMET in the area of the Awaba site during 2006, 2007, 2008, 2009 and 2010 is presented in **Figure 19**.

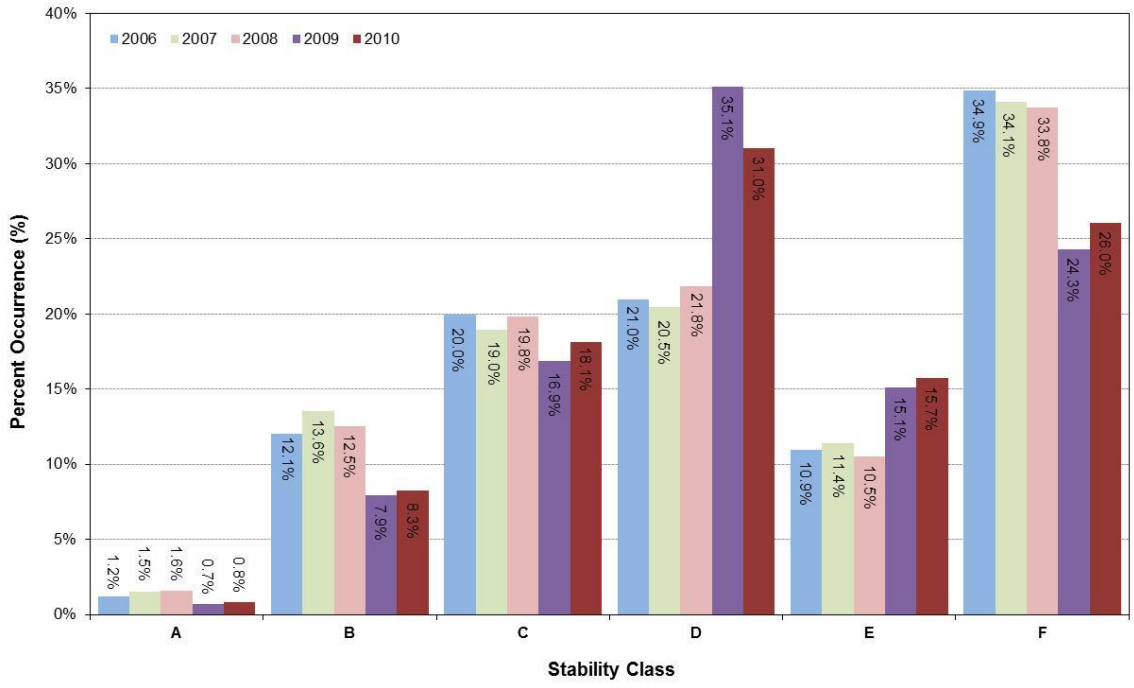
The results indicate a high frequency of conditions typical to Stability Class F. Stability Class F is indicative of very stable night time conditions, conducive to a low level of pollutant dispersion due to mechanical mixing. A similar trend in the stability classes during the years 2006 to 2010 is noted.

A higher percentage of stability class D is predicted for year 2009 and 2010. Stability Class D is indicative of neutral conditions, conducive to a moderate level of pollutant dispersion due to mechanical mixing.

Table 28 Description of Atmospheric Stability Classes

Atmospheric Stability Class	Category Description
A	Very unstable Low wind, clear skies, hot daytime conditions
B	Unstable Clear skies, daytime conditions
C	Moderately unstable Moderate wind, slightly overcast daytime conditions
D	Neutral High winds or cloudy days and nights
E	Stable Moderate wind, slightly overcast night-time conditions
F	Very stable Low winds, clear skies, cold night-time conditions

Figure 19 Stability Class Frequencies for Northern Coal Logistics Project (CALMET predictions, 2006-2010)



Mixing Heights

Diurnal variations in maximum and average mixing depths predicted by CALMET in the area of the Awaba site during 2006, 2007, 2008, 2009 and 2010 are illustrated in **Figure 20**, **Figure 21**, **Figure 22**, **Figure 23** and **Figure 24** respectively. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of the convective mixing layer. It is noted that a similar range of mixing heights is predicted for the years 2006, 2007, 2008, 2009 and 2010.

Figure 20 Mixing Heights for Northern Coal Logistics Project (CALMET predictions, 2006)

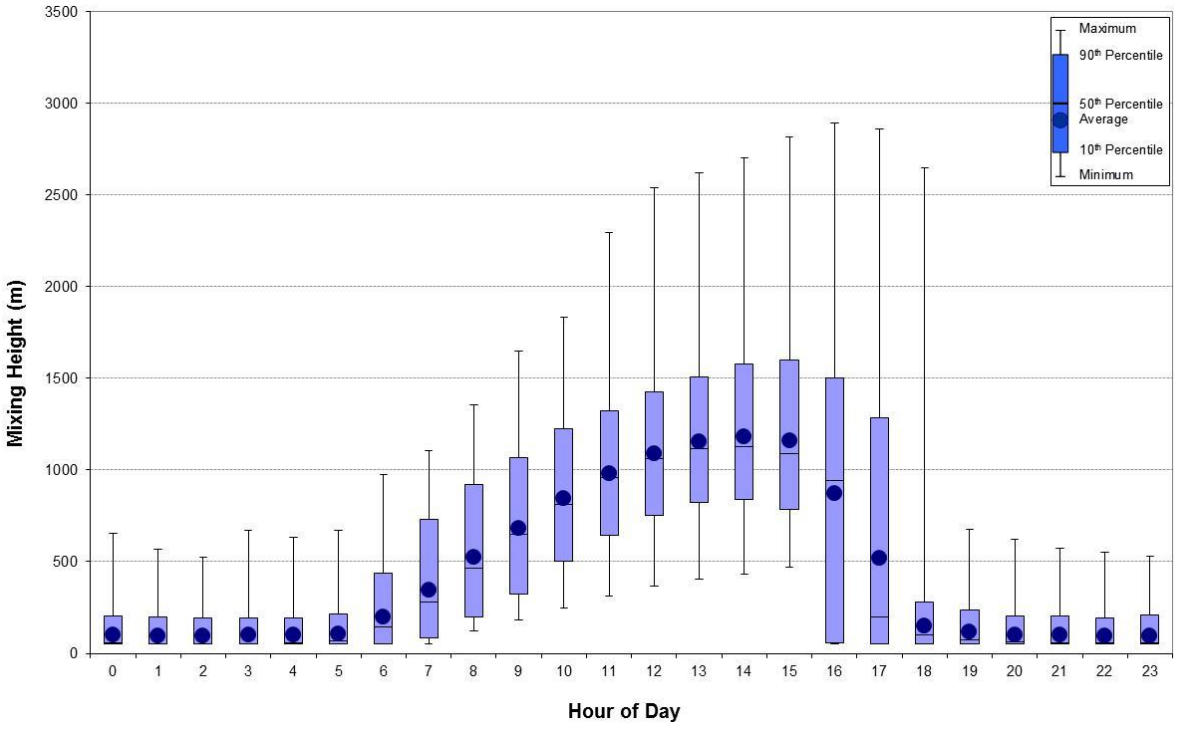


Figure 21 Mixing Heights for Northern Coal Logistics Project (CALMET predictions, 2007)

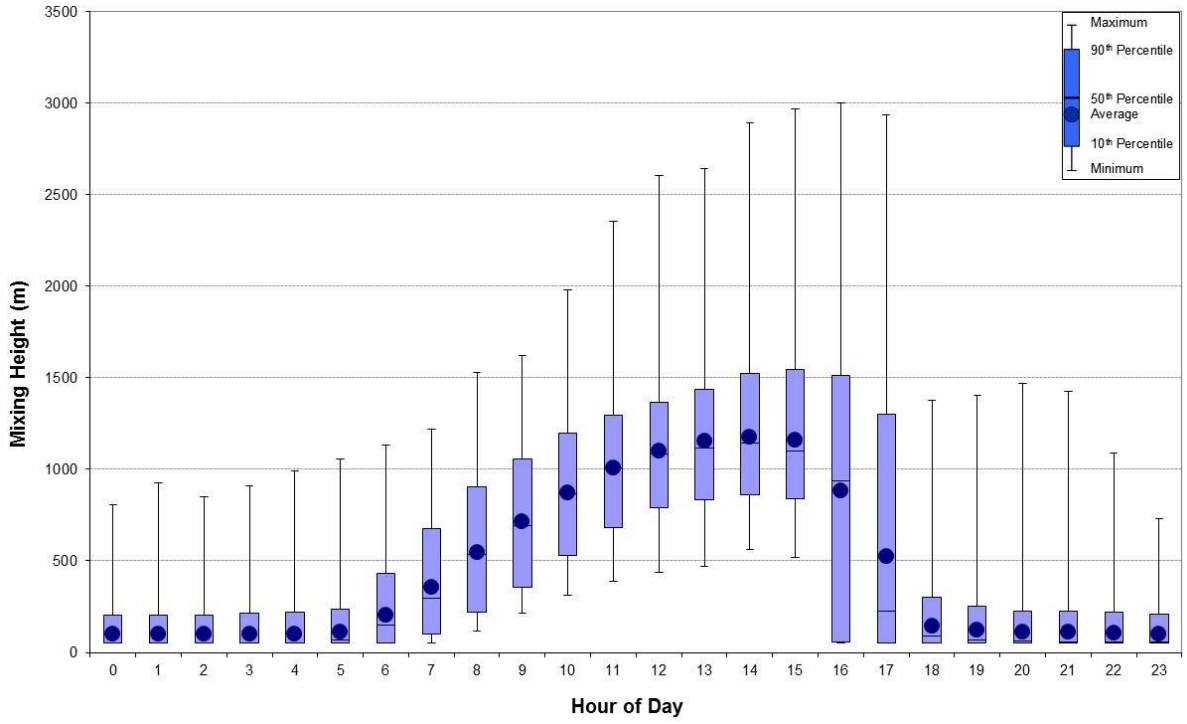


Figure 22 Mixing Heights for Northern Coal Logistics Project (CALMET predictions, 2008)

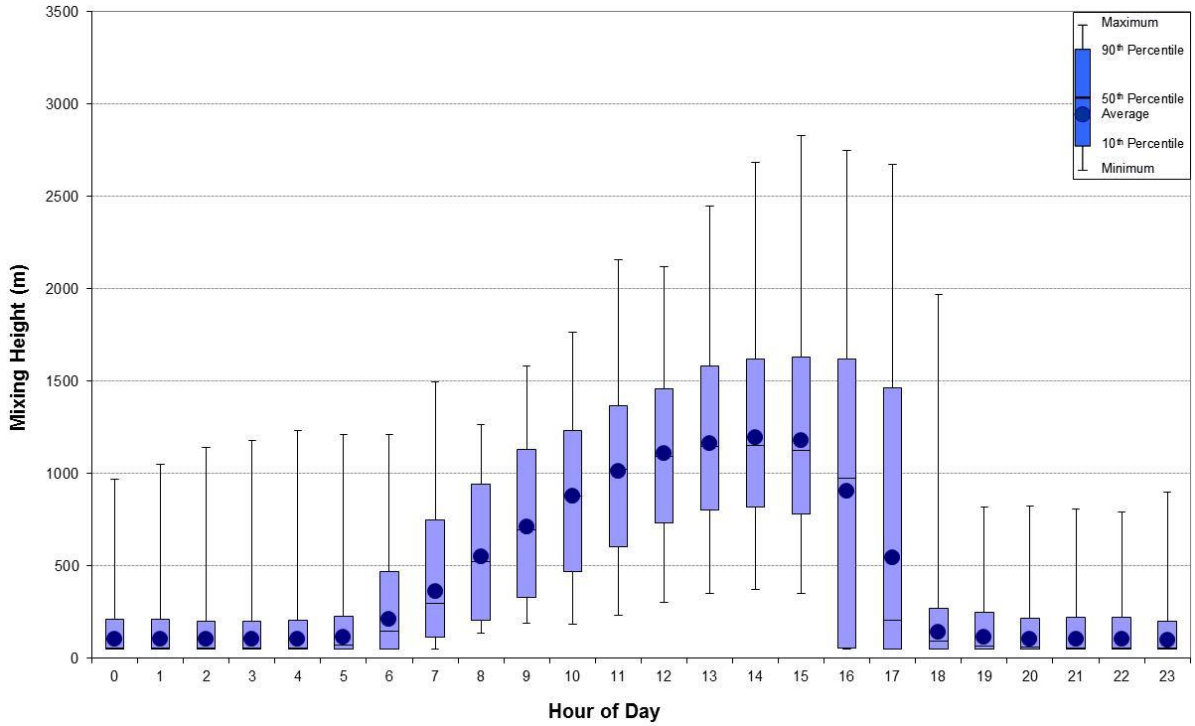


Figure 23 Mixing Heights for Northern Coal Logistics Project (CALMET predictions, 2009)

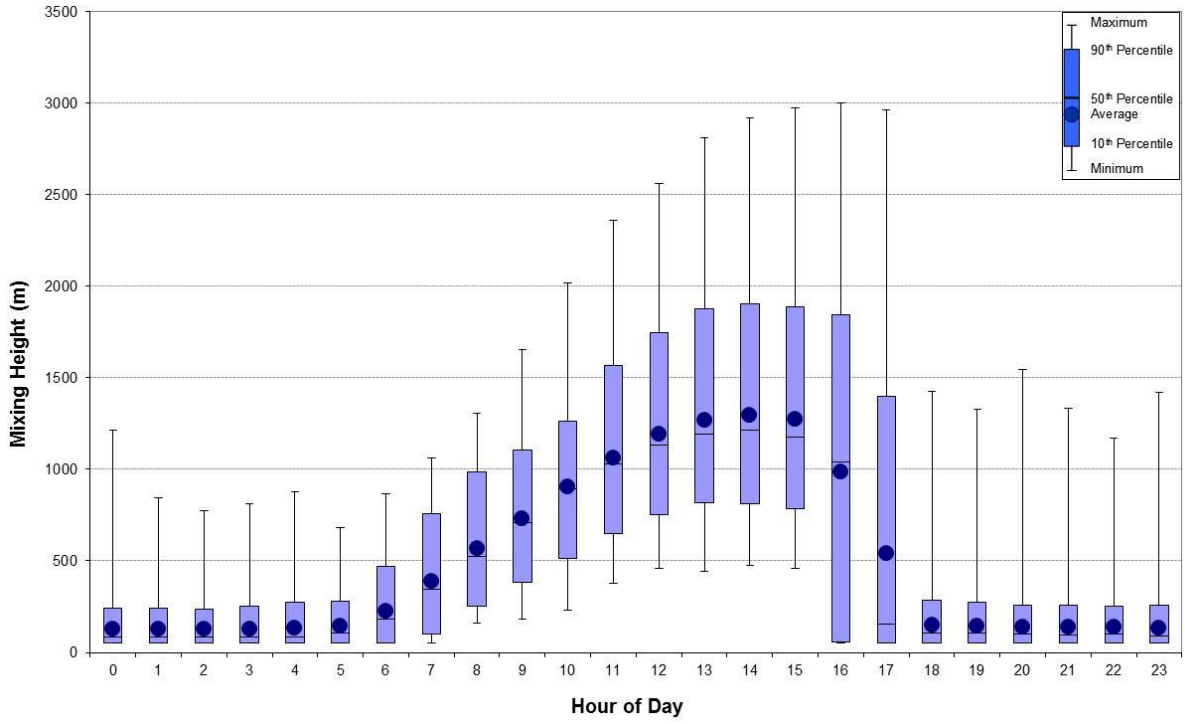
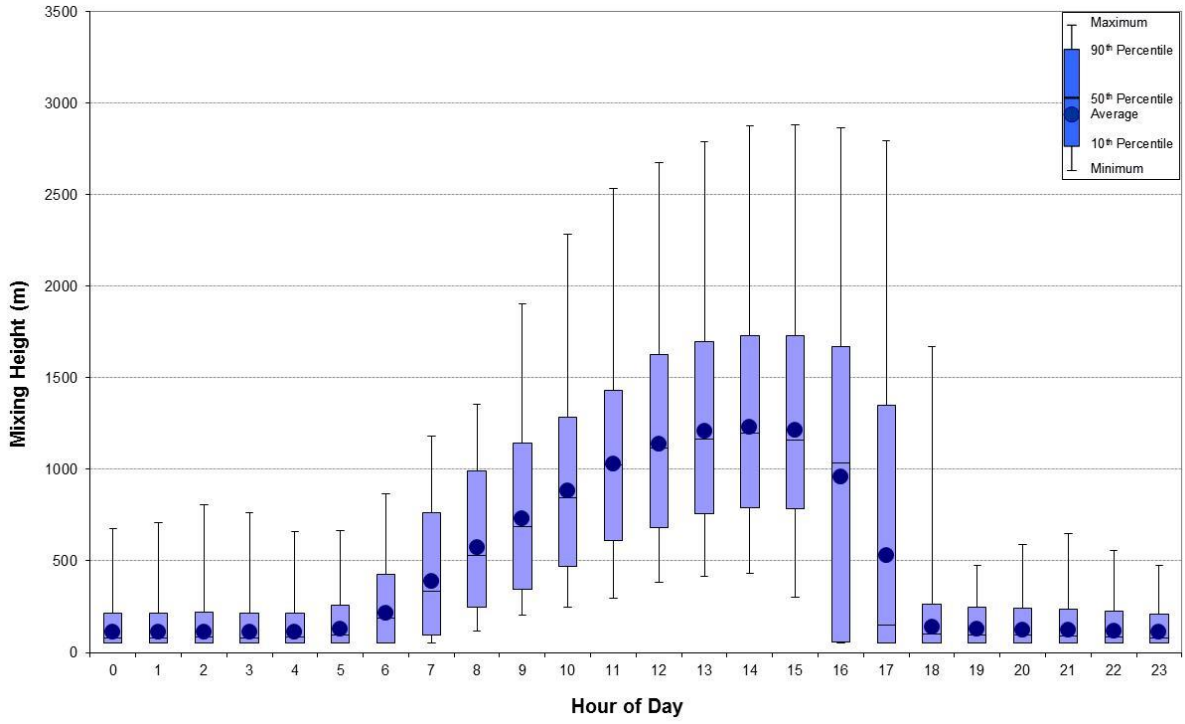


Figure 24 Mixing Heights for Northern Coal Logistics Project (CALMET predictions, 2010)



6.2.4 Meteorological Data Conclusion

The MM5 data generated by the Pennsylvania State University/National Centre for Atmospheric Research from was used for input into CALMET. The CALMET model was run for 2006, 2007, 2008, 2009 and 2010.

During the investigation, it was found that there was no apparent trend in the modelled wind speeds, wind directions or mixing heights. However for the modelled stability classes, it was found that a higher percentage of F class is predicted for the years 2006 to 2008. Stability Class F is indicative of very stable night time conditions, which is less conducive to pollutant dispersion due to reduced atmospheric mixing.

Investigations into this issue have revealed that the supplier of the MM5 data used in meteorological modelling (refer **Section 6.2.1**) altered the planetary boundary layer process parameterisation scheme from the Eta Turbulent Kinetic Energy (TKE) scheme to the MRF scheme between model years 2008 and 2009 as part of ongoing refinement and improvement in model outputs. The MRF scheme is a newer parameterisation scheme which better evaluates the interactions of a number of variables within the boundary layer. A study by Fernandez et al (2007) found that the Eta scheme yielded a colder bias at the surface than the MRF scheme which may result in the prevalence of more stable conditions. The changes in the stability class distribution should be viewed as an improvement in previous (2006-2008) predictions and ongoing improvements and changes in parameterisation schemes will be incorporated into modelling techniques as they become available.

The use of the 2010 meteorological year is consistent with all Centennial Coal Air Quality Impact Assessment studies performed and submitted for agency review since 2012. This approach has been adopted to allow the relevant agencies to review each assessment in the knowledge that a consistent meteorological dataset underpins each assessment and that no ‘cherry-picking’ of meteorological data has been performed.

6.2.5 Compatibility of Modelled Meteorological Data to other Assessments

This section describes compatibility of modelled meteorological data (refer to **Section 6.2**) for air quality impact assessments to other assessments such as the noise & vibration assessment.

Whilst the starting point for each assessment may be similar, the requirements for meteorological data vary as stated in guidance documentation from the appropriate regulatory authorities.

The meteorological dataset developed for use in the air quality impact assessment has been compiled to provide a robust and conservative assessment of potential downwind impacts due to particulate and other pollutant emissions from activities occurring within the Project Application Area. The factors considered in selecting the meteorological data for use in an air quality impact assessment can be considerably different to those that need to be considered when compiling data for a noise impact assessment, or even an air quality impact assessment which is addressing other issues, such as the potential for odour nuisance impacts.

For example, impacts resulting from particulate emissions tend to be greatest under moderate to strong wind speeds, when wind-blown dust is generated and particulate matter can be carried significant distances before settling out of the air. In comparison, worst-case noise and odour impacts tend to occur under calm wind conditions when there is little atmospheric turbulence to dissipate the noise/odours.

Dust impacts are also assessed based on longer term averages (24-hour and annual averages), whereas noise and odour nuisance impacts are more likely to be associated with peak events.

Also, the dataset as a whole is required to contain different meteorological parameters to assess the noise impacts or air quality impacts. For example, for air quality impacts, the mixing heights in the dataset are required to assess the vertical dispersion of pollutants which can have a significant impact on the resultant ground level concentration at the discrete receptors. Whereas for noise impacts, the mixing heights do not directly influence the noise impacts experienced.

For these reasons, the meteorological data used in this assessment is likely to differ from that used in the assessment of noise impacts from the site and possibly incompatible with the modelled meteorological data for the noise & vibration assessment.

6.3 Dispersion Model Configuration

6.3.1 Odour Peak-to-Mean Ratios

The Approved Methods states that Peak-to-Mean ratios should be incorporated when conducting atmospheric dispersion modelling of odour.

It is commonly recognised that dispersion models such as CALPUFF need to be supplemented to accurately simulate atmospheric dispersion of odours. This is because the instantaneous perception of odours by the human nose typically occurs over a time scale of approximately one second but dispersion model predictions are typically valid for time scales equivalent to ten minutes to one hour averaging periods. To estimate the effects of plume meandering and concentration fluctuations perceived by the human nose, it is possible to multiply dispersion model predictions by a correction factor called a “peak-to-mean ratio”. The peak to mean ratio (P/M60) is defined as the ratio of peak 1 second average concentrations to mean 1-hour average concentrations.

To estimate peak concentrations, this assessment has used data presented in Table 6.1 of the *Technical Framework – Assessment and management of odour from stationary sources in NSW* (hereafter ‘Odour Framework’). Specifically, to establish a conservatively high estimate of peak odour concentrations, a Peak-to-Mean Ratio (P/M60) of 2.3 has been applied to the emission rates for all identified sources modelled within this assessment.

7 EXISTING AIR QUALITY

The air quality in the region surrounding the Northern Coal Logistics Project is influenced by emissions generated by a range of sources, originating from both within and outside of the local area. Specifically, for the area surrounding the Northern Coal Logistics Project, air quality will be influenced by pollution transported into the area from more distant sources, emissions from power stations in the area, non-Project related traffic-generated pollution and pollution generated by the Project itself.

To determine the *incremental* impact of particulate emissions from the Project on the surrounding environment and sensitive receptors, a dispersion modelling exercise has been performed.

To appropriately assess the *cumulative* impact of the Project, the incremental impact needs to be added to a dataset which includes the contributions of all other significant sources of particulate in the region. Given that air quality monitoring locations in the local area are limited to those close to major particulate sources (such as mine sites) the use of an alternative dataset has been investigated to avoid possible double-counting of Project-related emissions.

This section outlines the methodology used to generate the background pollutant dataset used in this assessment. It involves the following steps:

1 Assessment of background dataset from the onsite monitoring conducted at the Newstan Colliery Surface Site and Cooranbong Entry Site - **Section 7.1** and **Section 7.2**.

2 Selection of an appropriate background dataset representative of regional air quality without the influence of major industrial sources in the local area (i.e. power stations and Project-related emissions) – **Section 7.3**;

3 Addition of an appropriate incremental contribution to ambient particulate levels due to controlled process and fugitive emissions from power stations in the local area (such as Eraring, Munmorah and Vales Point power stations) – **Section 7.4**; and,

4 Assessment of an appropriate incremental contribution (if any) to ambient particulate levels due to controlled process and fugitive emissions from other mining and ancillary operations in the local area (such as Teralba Quarry Extension, West Wallsend Colliery, Macquarie Coal Preparation Plant, Awaba Colliery and Mandalong Mine Access Site) – **Section 7.5**.

7.1 On-site Monitoring Program – Newstan Colliery Surface Site

On-site ambient monitoring has been performed at the Newstan Colliery Surface Site for TSP, PM_{10}, $PM_{2.5}$ and dust. A summary of the onsite monitoring program at Newstan Colliery is shown in **Table 29**.

Table 29 Summary of On-Site Monitoring Program at Newstan Colliery

Pollutant	Equipment Used
TSP	HVAS1, HVAS2
PM_{10}	HVAS1, HVAS2, TEOM
$PM_{2.5}$	HVAS1, HVAS2
Dust Gauges	DG1 to DG7, DG9 to DG12

Note: HVAS = High Volume Air Sampler, TEOM = Tapered Element Oscillating Microbalance, DG = Dust Gauge

7.1.1 TSP and PM_{10} - HVAS

On-site ambient TSP and PM_{10} monitoring has been performed at the Newstan Colliery Surface Site since November 2006 using a High Volume Air Sampler (HVAS). The ambient air quality monitoring program has been incorporated into a wider environmental monitoring campaign, and includes TSP

and PM_{10} measurements using co-located HVAS (refer **Figure 25**). The monitoring is undertaken in accordance with AS3580.9.3:2003 and AS3580.9.6:2003 for TSP and PM_{10}, respectively.

The measured 24-hour average TSP and PM_{10} concentrations at HVAS 1 and HVAS 2 are presented graphically in **Figure 26** and **Figure 27** respectively, while the overall average TSP and PM_{10} concentrations recorded during the monitoring period are summarised in **Table 30**.

Figure 25 Location of HVASs and Dust Deposition Gauges at Newstan Colliery

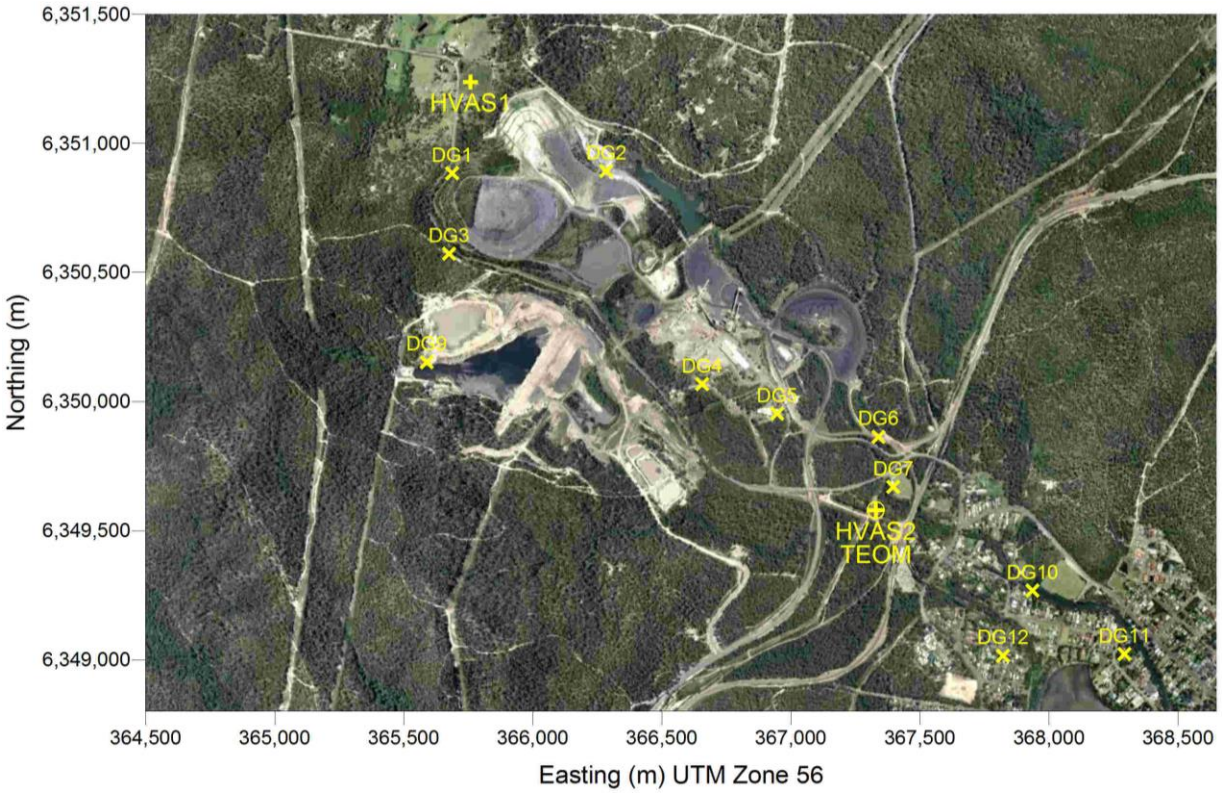


Figure 26 24-Hour Average TSP and PM_{10} Concentrations Monitored at HVAS 1

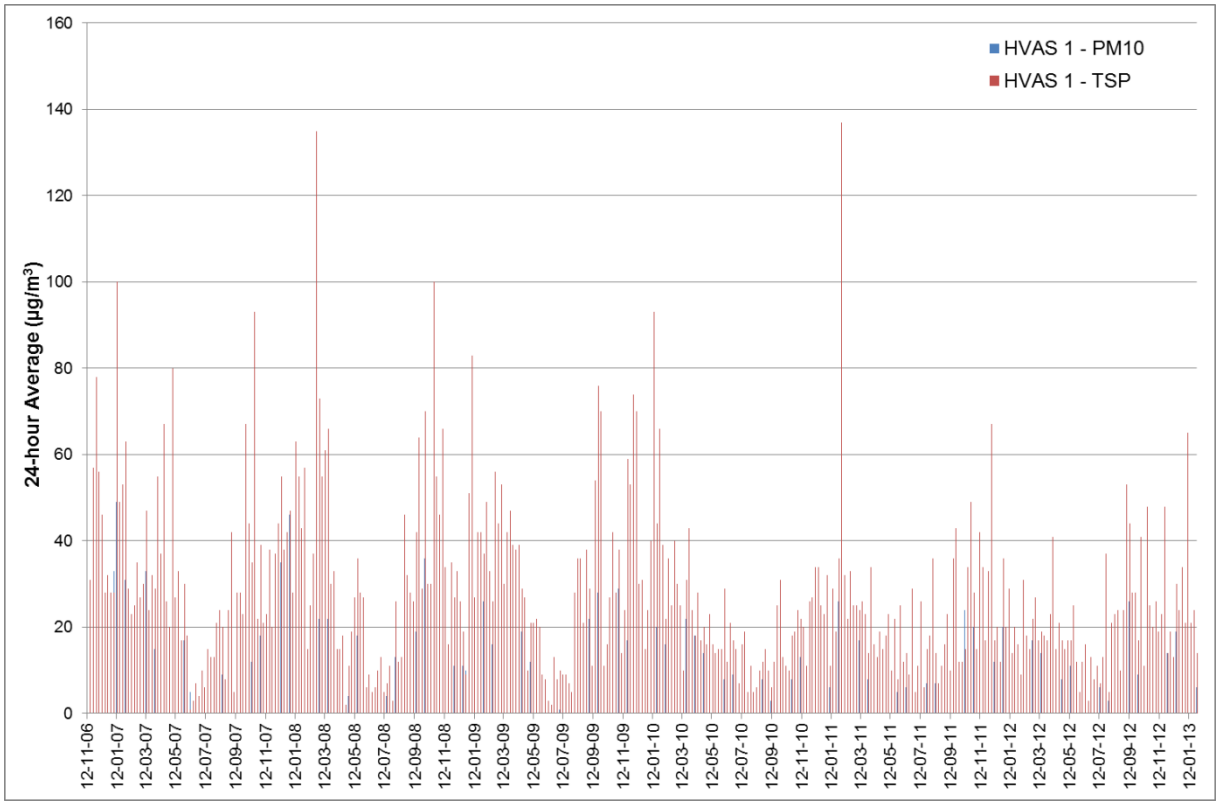


Figure 27 24-Hour Average TSP and PM_{10} Concentrations Monitored at HVAS 2

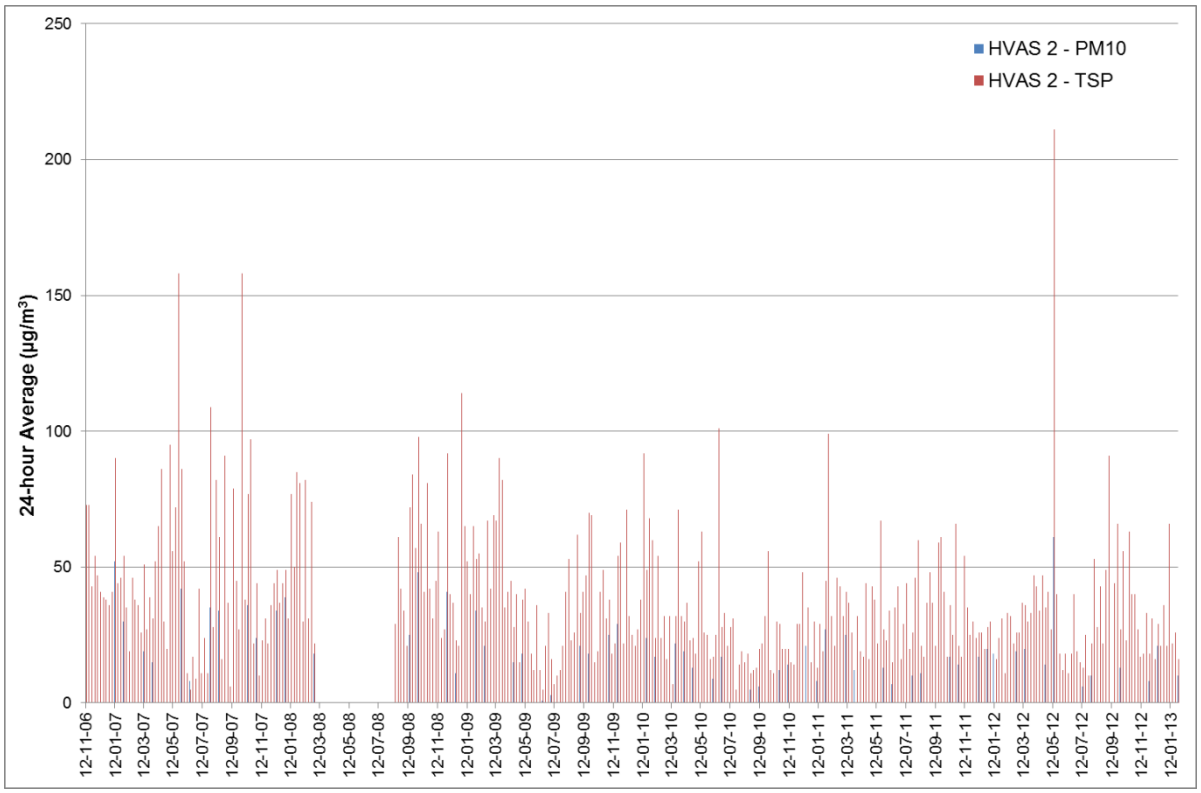


Table 30 Summary of HVAS Monitoring at Newstan Colliery (November 2006 to January 2013)

Pollutant	TSP		PM_{10}	
	Maximum	Average	Maximum	Average
HVAS 1	137.0	27.8	62.0	15.2
HVAS 2	211.0	38.7	84.0	20.0

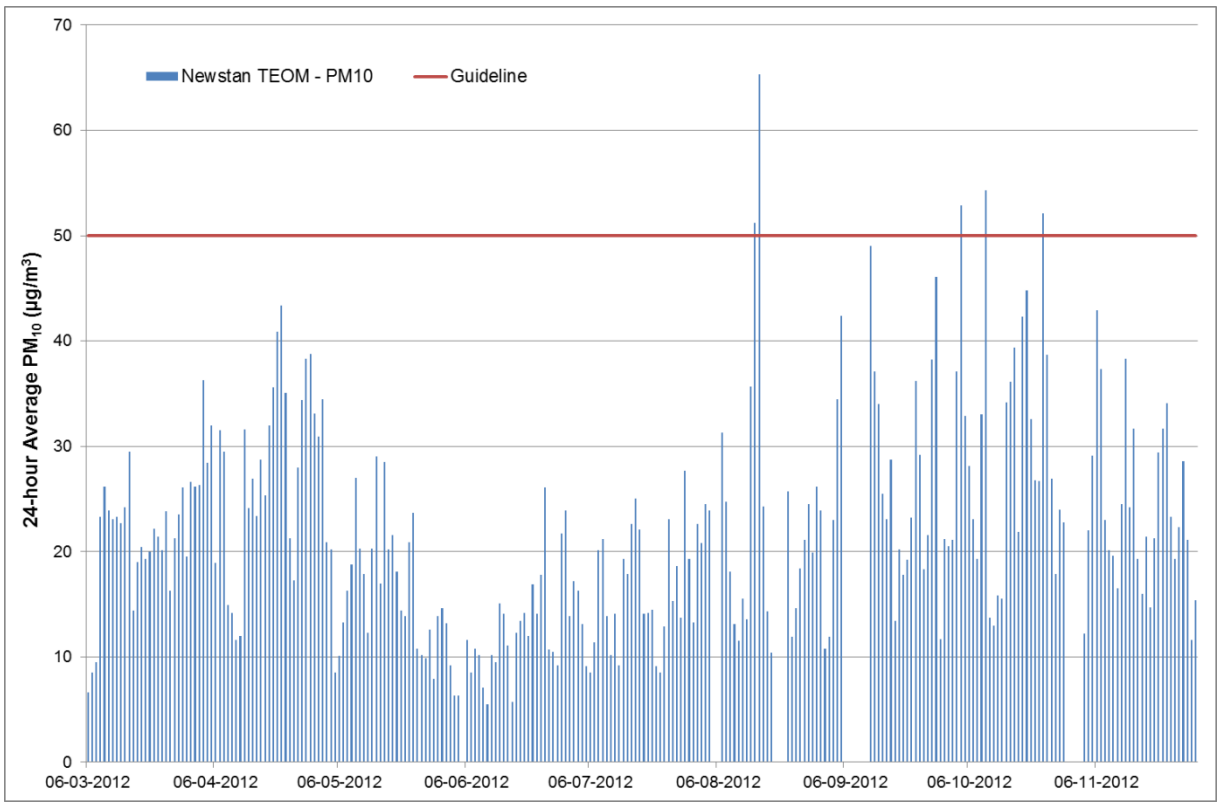
Of note, the ratio of mean TSP to PM_{10} measurements at HVAS 1 and HVAS 2 is of the order of 2.1 to 1. Also, it is noted that the monitored TSP and PM_{10} concentrations at Newstan Colliery Surface Site includes contributions from existing activities at Newstan Colliery Surface Site as well as other industrial facilities in the region.

As the monitoring data was measured on a 1-in-6-day cycle, it is not suitable for use in a contemporaneous cumulative impact analysis.

7.1.2 PM_{10} – TEOM

Continuous PM_{10} monitoring using co-located tapered element oscillating microbalance (TEOM) has been conducted at Newstan Colliery Surface Site since 6 March 2012. At the time of writing this report, validated data is available up to 30 November 2012. A summary of the available PM_{10} monitoring results using TEOM are shown in **Figure 28**.

Figure 28 24-hour Average PM_{10} Concentrations at TEOM (co-located at HVAS 2)



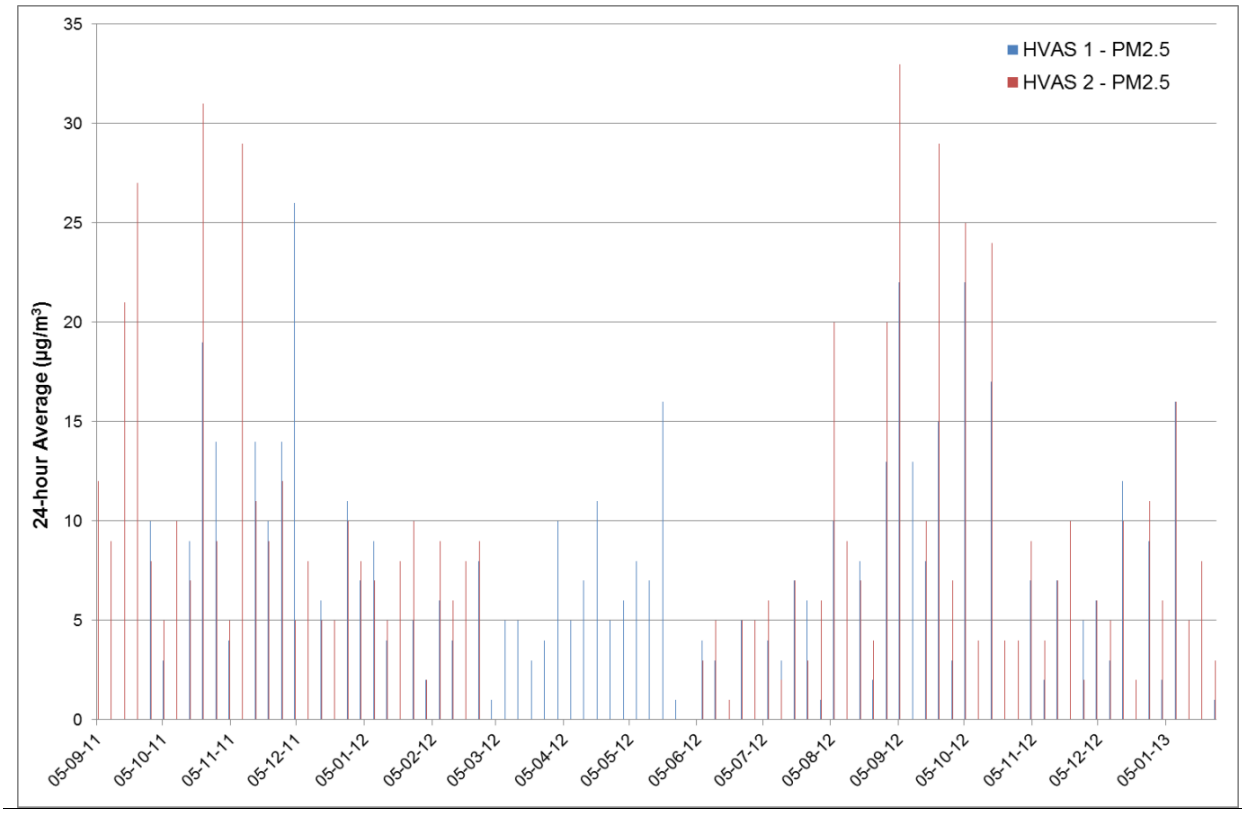
It is noted from **Figure 28** that since the monitoring began, there have been a total of five exceedances of the 24-hour average guideline (50 µg/m^3). The maximum concentration recorded was 65.3 µg/m^3 on 16 August 2012. The average over the nine months of monitoring has been 21.8 µg/m^3. The continuous monitoring data is deemed unsuitable for use as background as it is not contemporaneous with the modelled meteorological year.

7.1.3 $PM_{2.5}$ - HVAS

On-site ambient $PM_{2.5}$ monitoring has been performed at the Newstan Colliery Surface Site since September 2011 using a co-located HVAS with TSP and PM_{10} (refer **Figure 25**).

The measured 24-hour average $PM_{2.5}$ concentrations at locations HVAS 1 and HVAS 2 are presented graphically in **Figure 29**.

Figure 29 24-Hour Average $PM_{2.5}$ Concentrations Monitored at HVAS 1 and HVAS 2



Pollutant	$PM_{2.5}$	
	Maximum	Average
HVAS 1	26.0	7.6
HVAS 2	33.0	9.5

It is noted that the monitored $PM_{2.5}$ concentrations at Newstan Colliery Surface Ste includes contributions from existing activities at Newstan Colliery Surface Site as well as other industrial facilities in the region.

As the monitoring data was measured on a 1-in-6-day cycle, it is not suitable for use in a contemporaneous cumulative impact analysis.

7.1.4 Dust

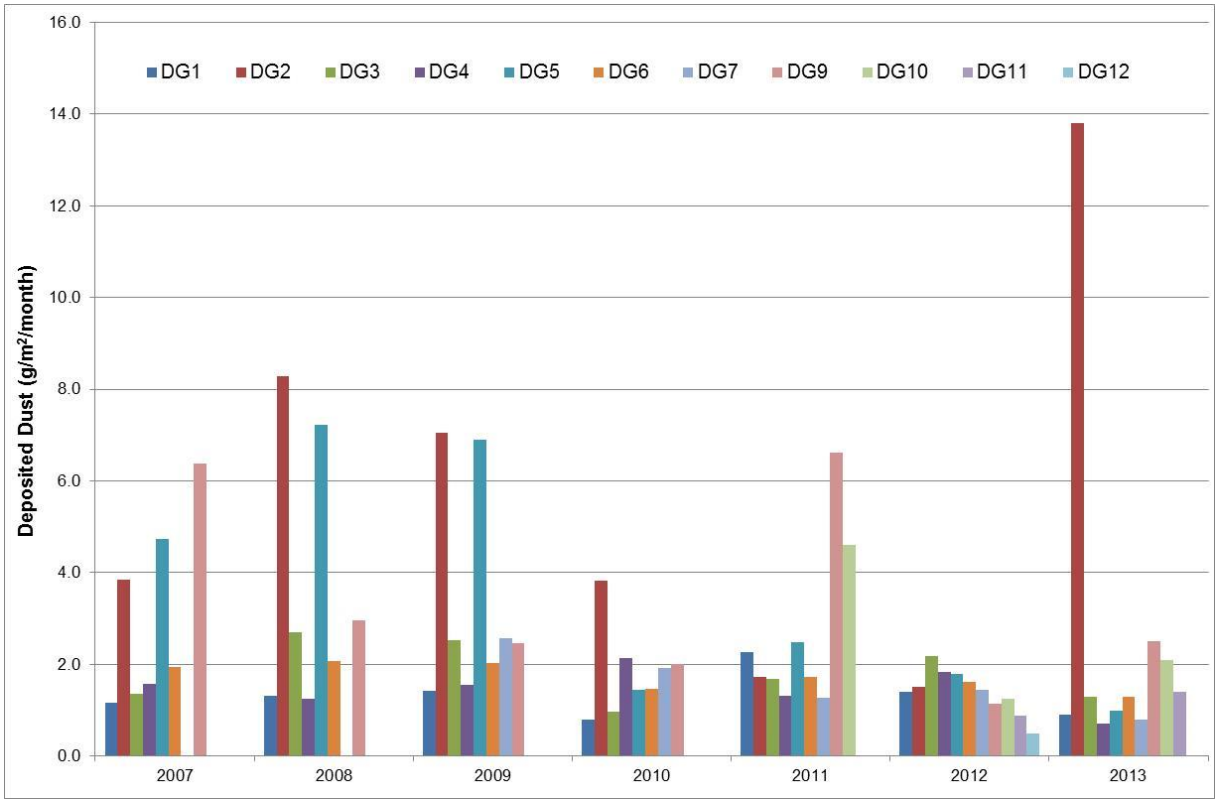
Newstan Colliery has a dust monitoring program in place since January 2007. The location of the dust monitoring sites is shown in **Figure 25**.

A summary of the dust deposition monitoring program is listed in **Table 31** and shown in **Figure 30**.

Table 31 Summary of the Dust Deposition Monitoring Program at Newstan Colliery

Gauge #	Monitoring Period	Average Deposition Rate (g/m^2/month)
DG1	January 2007 – February 2013	1.4
DG2	January 2007 – February 2013	4.6
DG3	January 2007 – February 2013	1.9
DG4	January 2007 – February 2013	1.6
DG5	January 2007 – February 2013	4.1
DG6	January 2007 – February 2013	1.8
DG7	January 2007 – February 2013	1.7
DG9	January 2007 – February 2013	3.5
DG10	December 2011 – January 2013	1.6
DG11	January 2012 – January 2013	0.9
DG12	June 2012 – September 2012	0.5
Overall Average		**2.1**

Figure 30 Summary of the Dust Deposition Monitoring Program at Newstan Colliery



It is noted that the long term average dust deposition rates shown in **Table 31** include the contribution of operations at Newstan Colliery Surface Site and background dust levels.

7.2 On-site Monitoring Program – Cooranbong Entry Site

On-site ambient monitoring has been performed at the Cooranbong Entry Site for dust deposition only.

7.2.1 Dust

Two dust deposition gauges are maintained at the Cooranbong Entry Site, DG1 and DG4, installed in November 2009 and January 2005 respectively. The location of the dust monitoring sites is shown in **Figure 31**.

Figure 31 Locations of Dust Deposition Gauges – Cooranbong Entry Site



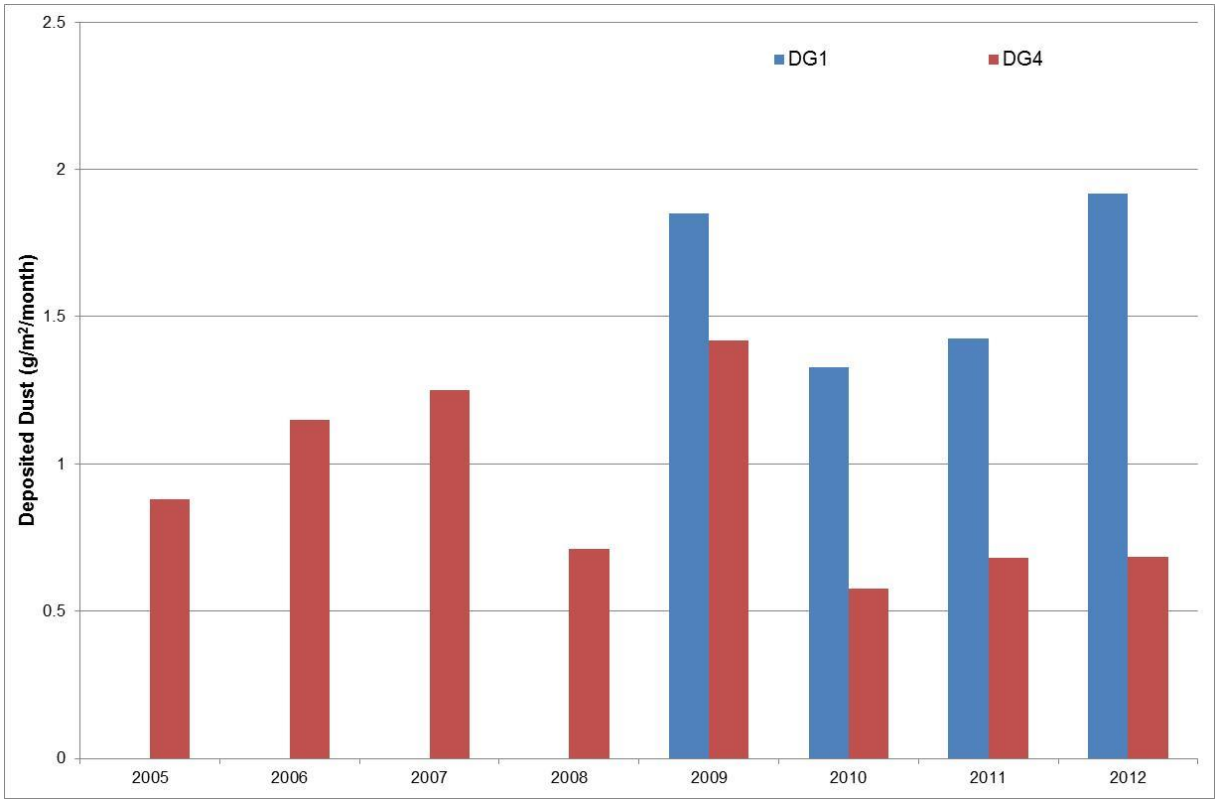
A summary of the dust deposition monitoring program is listed in **Table 32** and shown in **Figure 32**.

Table 32 Summary of the Dust Deposition Monitoring Program at Cooranbong Entry Site

Gauge #	Monitoring Period	Average Deposition Rate (g/m^2/month)
Newstan Colliery		
DG1	November 2009 – December 2012	1.6
DG4	January 2005 – December 2012	0.9

Gauge #	Monitoring Period	Average Deposition Rate (g/m^2/month)
Overall Average		**1.3**

Figure 32 Summary of the Dust Deposition Monitoring Program at Cooranbong Entry Site



It is noted that the long term average dust deposition rates shown in **Table 32** include the contribution of operations at Cooranbong Entry Site and background dust levels.

7.3 Regional Background Air Quality

7.3.1 Particulates (PM_{10} and $PM_{2.5}$)

Particulate data (PM_{10} and $PM_{2.5}$) from three NSW EPA air quality monitoring stations were obtained to assist in the determination of the background particulate environment excluding the impacts of power stations and Project-related sources. Data for the years 2006, 2007, 2008, 2009 and 2010 (concurrent with the meteorological modelling performed) was obtained for Newcastle, Beresfield and Wallsend. $PM_{2.5}$ is not monitored at the EPA Newcastle site. The locations of these three sites are presented in **Figure 6**.

Statistics for each site for each of the five years are presented in **Table 33**, **Table 34** and **Table 35**. All data is presented as 24-hour average concentrations in µg/m^3, except averaging period (hours), skew and kurtosis (dimensionless) and data capture (percentage of the monitoring period). Presented in **Figure 33** and **Figure 34** are time series plots for PM_{10} and $PM_{2.5}$, respectively.

Figure 33 24-hour Average PM_{10} Concentrations Measured at NSW EPA Beresfield, Wallsend and Newcastle Monitoring Sites 2006 – 2010

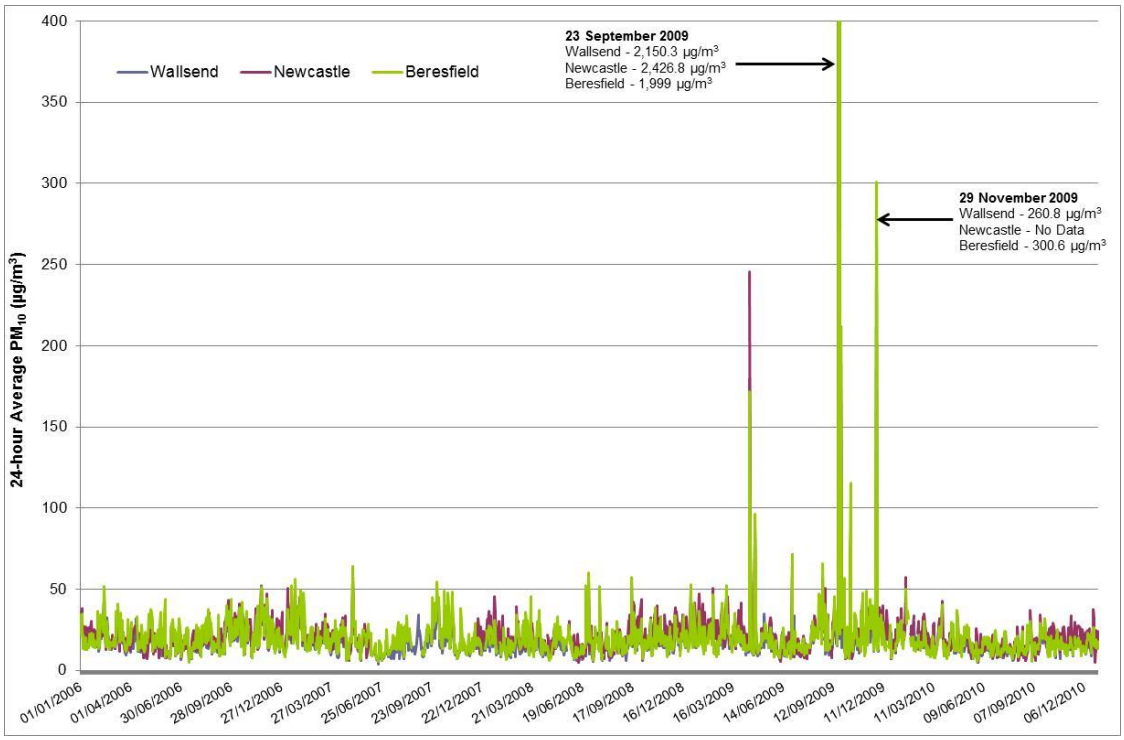
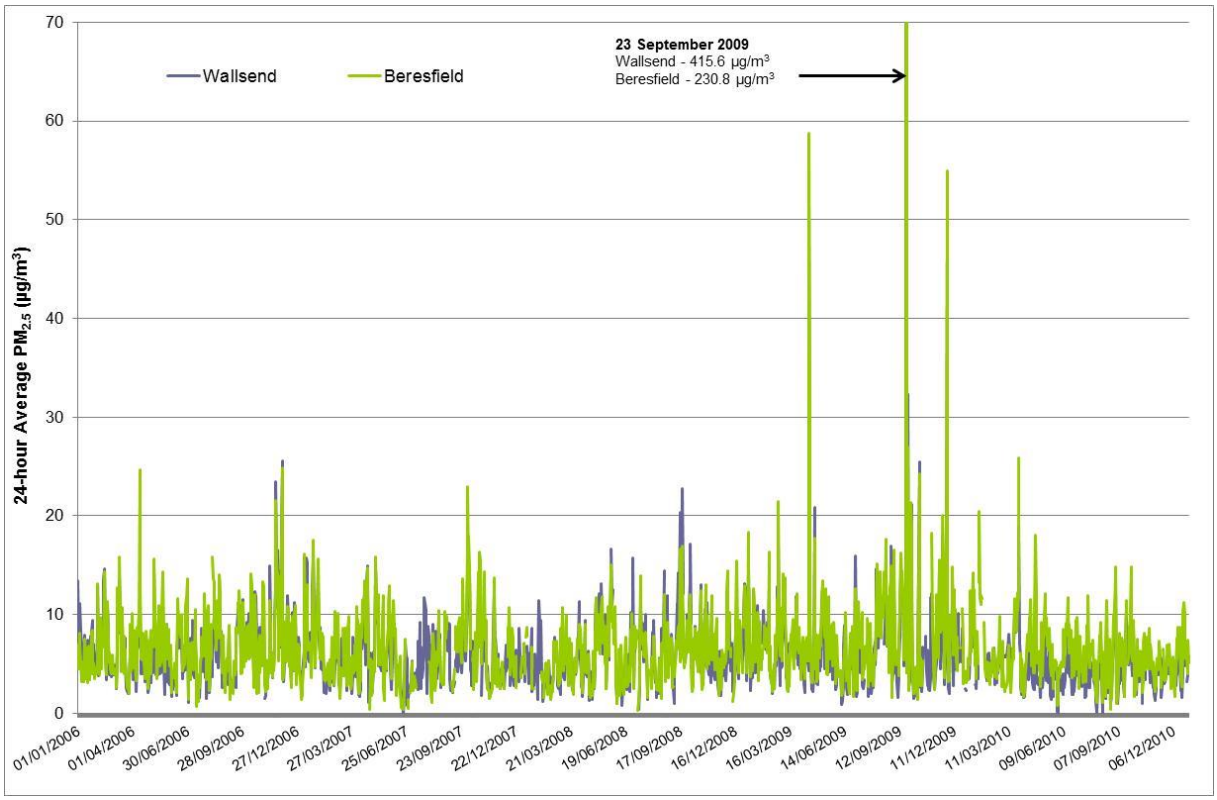


Figure 34 24-hour Average $PM_{2.5}$ Concentrations Measured at NSW EPA Beresfield and Wallsend Monitoring Sites 2006 – 2010



It is noted that on 23 September 2009, a dust storm was experienced in the region (DECC 2009), resulting in very high 24 hour averages for PM_{10} and $PM_{2.5}$. The recorded concentrations shown in **Figure 33** and **Figure 34** include the concentrations recorded on 23 September 2009 but the graphs have been truncated at appropriate levels to show the variations.

Table 33 Statistical Summary of Wallsend Background Monitoring Data

Statistic	**2006**		**2007**		**2008**		**2009**		**2010**	
	PM_{10}	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Averaging Period	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**
Data Points	359	362	341	337	303	320	333	323	318	338
Mean (µg/m^3)	18.6	6.4	17.4	5.8	15.7	5.8	19.9	6.8	14.7	4.6
Standard Deviation (µg/m^3)	± 7.1	± 3.3	± 7.4	± 3.2	± 6.4	± 3.4	±15.6	±5.3	±4.7	±2.3
Skew[1]	*+1.1*	*+1.5*	*+1.4*	*+1.0*	*+2.0*	*+1.4*	*+6.7*	*+4.1*	+0.7	+1.4
Kurtosis[2]	*+2.0*	*+4.9*	*+2.9*	*+1.0*	*+7.5*	*+3.4*	*+61.3*	*+27.6*	+0.6	+4.7
Minimum (µg/m^3)	5.6	1.1	3.6	-0.1	5.0	0.1	*6.9*	*0.9*	5	-0.2
Percentiles (µg/m^3)										
1st	7.3	1.6	6.9	1.2	6.3	1.0	7.2	1.5	6.2	0.3
2nd	7.7	1.8	7.2	1.6	6.7	1.2	7.7	1.7	7.0	1.1
3rd	8.4	2.0	7.3	1.7	7.3	1.4	8.3	1.9	7.5	1.3
5th	9.3	2.2	8.2	2.0	8.2	1.8	8.8	2.2	8.2	1.6
10th	10.8	2.8	9.6	2.3	9.0	2.4	9.9	2.5	9.3	2.0
25th	13.6	4.0	12.7	3.3	11.8	3.4	12.7	3.9	11.4	3.1
50th	17.4	5.9	16.0	5.1	14.8	5.2	16.5	5.6	14.0	4.2
75th	22.7	8.1	20.8	7.5	18.6	7.4	23.2	8.4	17.7	5.7
90th	27.5	10.5	26.5	10.0	23.2	10.0	31.0	12.4	20.8	7.4
95th	31.4	11.9	33.3	12.2	26.4	11.9	35.1	14.3	23.6	9.0
97th	34.2	13.5	35.0	13.9	30.1	13.0	38.2	16.9	25.3	10.1
98th	35.8	14.4	36.7	14.8	31.9	14.3	54.8	18.7	26.5	10.7
99th	40.7	15.5	40.0	15.2	39.9	17.0	73.1	24.6	28.0	11.7
Maximum 1 (µg/m^3)	52.0	25.6	50.9	18.2	56.5	22.8	179.5	50.5	32.8	18.8
Maximum 2 (µg/m^3)	45.3	23.5	50.8	15.7	43.6	20.3	173.9	49.8	29.5	13.7

Statistic	2006		2007		2008		2009		2010	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Averaging Period	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**
Maximum 3 (µg/m^3)	45.1	18.4	46.5	20.3	43.0	19.6	81.1	32.3	28.6	12.0
Data Capture	98.4%	99.2%	93.4%	92.3%	82.8%	87.4%	90.4%	87.0%	85.2%	92.0%

Notes 1 Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2 Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more pointed distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Table 34 Statistical Summary of Beresfield Background Monitoring Data

Statistic	**2006**		**2007**		**2008**		**2009**		**2010**	
	PM_{10}	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**	**PM_{10}**	**$PM_{2.5}$**
Averaging Period	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**
Data Points	352	361.0	329	314	349	336	358	341	354	355
Mean (µg/m^3)	21.2	6.8	20.4	6.3	18.4	5.9	22.7	7.9	16.6	6.0
Standard Deviation (µg/m^3)	± 8.7	± 3.5	± 10.0	± 3.7	± 7.9	± 3.0	±17.7	±5.6	±6.3	±3.1
Skew[1]	*+0.8*	*+1.5*	*+1.4*	*+1.1*	*+1.8*	*+0.8*	*+6.0*	*+4.4*	+1.4	+1.6
Kurtosis[2]	*+0.2*	*+4.0*	*+2.4*	*+1.4*	*+5.8*	*+0.8*	*+51.2*	*+32.9*	+3.9	+5.8
Minimum (µg/m^3)	4.8	0.7	5.7	0.3	5.8	0.2	*7.2*	*1.4*	5.6	0.4
Percentiles (µg/m^3)										
1st	7.6	1.7	6.6	0.5	7.0	1.1	*7.9*	*1.8*	7.2	1.1
2nd	8.3	2.0	7.4	1.3	7.6	1.4	*8.3*	*2.1*	7.6	1.5
3rd	8.8	2.1	8.1	1.4	8.2	1.6	*9.3*	*2.2*	8.4	1.7
5th	10.1	2.6	8.6	1.8	9.2	1.9	*10.1*	*2.7*	8.7	2.1
10th	11.7	3.2	10.2	2.4	10.1	2.3	*11.6*	*3.2*	9.7	2.6
25th	14.6	4.3	13.1	3.5	13.4	3.6	*14.2*	*4.8*	12.3	4.0
50th	18.8	5.9	18.4	5.5	16.9	5.7	*18.4*	*6.6*	15.4	5.4
75th	26.6	8.6	25.2	8.4	21.5	7.6	*26.1*	*9.6*	20.0	7.5
90th	34.1	11.3	32.0	11.5	27.2	9.6	*35.1*	*13.4*	24.6	9.9
95th	36.7	13.3	41.3	13.6	32.1	11.5	*46.3*	*15.7*	28.2	11.6
97th	39.1	14.1	47.7	14.6	34.5	12.1	*53.1*	*18.1*	30.1	12.1
98th	42.1	15.2	49.1	15.7	36.9	13.7	*65.4*	*20.3*	31.9	13.1
99th	44.1	16.5	53.8	16.9	52.1	14.8	*82.0*	*25.9*	36.9	14.8
Maximum 1 (µg/m^3)	51.9	24.9	64.0	23.0	59.9	16.9	*211.4*	*58.8*	50.0	25.9
Maximum 2 (µg/m^3)	51.4	24.7	57.9	17.9	57.6	16.6	*171.8*	*55.0*	47.2	20.4
Maximum 3 (µg/m^3)	46.3	21.6	56.2	17.5	53.1	15.4	*115.2*	*28.1*	40.6	18.0

Statistic	2006		2007		2008		2009		2010	
	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$	PM_{10}	$PM_{2.5}$
Averaging Period	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**
Data Capture	96.4%	98.9%	90.1%	86.0%	95.4%	91.8%	98.0%	93.0%	96.9%	97.2%

Notes 1 Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2 Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more pointed distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Table 35 Statistical Summary of Newcastle Background Monitoring Data

Statistic	**2006**	**2007**	**2008**	**2009**	**2010**
	PM_{10}	**PM_{10}**	**PM_{10}**	**PM_{10}**	**PM_{10}**
Averaging Period	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**
Data Points	355	172	341	339	365
Mean (µg/m^3)	21.1	22.8	20.5	24.9	17.9
Standard Deviation (µg/m^3)	±7.4	±8.9	±7.9	±19.3	±7.9
Skew[1]	*+0.7*	*+1.2*	*+0.9*	+7.4	+0.5
Kurtosis[2]	*+0.8*	*+2.5*	*+1.2*	+75.3	+2.0
Minimum (µg/m^3)	6.5	6.1	4.9	5.6	0.0
Percentiles (µg/m^3)					
1st	7.6	6.2	7.1	7.2	0.0
2nd	7.8	8.2	8.2	7.6	0.0
3rd	9.1	10.1	8.7	8.2	0.0
5th	11.1	11.1	10.1	9.7	6.5
10th	12.4	13.0	11.4	11.8	9.1
25th	15.8	17.2	15.1	16.5	13.2
50th	20.5	21.6	19.1	22.3	17.4
75th	25.6	26.8	24.6	27.8	22.8
90th	30.7	33.4	31.1	36.1	27.1
95th	34.1	39.2	34.3	43.1	30.1
97th	36.1	43.4	38.1	50.7	33.8
98th	38.0	47.8	39.2	60.3	34.6
99th	42.0	52.4	43.1	80.8	37.6
Maximum 1 (µg/m^3)	51.2	58.1	54.4	245.4	57.1
Maximum 2 (µg/m^3)	47.2	57.2	50.6	211.6	48.3
Maximum 3 (µg/m^3)	43.3	50.4	45.6	86.6	42.5

Statistic	2006	2007	2008	2009	2010
	PM_{10}	PM_{10}	PM_{10}	PM_{10}	PM_{10}
Averaging Period	**24-hour**	**24-hour**	**24-hour**	**24-hour**	**24-hour**
Data Capture	97.3%	47.1%	93.2%	92.3%	100.0%

Notes 1 Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2 Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more pointed distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

The statistics presented indicate that in general, higher concentrations of PM_{10} and $PM_{2.5}$ are measured at Beresfield when compared with Wallsend. Also, higher concentrations of PM_{10} are measured at Newcastle when compared with Wallsend.

This is unsurprising given the location of the Newcastle site in an urban location, with a not insignificant contribution to particulate concentrations from vehicle traffic and industrial sources located in the area. The Beresfield station is also located near to a major road and the influence from vehicle traffic in the particulate monitoring record will be observed.

Data from the Wallsend station shows lower maximum concentrations and lower annual average particulate concentrations than the other two sites in the area. The Wallsend station is located approximately 9 km from the urban centre of Newcastle and although it will experience some contribution from vehicle traffic, the impact will not be as significant as that experienced within Newcastle. Additionally, impacts from industry will be markedly lower at Wallsend.

Based on the statistical analysis and discussion of the particulate monitoring data for the three stations, it is concluded that the use of the Wallsend PM_{10} and $PM_{2.5}$ data as a "regional background" dataset is appropriate and valid. The prevailing air quality conditions experienced in the area surrounding the Project site (not considering the effects of nearby power stations or Project activities) is expected to be most similar to those experienced at Wallsend.

Also noted is that the data recorded at Wallsend monitoring station captured 85% and 92% data for PM_{10} and $PM_{2.5}$ respectively. The missing data has been replaced by the respective annual averages. This is considered appropriate in the absence of data, as it ensures that the regional background is taken into account for the cumulative impact assessment.

7.3.2 TSP

Currently, there is no TSP monitoring performed by the NSW EPA at any of the three monitoring locations.

In this instance, TSP concentrations have been assumed to be 2.1 times those of the measured PM_{10} concentrations at Wallsend. The ratio of 2.1 has been referenced from onsite monitoring of TSP and PM_{10} (as discussed in **Section 7.1**). Based on this measured ratio, the annual average background TSP concentration is estimated to be 30.9 $\mu g/m^3$.

7.3.3 Odour

No site specific odour monitoring has been performed at Newstan Colliery Surface Site. However, an odour monitoring program was conducted by SLR Consulting (SLR 2012b) at the existing Mandalong Mine Access Site operation ventilation fan, located approximately 20 km south-west of Newstan Colliery Surface Site.

The odour monitoring campaign identified the characteristics of the odour from the ventilation fans as yeast, exhaust and metallic. It is considered that there are no similar odour sources in the vicinity of Newstan Colliery Surface Site or Cooranbong Entry Site.

In the absence of any similar odour sources, the background odour concentration is assumed to be negligible (i.e zero).

7.4 Power Stations

To determine the background particulate concentrations experienced across the domain, the increment from power stations located in the area needs to be added to the regional background particulate concentrations from **Section 7.3**. The locations of Vales Point, Munmorah and Eraring power stations in relation to Centennial's Northern operations are presented in **Figure 6**.

A dispersion modelling exercise has been performed using publicly available information to determine the contribution from power station emissions to particulate concentrations within the modelling domain. The information in **Table 36** has been obtained for stack sources associated with Eraring, Vales Point and Munmorah power stations. Emission rates of $PM_{2.5}$ were not publicly available and therefore the WRAPAIR factor (refer **Section 5**) of 0.1 has been applied to the PM_{10} emission rates for all particulate emissions sources.

Table 36 Point Source Emissions from Eraring, Munmorah and Vales Point Power Stations

Source	ID	Easting (m)	Northing (m)	Height (m)	Diameter (m)	Temperature (°C)	Velocity (m/s)	TSP (g/s)	PM_{10} (g/s)	$PM_{2.5}$ (g/s)
Eraring	ES1	361,938	6,340,750	200	10.5	107	17	64.0	12.7	1.3
Eraring	ES2	361,975	6,340,938	200	10.5	107	17	64.0	12.7	1.3
Munmorah[1]	MS1	364,190	6,324,292	150	7.9	153	19	30.5	30.5	3.1
Vales Point[2]	VPS1	364,347	6,329,916	178	11	110	15.4	60.0	12.5	1.3

[1] No information on TSP emissions rate available – taken to be the same as PM_{10} (equivalent to 50 mg/m^3 stack concentration).

[2] Vales Point B Station (A Station decommissioned and two associated 138 m stacks now redundant).

The influence of building wake effects on the power station stack emissions has been taken into account in the dispersion modelling. Building dimensions were estimated using Google Earth images and the relationship between known stack heights and associated shadow lengths. This relationship has then been applied to the building shadow lengths to estimate building heights. The building heights used in the modelling assessment are presented in **Table 37**.

Table 37 Details of Building Coordinates and Dimensions at Eraring, Munmorah and Vales Point Power Stations

Site	Building	ID	Easting (m)	Northing (m)	Height (m)
Eraring	Powerhouse	EB1	361,836	6,341,059	40
			361,985	6,341,040	
			361,924	6,340,658	
			361,783	6,340,675	
Munmorah	Powerhouse	MB1	364,147	6,324,453	42
			364,190	6,324,393	
			364,010	6,324,241	
			363,961	6,324,294	
Vales Point	Powerhouse	VPB1	364,169	6,330,013	39
			364,335	6,330,136	
			364,364	6,330,099	
			364,199	6,329,976	
	Coal units	VPB3	364,239	6,329,993	59
			364,317	6,330,055	
			364,348	6,330,031	
			364,261	6,329,973	

In addition to emissions from stack sources, emissions from coal stockpiles and ash dams have also been considered. The location and surface area of coal stockpiles have been obtained from Google Earth imagery. Heights of all coal stockpiles have been assumed to be 5 m above ground level (AGL). For ash dams, half of the total area observed in Google Earth imagery has been taken to be available for wind erosion. For modelling purposes, the height of the ash dams has been taken to be 0 m AGL.

Emission rates for all stockpiles and ash dams have been taken to be the National Pollutant Inventory (NPI) default for wind erosion of 0.4 kg/ha/hr for TSP and 0.2 kg/ha/hr for PM_{10} and 0.02 kg/ha/hr for $PM_{2.5.}$ The emission rate for $PM_{2.5}$ has been calculated using the WRAPAIR emission factors as discussed in **Section 5**.

It is acknowledged that the use of the default value may result in under- or over-estimation of 24-hour particulate concentrations at some locations, although taking into account the nature and scale of this assessment, it is considered to be appropriate.

Details of stockpile and ash dam locations are presented in **Table 38**.

Table 38 Details of Stockpile and Ash Dam Locations at Eraring, Munmorah and Vales Point Power Stations

Site	Stockpile	ID	Easting (m)	Northing (m)	Height (m)
Eraring	Coal	ESP1	361,715	6,341,677	5
			361,715	6,341,345	
			362,097	6,341,345	
			362,097	6,341,677	
	Coal	ESP2	362,161	6,341,677	5
			361,897	6,341,674	

			361,897	6,341,935	
			362,161	6,341,935	
	Ash Dam	EAD1	363,128	6,342,672	0
			362,915	6,342,178	
			364,080	6,341,921	
			364,142	6,342,278	
Munmorah	Coal	MSP1	364,158	6,324,004	5
			364,374	6,324,048	
			364,418	6,323,861	
			364,226	6,323,811	
Vales Point	Coal	VPSP1	363,648	6,329,355	5
			363,937	6,329,204	
			363,815	6,328,965	
			363,519	6,329,106	
	Coal	VPSP2	364,787	6,329,587	5
			364,852	6,329,562	
			364,760	6,329,398	
			364,700	6,329,429	
	Ash Dam	VPAD1	362,437	6,328,584	0
			363,447	6,327,984	
			362,433	6,326,172	
			361,976	6,327,423	

Through the dispersion modelling exercise, particulate concentrations experienced at each of the identified sensitive receptor locations (refer **Section 3.2**) due to emissions from the power stations have been estimated. Additionally, impacts have also been predicted at the Wallsend EPA monitoring station (refer **Section 7.3**) to verify that concentrations of particulate measured at the station do not include a significant contribution from power station related emissions.

The maximum modelled 24-hour average PM_{10} concentration at the Wallsend monitoring station from power station operations was predicted to be 0.8 µg/m^3, and it is therefore concluded that the PM_{10} monitoring data from Wallsend does not include a significant contribution from power station operations, and that data may be used as a "regional background" dataset for the domain.

The maximum modelled 24-hour average $PM_{2.5}$ concentration at the Wallsend monitoring station from power station operations was predicted to be 0.01 µg/m^3. It is therefore concluded that the $PM_{2.5}$ monitoring data from Wallsend monitoring station does not include a significant contribution from power station operations and therefore the data can be used as a "regional background" dataset for the domain.

Figure 35 presents the predicted incremental PM_{10} concentrations from power station operations at the sensitive receptors during 2010. **Figure 36** presents the predicted incremental $PM_{2.5}$ concentrations from power station operations at the sensitive receptors during 2010.

Figure 35 shows that over the modelling year 2010, the maximum predicted 24-hour average PM_{10} concentration due to the power station emissions was 4.0 µg/m^3 on 3 October 2010 at Receptor '23' (near Cooranbong Entry Site).

Figure 35 Predicted Power Station Related PM_{10} Concentrations at Receptors - 2010

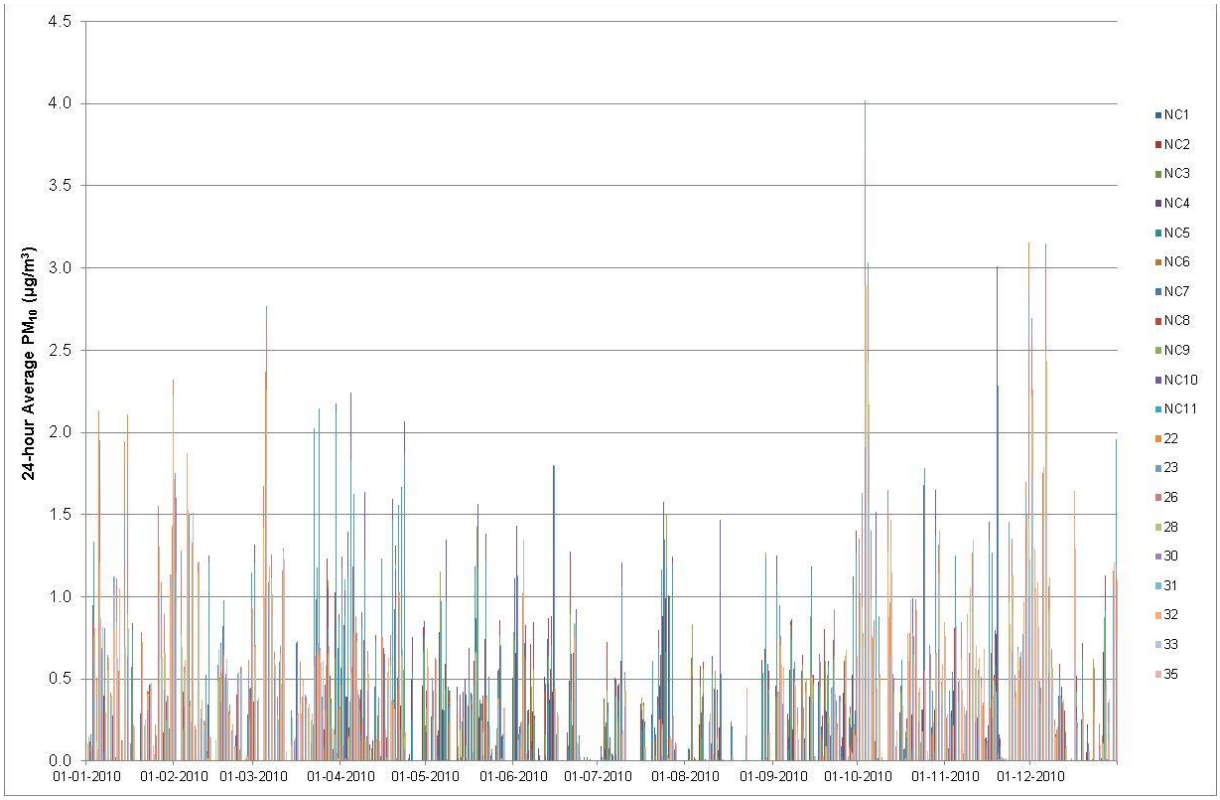
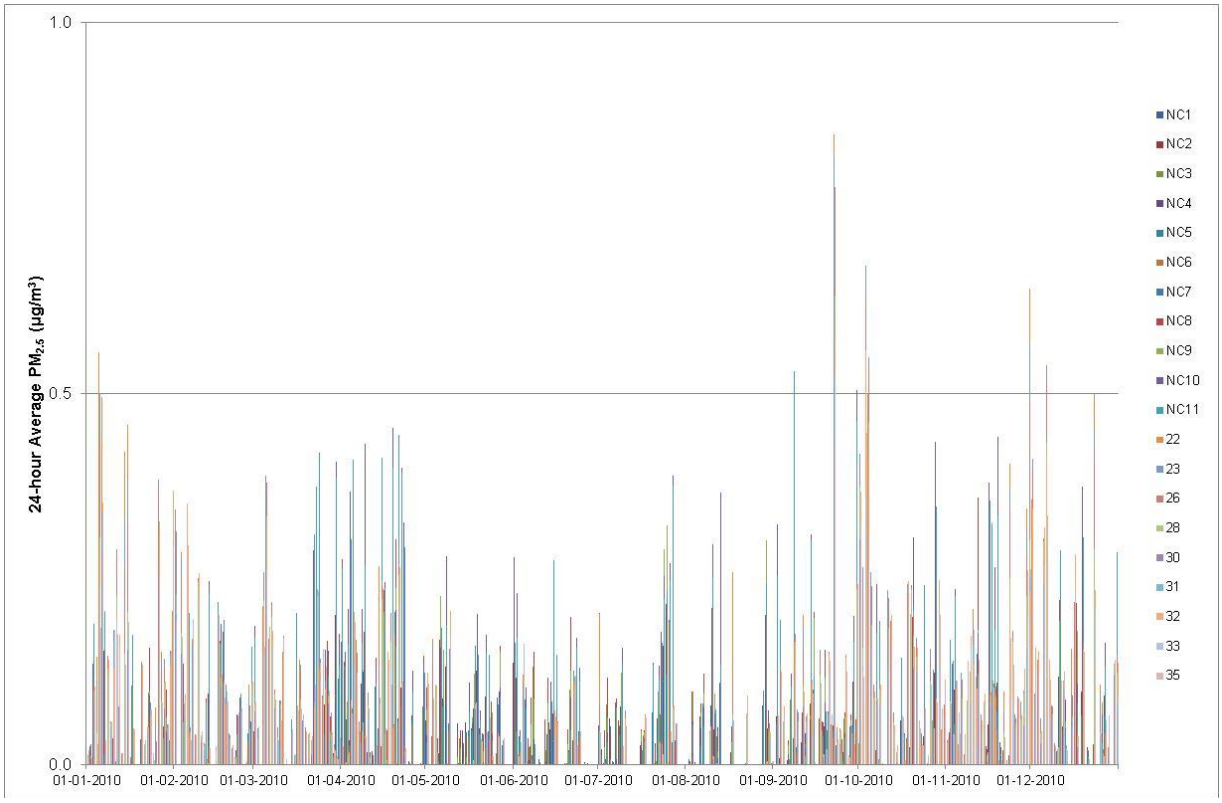


Figure 36 shows that during the year 2010, the maximum predicted 24-hour average $PM_{2.5}$ concentration due to the power station emissions was 0.8 µg/m^3 on 22 September 2010 at Receptor '22' (near Cooranbong Entry Site).

Figure 36 Predicted Power Station Related $PM_{2.5}$ Concentrations at Receptors - 2010



For each receptor location, daily-varying background PM_{10} and $PM_{2.5}$ concentration files have been constructed, using the regional background particulate data from Wallsend, added to the predicted incremental particulate concentrations from modelling of the power stations.

As the maximum concentrations of PM_{10} and $PM_{2.5}$ are predicted at receptors '23' and '22' respectively, it is considered appropriate to assess the contributions of regional background and power stations at these two receptors. Presented in **Figure 37** and **Figure 38** are the time series of background PM_{10} and $PM_{2.5}$ concentrations for receptor '23' and receptor '22' respectively.

As mentioned in Section **7.3.1**, the missing data recorded at Wallsend monitoring station for PM_{10} and $PM_{2.5}$ has been replaced by the respective annual averages. This is considered appropriate in the absence of data, as it ensures that the regional background is taken into account for cumulative impact assessment.

Figure 37 Regional Background and Power Station Increment at Receptor '23' (PM_{10})

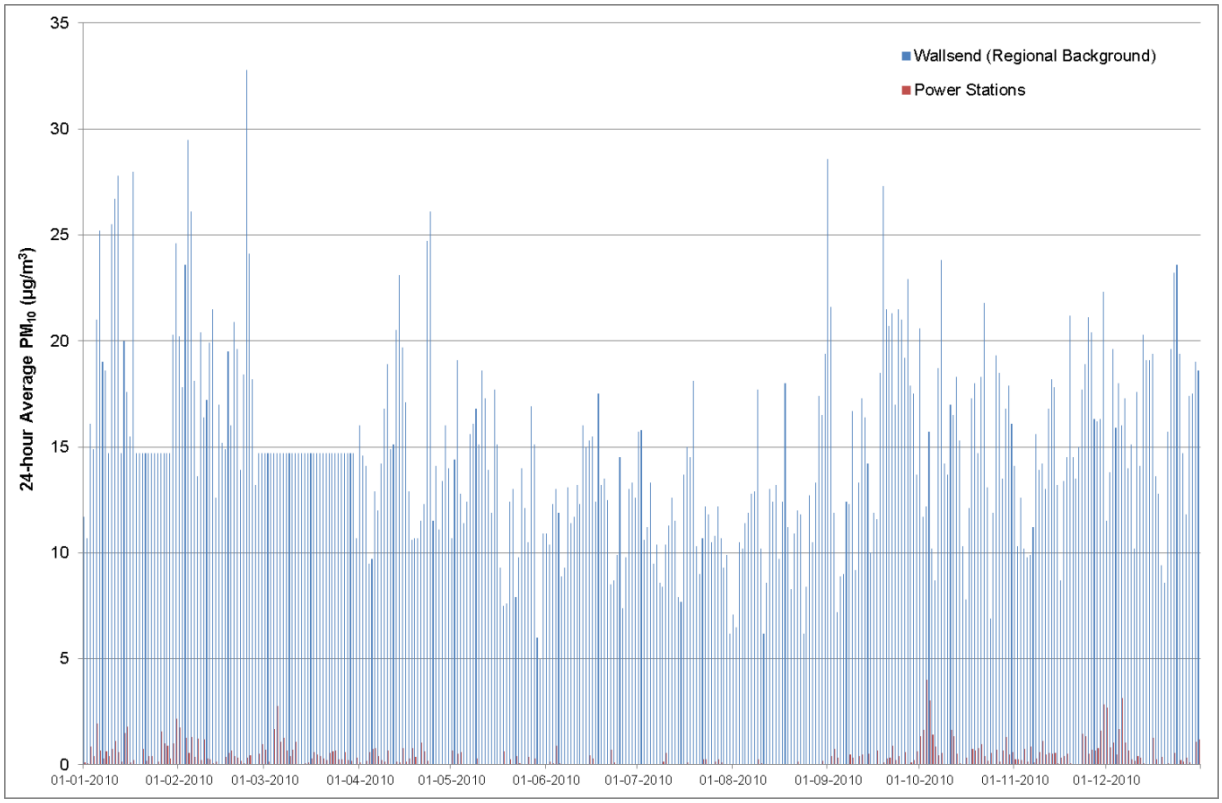
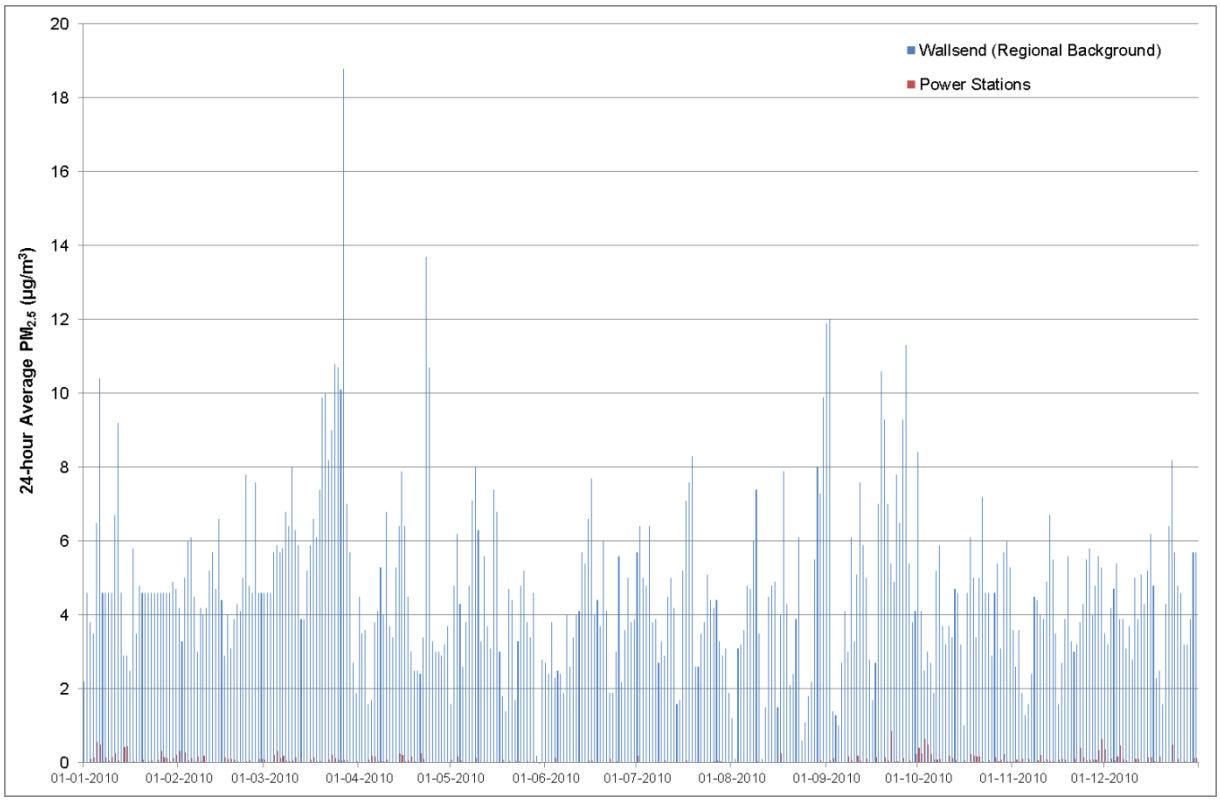


Figure 38 Regional Background and Power Station Increment at Receptor '22' ($PM_{2.5}$)



The derived background concentration files (regional plus power station) vary spatially across the modelling domain based on the results of power station emission modelling results.

For the assessment of cumulative TSP concentrations, the annual average predictions provided by the power station modelling study were added to an estimated annual average regional background value of 30.9 µg/m^3 (as discussed in **Section 7.3.2**).

7.5 Surrounding Mining and Ancillary Industries

A number of surrounding industries have been identified in the region, which are anticipated to have a cumulative impact on the identified sensitive receptors. This section identifies those industries and assesses the possibility of their operations resulting in having a cumulative impact on the sensitive receptors. A summary of the industries considered in this regard is shown in **Table 39**.

Table 39 A Summary of the Mining and Ancillary Industries in the Region

Industry	Location	Section
Teralba Quarry Extensions	~ 2.5 km northeast of Newstan Colliery Surface Site	**Section 7.5.1**
West Wallsend Colliery	~ 4.5 km north of Newstan Colliery Surface Site	**Section 7.5.2**
Macquarie Coal Preparation Plant	~4.5 km northeast of Newstan Colliery Surface Site	**Section 7.5.3**
Awaba Colliery	~ 5.5 km northeast of Cooranbong Entry Site	**Section 7.5.4**
Mandalong Mine Access Site	~ 7.5 km southwest of Cooranbong Entry Site	**Section 7.5.5**

7.5.1 Teralba Quarry Extension

An AQIA was completed by SLR Consulting in November 2011 which assessed the air quality impacts associated with the proposed Teralba Quarry Extension located adjacent to Rhonda Road in Teralba.

A total of three scenarios were assessed, of which the scenario that assessed the extraction in the Southern Extension Area (Stage C) was regarded as the worst case scenario out of the three scenarios assessed. In order to assess the cumulative impacts from Teralba Quarry Extension Project on the identified sensitive receptors (in **Section 3.2**), it is considered appropriate to assess the predicted 24-hour average PM_{10} concentrations.

Table 40 Predicted 24-hour Average PM_{10} Concentrations for Scenario 5A - Extraction in the Southern Extension Area (Stage C)

Receptor	Incremental	Cumulative
A	0.9	40
B	1.5	41
C	1.9	43
D	1.2	41
E	0.3	40
F	0.2	40
G	0.0	39
H	0.0	39
I	0.0	39

Source: SLR 2011a

It is noted that the predicted incremental 24-hour average PM_{10} concentrations were negligible at a receptor 'I' (the furthest receptor from Teralba Quarry), which is receptor 'NC1' (near Newstan Colliery Surface Site) in the current assessment.

It is therefore concluded that the Teralba Quarry Extension Project will not have any significant cumulative impacts with the Northern Coal Logistics Project.

7.5.2 West Wallsend Colliery

The Xstrata owned West Wallsend Colliery has been identified as a potential source of particulate in the region.

West Wallsend Colliery services an underground coal mine, and is located approximately 4.5 km north of Newstan Colliery Surface Site.

The West Wallsend Colliery includes a car park, administrative buildings, store, maintenance workshop, bath house, surface coal handling infrastructure, hard stand area, wash-down bays, coal bin, three ventilation shafts and water management dams and drain.

An AQIA was completed by Umwelt Environmental Consultants in 2010 for the West Wallsend Colliery Continued Operations Project (Umwelt 2010), which concluded that the maximum 24-hour average PM_{10} concentrations predicted at a privately owned residence, located approximately 2.5 km from the Colliery would be approximately 4.7 $\mu g/m^3$.

Considering the relatively large separation distance between the West Wallsend Colliery and identified sensitive receptors within this assessment, it is considered appropriate to assume that West Wallsend Colliery is unlikely to have any significant cumulative impact with the Northern Coal Logistics Project.

7.5.3 Macquarie Coal Preparation Plant (MCPP)

The MCPP is operated in conjunction with West Wallsend Colliery, and is located approximately 5 km north-east of Newstan Colliery Surface Site. The MCPP handles and processes ROM coal received from West Wallsend Colliery.

The MCPP surface holding consists of a coal preparation plant, car park, administrative buildings, bath house, store, coal stockpiles, coal load-out bin, rail loop, coarse reject emplacement area, tailings dam and water management dams and drain.

No air quality impact assessment is available for reference for this site. In the absence of any publicly available impact assessment, it is difficult to comment on the likelihood of the impacts due to this site operation on the identified sensitive receptors.

Referring to the modelling conducted for power stations (**Section 7.4**), it is noted that at a receptor approximately 2.5 km away from a power station (EPS), the maximum 24-hour average PM_{10} predicted is 4.0 $\mu g/m^3$. It is also noted that the EPS and MCPP have very similar emission sources with the exception of stacks (albeit marginally different in size) i.e. coal stockpiles, continuous coal handling and tailings dam. Based on the aforementioned factors, it is assumed that the MCPP is unlikely to have any significant cumulative impact with the Northern Coal Logistics Project.

7.5.4 Awaba Colliery

An AQIA was completed by SLR Consulting in May 2010 which assessed the air quality impacts associated with the Awaba Colliery underground mine located approximately 5.5 km north-east of the Cooranbong Entry Site.

At the time of the assessment, the facilities associated with Awaba Colliery were coal processing and handling, Awaba Quarry, coal stockpiles and exposed areas and product transportation (via haul roads).

It is noted that the maximum predicted incremental 24-hour average PM_{10} concentrations was around 17 $\mu g/m^3$ at receptor 'R4' in the May 2010 Awaba Colliery AQIA, which is the same as receptor 'NC11' (near Awaba Colliery Surface Site) for the current assessment.

It is noted that all coal handling and processing operations at the Awaba Colliery ceased in early 2012, thus reducing emissions considerably. The potential utilisation of the Awaba Colliery for the Newstan Colliery underground mining workforce and associated mining support infrastructure will be considered as part of the Newstan Extension of Mining Project.

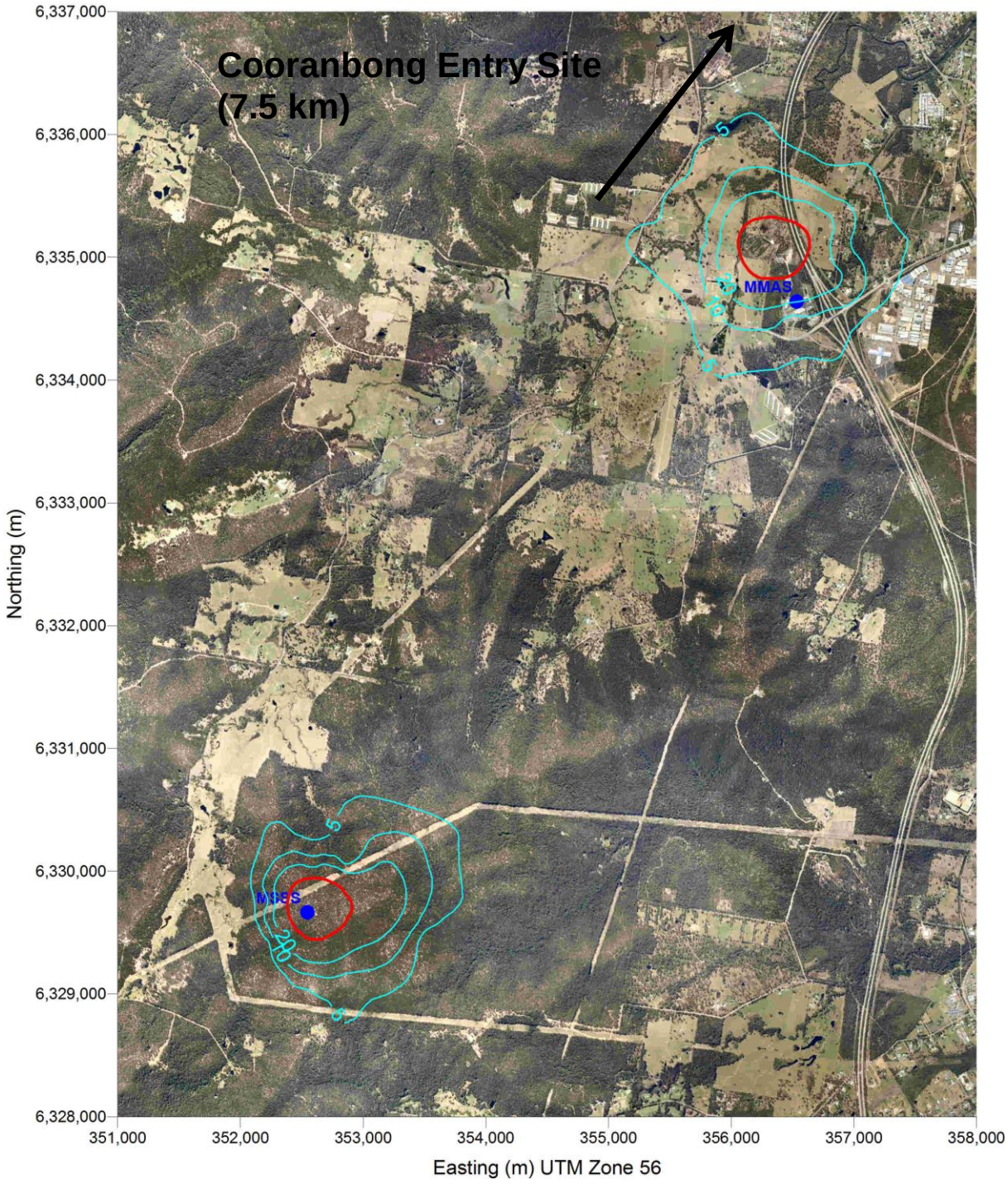
7.5.5 Mandalong Mine Access Site

An AQIA was completed by SLR Consulting in March 2013 which assessed the air quality impacts associated with the Mandalong Mine Access Site and proposed Mandalong South Surface Site located approximately 7.5 km south-west of the Cooranbong Entry Site. In terms of particulate emissions, the activity associated with the Mandalong Mine Access Site which is of primary relevance to this study are ventilation shaft emissions.

In order to assess the cumulative impacts from the Mandalong Mine Access Site on the identified sensitive receptors (in **Section 3.2**), it is considered appropriate to assess the predicted 24-hour average PM_{10} concentrations.

A contour plot of the 24-hour average PM_{10} for the above mentioned scenario is reproduced in **Figure 39**.

Figure 39 Predicted 24-hour Average PM_{10} Concentrations for the Mandalong Mine Access Site and Mandalong South Surface Site



It was concluded that the maximum incremental 24-hour average PM_{10} concentrations predicted at a receptor located approximately 1.3 km from the Mandalong Mine Access Site is approximately 4.8 µg/m^3.

Considering the relatively large separation distance (~7.5 km) between the Mandalong Mine Access Site and identified sensitive receptors (**Section 3.2**), it is considered appropriate to assume that the Mandalong Mine Access Site is unlikely to have any significant cumulative impact with the Project.

7.6 Background Air Quality for Assessment Purposes

For the purposes of assessing the potential air quality impacts from the Project, an estimation of ambient air quality concentrations is required. The site-specific ambient air quality concentrations adopted for this assessment are summarised in **Table 41**.

7.6.1 Dust

The onsite dust monitoring at Newstan Colliery Surface Site and Cooranbong Entry Site shows that the average dust deposition is 2.1 g/m^2/month and 1.3 g/m^2/month respectively. However it was noted that the monitored dust deposition averages include a contribution from the relevant operations and other regional dust sources. It is considered appropriate to adopt a value of 2 g/m^2/month as a background dust deposition level.

7.6.2 TSP

NSW EPA managed monitoring stations (Wallsend, Beresfield and Newcastle) do not monitor TSP concentrations.

Concurrent TSP concentrations are available from two HVAS (HVAS 1 and HVAS 2) at Newstan Colliery. These monitored concentrations are deemed unfit for use in the cumulative assessment, as they are recorded on a 1-in-6 day cycle.

However, a TSP:PM_{10} ratio was noted from this data and applied to the available continuous PM_{10} data to obtain appropriate TSP concentrations.

7.6.3 PM_{10}

Concurrent PM_{10} concentrations are available from two HVAS (HVAS 1 and HVAS 2) at Newstan Colliery Surface Site. These monitored concentrations are deemed unfit for use in the cumulative assessment, as they are recorded on a 1-in-6 day cycle. Continuous PM_{10} concentrations from a TEOM are also available (co-located at HVAS 2) at Newstan Colliery Surface Site. These monitored concentrations are deemed unfit for use in the cumulative assessment, as they are not recorded during a contemporaneous year with modelled meteorological year (2010).

The PM_{10} concentrations recorded at Wallsend monitoring station are used to represent a regional background concentration of PM_{10}.

7.6.4 PM2.5

The $PM_{2.5}$ concentrations recorded at Wallsend monitoring station are used to represent a regional background concentration of $PM_{2.5}$.

Table 41 Ambient Air Quality Environment for Assessment Purposes

Air Quality Parameter	Averaging Period	Assumed Background Ambient Level	Notes
TSP	Annual	30.9 µg/m^3 PLUS Power Station Increments	Maximum Increment due to Power Station is 0.79 µg/m^3 at Receptor ‘23’
PM_{10}	24-hour	Varying	Maximum Increment due to Power Station is 4.0 µg/m^3 at Receptor ’23’
	Annual	14.7 µg/m^3 PLUS Power Station Increments	
$PM_{2.5}$	24-hour	Varying	Maximum Increment due to Power Station is 0.85 µg/m^3 at Receptor ’22’
	Annual	4.6 µg/m^3 PLUS Power Station	

Air Quality Parameter	Averaging Period	Assumed Background Ambient Level	Notes
		Increments	
Deposited Dust	Annual	2 g/m^2/month	Assumed
Odour	1-hour	0 OU	Assumed

8 AIR QUALITY IMPACT ASSESSMENT

Dispersion modelling predictions of dust deposition rates, TSP, PM_{10} and $PM_{2.5}$ and odour concentrations at the residences/properties nominated in **Section 3.2** attributable to the Northern Coal Logistics Project are presented in **Section 8.1** to **Section 8.7**. Pollutant isopleth plots are also provided in **Appendix B** which show the maximum predicted incremental (Project operations only) concentrations and deposition rates of the pollutants assessed.

As discussed in **Section 7** a detailed assessment of the background concentrations in the area surrounding the Project site has been performed. A regional background concentration has been determined, to which a contribution from local power stations has been added. Within this results section, a contribution from Project activities has been added to the background dataset (refer to **Section 7.6**), in order to provide information on the cumulative impact of Project activities on the air quality within the local area. For TSP, PM_{10} and $PM_{2.5}$ concentration results, several values are presented. The value presented and an explanation of each is provided in **Table 42**.

Table 42 Results Presentation and Explanation

Description in Results Tables	Data Presented	Reason for Presentation
Increment Background	Maximum *Regional* Background Concentration	Allows identification of the maximum regional measured particulate concentration across the entire year without power station and Project related sources.
Increment Power Station	Maximum Incremental Contribution from *Power Stations*	Indicates the maximum impact at each receptor across the entire year from power station operation only.
Increment Project	Maximum Incremental Contribution from *Project*	Identifies the maximum impact across the entire year from Project related sources only.
Cumulative Total Background + Project	Maximum Cumulative Concentration (ALL SOURCES)	Indicates the maximum particulate concentration when regional background, power station sources and Project sources are added together. However, the day of maximum impact from the Project may not fall on the same day as maximum impact from the power stations and regional background.

The following Sections detail the dispersion modelling results for dust deposition (**Section 8.1**), TSP (**Section 8.2**), PM_{10} (**Section 8.3** and **Section 8.5**), $PM_{2.5}$ (**Section 8.4** and **Section 8.6**) and Odour (**Section 8.7**).

8.1 Dust Deposition

8.1.1 Newstan Colliery Surface Site and Private Haul Roads

Table 43 shows the results of the dispersion modelling for dust deposition from the Project at each of the identified receptors around Newstan Colliery Surface Site and private haul roads. Contour plots of the incremental increase in dust deposition are also presented in **Appendix B**.

The results indicate that incremental and cumulative annual average dust deposition rates at all nominated receptors surrounding the Newstan Colliery Surface Site are predicted to be well below the criterion of 2 g/m^2/month (incremental increase in dust deposition) and below 4 g/m^2/month (cumulative dust deposition) for all modelled scenarios.

Table 43 Predicted Annual Average Dust Deposition Rates - Newstan Colliery Surface Site and Private Haul Roads

Receptor ID	Annual Average Dust Deposition Rate (g/m^2/month)																	
	Background		Scenario 1		Scenario 2a		Scenario 2b		Scenario 2c		Scenario 3a		Scenario 3b		Scenario 3c		Scenario 4	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
NC1	2.0	<0.1	0.3	2.3	0.3	2.3	0.3	2.3	0.2	2.2	0.3	2.3	0.3	2.3	0.2	2.2	0.2	2.2
NC2	2.0	<0.1	0.7	2.7	0.7	2.7	0.7	2.7	0.6	2.6	0.8	2.8	0.7	2.7	0.6	2.6	0.6	2.6
NC3	2.0	<0.1	0.5	2.5	0.6	2.6	0.5	2.5	0.4	2.4	0.7	2.7	0.6	2.6	0.5	2.5	0.5	2.5
NC4	2.0	<0.1	0.3	2.3	0.3	2.3	0.3	2.3	0.3	2.3	0.4	2.4	0.4	2.4	0.3	2.3	0.3	2.3
NC5	2.0	<0.1	0.5	2.5	0.5	2.5	0.5	2.5	0.4	2.4	0.6	2.6	0.5	2.5	0.4	2.4	0.4	2.4
NC6	2.0	<0.1	0.7	2.7	0.9	2.9	0.7	2.7	0.5	2.5	1.0	3.0	0.9	2.9	0.6	2.6	0.6	2.6
NC7	2.0	<0.1	0.3	2.3	0.4	2.4	0.3	2.3	0.3	2.3	0.4	2.4	0.4	2.4	0.3	2.3	0.3	2.3
NC8	2.0	<0.1	0.5	2.5	0.5	2.5	0.5	2.5	0.5	2.5	0.6	2.6	0.5	2.5	0.5	2.5	0.5	2.5
NC9	2.0	<0.1	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4
NC10	2.0	<0.1	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4	0.4	2.4
NC11	2.0	<0.1	0.4	2.4	0.4	2.4	0.4	2.4	0.3	2.3	0.4	2.4	0.4	2.4	0.3	2.3	0.3	2.3

Note: Criteria – 2 g/m^2/month (incremental), 4 g/m^2/month (cumulative)

8.1.2 Cooranbong Entry Site

Table 44 shows the results of the dispersion modelling for dust deposition from the Project at each of the identified receptors around Cooranbong Entry Site. Contour plots of the incremental increase in dust deposition are also presented in **Appendix B**.

The results indicate that incremental and cumulative annual average dust deposition rates at all nominated receptors surrounding the Cooranbong Entry Site are predicted to be well below the criterion of 2 g/m^2/month (incremental increase in dust deposition) and below 4 g/m^2/month (cumulative dust deposition) for both modelled scenarios.

Table 44 Predicted Annual Average Dust Deposition Rates - Cooranbong Entry Site

Receptor ID	Annual Average Dust Deposition Rate (g/m^2/month)					
	Background		Scenario 5a		Scenario 5b	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative
22	2.0	<0.1	0.5	2.5	0.1	2.1
23	2.0	<0.1	0.4	2.4	0.1	2.1
26	2.0	<0.1	0.3	2.3	0.1	2.1
28	2.0	<0.1	0.2	2.2	<0.1	<2.1
30	2.0	<0.1	0.2	2.2	<0.1	<2.1
31	2.0	<0.1	0.2	2.2	<0.1	<2.1
32	2.0	<0.1	0.2	2.2	<0.1	<2.1
33	2.0	<0.1	0.2	2.2	<0.1	<2.1
35	2.0	<0.1	0.2	2.2	<0.1	<2.1

Note: Criteria – 2 g/m^2/month (incremental), 4 g/m^2/month (cumulative)

8.2 Particles (as TSP) – Annual Average

8.2.1 Newstan Colliery Surface Site and Private Haul Roads

Table 45 presents the annual average TSP concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Newstan Colliery Surface Site and private haul roads. The calculated background TSP concentrations have been discussed in detail in **Section 7**.

The results indicated that the annual average TSP concentrations are predicted to be well below the criterion of 90 µg/m^3 at all identified sensitive receptor locations around Newstan Colliery Surface Site and private haul roads for all modelled scenarios.

Table 45 Predicted Annual Average TSP Concentrations - Newstan Colliery Surface Site and Private Haul Roads

Receptor ID	Annual Average TSP (µg/m^3)																	
	Background		Scenario 1		Scenario 2a		Scenario 2b		Scenario 2c		Scenario 3a		Scenario 3b		Scenario 3c		Scenario 4	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
NC1	30.9	0.3	6.1	37.3	7.0	38.2	6.4	37.6	5.4	36.6	7.9	39.1	7.1	38.3	5.7	36.9	5.6	36.9
NC2	30.9	0.3	15.2	46.4	16.7	47.9	15.6	46.9	14.3	45.5	18.2	49.5	16.8	48.0	14.7	45.9	14.6	45.9
NC3	30.9	0.4	11.5	42.7	13.3	44.6	11.7	42.9	9.9	41.2	15.4	46.7	13.2	44.4	10.5	41.7	10.5	41.7
NC4	30.9	0.4	6.9	38.2	7.9	39.2	7.1	38.4	5.9	37.2	9.2	40.5	8.1	39.3	6.2	37.4	6.2	37.4
NC5	30.9	0.4	10.3	41.6	11.6	42.9	10.5	41.8	9.0	40.3	13.2	44.5	11.6	42.9	9.4	40.7	9.4	40.7
NC6	30.9	0.3	15.6	46.8	19.4	50.7	16.5	47.8	11.8	43.1	23.8	55.0	19.9	51.1	12.8	44.1	12.8	44.1
NC7	30.9	0.4	7.7	39.0	8.3	39.6	7.7	39.0	7.0	38.3	9.1	40.4	8.3	39.6	7.2	38.5	7.2	38.5
NC8	30.9	0.5	11.7	43.1	12.2	43.6	11.8	43.2	11.3	42.7	12.7	44.1	12.2	43.6	11.4	42.8	11.4	42.8
NC9	30.9	0.5	9.1	40.5	9.5	40.9	9.2	40.6	8.6	40.0	10.0	41.4	9.6	41.0	8.8	40.2	8.8	40.2
NC10	30.9	0.7	8.2	39.9	8.4	40.0	8.3	39.9	8.1	39.7	8.6	40.2	8.4	40.0	8.1	39.8	8.1	39.8
NC11	30.9	0.7	8.0	39.6	8.1	39.7	8.0	39.6	7.9	39.5	8.3	39.9	8.1	39.8	7.9	39.5	7.9	39.5

Note: Project criterion – 90 µg/m^3

8.2.2 Cooranbong Entry Site

Table 46 presents the annual average TSP concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Cooranbong Entry Site. The calculated background TSP concentrations have been discussed in detail in **Section 7**.

Table 46 Predicted Annual Average TSP Concentrations – Cooranbong Entry Site

Receptor ID	Annual Average TSP (µg/m^3)					
	Background		Scenario 5a		Scenario 5b	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative
22	30.9	0.7	11.5	43.1	8.6	40.2
23	30.9	0.8	8.0	39.7	6.6	38.3
26	30.9	0.8	7.1	38.8	6.6	38.3
28	30.9	0.7	5.4	37.0	3.8	35.4
30	30.9	0.6	5.2	36.7	3.5	34.9
31	30.9	0.6	5.6	37.2	2.4	33.9
32	30.9	0.7	4.6	36.2	1.8	33.4
33	30.9	0.6	5.3	36.8	1.5	33.0
35	30.9	0.6	4.0	35.6	1.7	33.2

Note: Project criterion – 90 µg/m^3

The results indicated that the annual average TSP concentrations are predicted to be well below the criterion of 90 µg/m^3 at all identified sensitive receptor locations around Cooranbong Entry Site for both modelled scenarios.

8.3 Particles (as PM_{10}) – Annual Average

8.3.1 Newstan Colliery Surface Site and Private Haul Roads

Table 47 presents the annual average PM_{10} concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Newstan Colliery Surface Site and private haul roads. The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

The results indicated that the annual average PM_{10} concentrations are predicted to be well below the criterion of 30 µg/m^3 criteria set by the EPA and the 20 µg/m^3 criteria set by the WHO at all identified sensitive receptor locations around Newstan Colliery Surface Site and private haul roads for all modelled scenarios.

Table 47 Predicted Annual Average PM_{10} Concentrations - Newstan Colliery Surface Site and Private Haul Roads

Receptor ID	Annual Average PM_{10} ($\mu g/m^3$)																	
	Background		Scenario 1		Scenario 2a		Scenario 2b		Scenario 2c		Scenario 3a		Scenario 3b		Scenario 3c		Scenario 4	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
NC1	14.7	0.1	1.7	16.5	1.8	16.7	1.7	16.5	1.6	16.5	2.0	16.8	1.8	16.6	1.7	16.5	1.7	16.5
NC2	14.7	0.1	4.5	19.3	4.8	19.6	4.5	19.3	4.5	19.3	5.1	19.9	4.7	19.5	4.6	19.4	4.6	19.4
NC3	14.7	0.1	2.4	17.2	2.8	17.6	2.3	17.2	2.3	17.1	3.2	18.0	2.6	17.5	2.4	17.3	2.4	17.3
NC4	14.7	0.1	1.4	16.3	1.6	16.4	1.4	16.2	1.3	16.2	1.9	16.7	1.6	16.4	1.4	16.2	1.4	16.2
NC5	14.7	0.2	2.0	16.9	2.3	17.1	2.0	16.8	1.9	16.8	2.6	17.4	2.2	17.0	2.0	16.9	2.0	16.9
NC6	14.7	0.1	3.2	18.1	4.0	18.8	3.2	18.0	2.8	17.7	4.9	19.7	3.8	18.7	3.1	17.9	3.1	17.9
NC7	14.7	0.2	1.5	16.4	1.6	16.5	1.5	16.3	1.4	16.3	1.8	16.6	1.6	16.4	1.5	16.4	1.5	16.4
NC8	14.7	0.2	2.3	17.2	2.4	17.3	2.3	17.2	2.2	17.1	2.5	17.4	2.3	17.2	2.3	17.2	2.3	17.2
NC9	14.7	0.2	1.8	16.7	1.9	16.8	1.8	16.7	1.7	16.6	2.0	16.9	1.8	16.7	1.8	16.7	1.8	16.7
NC10	14.7	0.3	1.6	16.7	1.7	16.7	1.6	16.7	1.6	16.7	1.7	16.7	1.7	16.7	1.6	16.7	1.6	16.7
NC11	14.7	0.3	1.6	16.6	1.6	16.6	1.6	16.6	1.6	16.6	1.7	16.7	1.6	16.6	1.6	16.6	1.6	16.6

Note: Project criterion – 20 $\mu g/m^3$

8.3.2 Cooranbong Entry Site

Table 48 presents the annual average PM_{10} concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Cooranbong Entry Site. The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

Table 48 Predicted Annual Average PM_{10} Concentrations – Cooranbong Entry Site

Receptor ID	Annual Average PM_{10} ($\mu g/m^3$)					
	Background		Scenario 5a		Scenario 5b	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative
22	14.7	0.7	2.2	17.6	1.1	16.1
23	14.7	0.8	1.6	17.1	1.2	16.3
26	14.7	0.8	1.4	16.9	1.2	16.3
28	14.7	0.7	1.1	16.5	1.1	16.1
30	14.7	0.6	1.0	16.3	0.9	15.8
31	14.7	0.6	1.1	16.4	0.9	15.9
32	14.7	0.7	0.9	16.3	1.1	16.1
33	14.7	0.6	1.0	16.3	0.9	15.8
35	14.7	0.6	0.8	16.1	0.9	15.9

Note: Project criterion – 20 $\mu g/m^3$

The results indicated that the annual average PM_{10} concentrations are predicted to be well below the criterion of 30 $\mu g/m^3$ criteria set by the EPA and the 20 $\mu g/m^3$ criteria set by the WHO at all identified sensitive receptor locations around Cooranbong Entry Site for both modelled scenarios.

8.4 Particles (as $PM_{2.5}$) – Annual Average

8.4.1 Newstan Colliery Surface Site and Private Haul Roads

Table 49 presents the annual average $PM_{2.5}$ concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Newstan Colliery Surface Site and private haul roads. The calculated background $PM_{2.5}$ concentrations have been discussed in detail in **Section 7**.

The results indicated that the annual average $PM_{2.5}$ concentrations are predicted to be well below the criterion of 10 $\mu g/m^3$ set by the WHO and 8 $\mu g/m^3$ set by the NEPM at all identified sensitive receptor locations around Newstan Colliery Surface Site and private haul roads for all modelled scenarios.

Table 49 Predicted Annual Average $PM_{2.5}$ Concentrations - Newstan Colliery Surface Site and Private Haul Roads

Receptor ID	Annual Average $PM_{2.5}$ (µg/m^3)																	
	Background		Scenario 1		Scenario 2a		Scenario 2b		Scenario 2c		Scenario 3a		Scenario 3b		Scenario 3c		Scenario 4	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
NC1	4.6	<0.1	0.4	5.0	0.4	5.0	0.4	5.0	0.4	5.0	0.4	5.1	0.4	5.0	0.4	5.0	0.4	5.0
NC2	4.6	<0.1	0.9	5.5	0.9	5.6	0.9	5.5	0.9	5.5	1.0	5.6	0.9	5.6	0.9	5.5	0.9	5.5
NC3	4.6	<0.1	0.6	5.3	0.7	5.3	0.6	5.2	0.6	5.2	0.8	5.4	0.7	5.3	0.6	5.3	0.6	5.3
NC4	4.6	<0.1	0.5	5.1	0.5	5.1	0.4	5.1	0.4	5.1	0.5	5.2	0.5	5.1	0.5	5.1	0.5	5.1
NC5	4.6	<0.1	0.7	5.4	0.8	5.4	0.7	5.3	0.7	5.3	0.8	5.5	0.8	5.4	0.7	5.4	0.7	5.4
NC6	4.6	<0.1	0.8	5.4	0.9	5.5	0.8	5.4	0.7	5.3	1.0	5.6	0.9	5.5	0.8	5.4	0.8	5.4
NC7	4.6	<0.1	0.5	5.2	0.6	5.2	0.5	5.2	0.5	5.2	0.6	5.2	0.5	5.2	0.5	5.2	0.5	5.2
NC8	4.6	<0.1	0.8	5.5	0.9	5.5	0.8	5.5	0.8	5.5	0.9	5.5	0.9	5.5	0.8	5.5	0.8	5.5
NC9	4.6	<0.1	0.6	5.3	0.6	5.3	0.6	5.3	0.6	5.3	0.7	5.3	0.6	5.3	0.6	5.3	0.6	5.3
NC10	4.6	<0.1	0.6	5.3	0.6	5.3	0.6	5.3	0.6	5.3	0.6	5.3	0.6	5.3	0.6	5.3	0.6	5.3
NC11	4.6	<0.1	0.6	5.2	0.6	5.2	0.6	5.2	0.6	5.2	0.6	5.3	0.6	5.2	0.6	5.2	0.6	5.2

Note: Project criterion – 8 µg/m^3

8.4.2 Cooranbong Entry Site

Table 50 presents the annual average $PM_{2.5}$ concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Cooranbong Entry Site. The calculated background $PM_{2.5}$ concentrations have been discussed in detail in **Section 7**.

Table 50 Predicted Annual Average $PM_{2.5}$ Concentrations – Cooranbong Entry Site

Receptor ID	Annual Average $PM_{2.5}$ ($\mu g/m^3$)					
	Background		Scenario 5a		Scenario 5b	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative
22	4.6	0.1	0.6	5.2	0.3	5.0
23	4.6	0.1	0.4	5.1	0.3	5.0
26	4.6	0.1	0.4	5.1	0.3	5.0
28	4.6	0.1	0.3	5.0	0.2	4.8
30	4.6	<0.1	0.3	4.9	0.2	4.8
31	4.6	0.1	0.3	5.0	0.2	4.8
32	4.6	0.1	0.3	4.9	0.2	4.8
33	4.6	<0.1	0.3	5.0	0.2	4.8
35	4.6	0.1	0.2	4.9	0.2	4.8

Note: Project criterion – 8 $\mu g/m^3$

The results indicated that the annual average $PM_{2.5}$ concentrations are predicted to be well below the criterion of 10 $\mu g/m^3$ set by the WHO and 8 $\mu g/m^3$ set by the NEPM at all identified sensitive receptor locations around Cooranbong Entry Site for both modelled scenarios.

8.5 Particles (as PM_{10}) – 24-Hour Average

8.5.1 Newstan Colliery Surface Site and Private Haul Roads

Table 51 presents the maximum 24-hour average PM_{10} concentrations predicted by the dispersion modelling at each of the receptors around Newstan Colliery Surface Site and private haul roads. The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

Table 51 Predicted Maximum 24-Hour Average PM_{10} Concentrations - Newstan Colliery Surface Site and Private Haul Roads

Receptor ID	Maximum 24-hour Average PM_{10} (µg/m^3)																	
	Background		Scenario 1		Scenario 2a		Scenario 2b		Scenario 2c		Scenario 3a		Scenario 3b		Scenario 3c		Scenario 4	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
NC1	32.8	1.0	16.7	36.0	16.7	36.5	16.7	36.0	16.7	36.0	20.4	40.2	16.7	36.2	16.7	36.0	16.7	36.0
NC2	32.8	1.0	31.5	49.0	31.5	49.2	31.5	49.1	31.5	48.8	31.5	49.5	31.5	49.2	31.5	48.8	31.5	48.8
NC3	32.8	1.0	14.5	35.0	21.9	35.0	17.1	35.0	13.4	35.0	26.0	39.4	19.6	35.1	14.7	35.0	14.7	35.0
NC4	32.8	1.0	10.7	33.5	13.0	33.5	11.8	33.5	7.6	33.5	16.9	33.9	15.2	33.5	8.1	33.5	8.0	33.5
NC5	32.8	1.0	15.3	36.5	20.0	40.8	13.3	36.2	13.4	33.5	31.0	45.1	21.7	39.0	15.8	34.3	15.8	34.3
NC6	32.8	1.0	25.6	47.6	36.5	53.6	27.6	49.4	20.3	40.1	56.9	72.0	44.9	60.0	23.8	41.6	23.7	41.5
NC7	32.8	1.0	7.4	33.4	9.6	33.4	7.6	33.4	5.0	33.4	12.0	33.4	9.4	33.4	5.7	33.4	5.7	33.4
NC8	32.8	1.4	7.4	33.7	7.6	33.7	7.4	33.7	7.4	33.7	8.3	33.7	7.8	33.7	7.4	33.7	7.4	33.7
NC9	32.8	1.6	6.6	34.6	6.8	34.6	6.6	34.6	6.5	34.6	6.9	34.6	6.7	34.6	6.6	34.6	6.6	34.6
NC10	32.8	3.0	6.4	34.8	6.4	34.8	6.4	34.8	6.4	34.8	6.4	34.8	6.4	34.8	6.4	34.8	6.4	34.8
NC11	32.8	2.3	6.5	35.5	6.5	35.5	6.5	35.5	6.5	35.5	6.5	35.5	6.5	35.5	6.5	35.5	6.5	35.5

Note: The cumulative results columns may not be equal to the sum of the incremental results columns. This is because the incremental results are the maximum 24-hour average predicted over the entire year modelled as a result of the emissions from each source, while the cumulative results are the maximum 24-hour average predicted as a result of the combined emissions from each source. If the maximum incremental 24-hour impacts from each source occur on different days at a given receptor (i.e. under different meteorological conditions), then the maximum cumulative prediction may be lower than the sum of the maximum predicted incremental impacts. For further information, refer to **Table 42.**

The results indicated that the 24-hour average PM_{10} concentrations are predicted to exceed the criterion of 50 µg/m^3 at receiver NC6 for scenarios:

- 2a - Exporting up to 6 Mtpa of coal by rail, trucks dumping coal at the rail loop stockpile and manual train loading using front end loaders;
- 3a - Exporting up to 8 Mtpa of coal by rail, trucks dumping coal at the rail loop stockpile and manual train loading using front end loaders; and
- 3b - Exporting up to 8 Mtpa of coal by rail, automation of coal transport from the CPP to the rail loop stockpile and manual train loading using front end loaders.

8.5.1 Cooranbong Entry Site

Table 52 presents the 24-hour average PM_{10} concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Cooranbong Entry Site. The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

Table 52 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Cooranbong Entry Site

Receptor ID	Maximum 24-hour Average PM_{10} (µg/m^3)					
	Background		Scenario 5a		Scenario 5b	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative
22	32.8	3.8	34.4	46.7	7.8	33.0
23	32.8	4.0	21.8	37.2	7.2	33.0
26	32.8	3.7	23.7	35.0	7.5	33.1
28	32.8	2.9	12.3	33.2	6.9	33.1
30	32.8	1.9	12.5	33.3	6.5	33.1
31	32.8	2.3	16.3	36.4	5.7	33.1
32	32.8	2.9	12.2	33.3	5.4	33.1
33	32.8	2.0	10.3	33.3	4.8	33.2
35	32.8	2.2	13.6	33.2	4.4	33.1

Note: Project criterion – 50 µg/m^3

The results indicated that the 24-hour average PM_{10} concentrations are predicted to be well below the criterion of 50 µg/m^3 at all identified sensitive receptor locations around Cooranbong Entry Site for both modelled scenarios.

8.6 Particles (as $PM_{2.5}$) – 24-Hour Average

8.6.1 Newstan Colliery Surface Site and Private Haul Roads

Table 53 presents the maximum 24-hour average $PM_{2.5}$ concentrations predicted by the dispersion modelling at each of the sensitive receptors around Newstan Colliery Surface Site and private haul roads. The calculated background $PM_{2.5}$ concentrations have been discussed in detail in **Section 7**.

Table 53 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations - Newstan Colliery Surface Site and Private Haul Roads

Receptor ID	Maximum 24-hour Average $PM_{2.5}$ ($\mu g/m^3$)																	
	Background		Scenario 1		Scenario 2a		Scenario 2b		Scenario 2c		Scenario 3a		Scenario 3b		Scenario 3c		Scenario 4	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative	Increment	Cumulative
NC1	18.8	0.2	2.7	19.9	2.9	19.9	2.7	19.9	2.7	19.9	3.5	20.0	2.8	19.9	2.7	19.9	2.7	19.9
NC2	18.8	0.2	5.2	20.8	7.3	20.8	5.9	20.8	6.1	20.8	9.1	20.9	7.2	20.8	6.6	20.8	6.6	20.8
NC3	18.8	0.2	3.4	19.2	3.9	19.2	3.4	19.1	3.1	19.2	4.5	19.3	3.6	19.2	3.2	19.2	3.2	19.2
NC4	18.8	0.2	2.7	19.3	2.9	19.5	2.8	19.4	3.0	19.3	3.0	19.5	2.9	19.5	3.0	19.3	3.0	19.3
NC5	18.8	0.2	4.3	19.3	4.7	19.3	4.6	19.3	4.4	19.3	6.2	19.3	4.7	19.3	4.4	19.3	4.4	19.3
NC6	18.8	0.2	5.3	19.1	6.7	19.2	4.6	19.1	4.7	19.1	11.6	19.2	8.8	19.2	5.4	19.1	5.4	19.1
NC7	18.8	0.2	2.2	19.1	2.7	19.1	2.2	19.1	2.2	19.1	3.4	19.1	2.7	19.1	2.2	19.1	2.2	19.1
NC8	18.8	0.4	4.1	19.2	4.1	19.2	4.1	19.2	4.1	19.2	4.1	19.3	4.1	19.2	4.1	19.2	4.1	19.2
NC9	18.8	0.3	3.3	19.4	3.4	19.4	3.3	19.4	3.3	19.4	3.4	19.4	3.3	19.4	3.3	19.4	3.3	19.4
NC10	18.8	0.5	2.7	19.5	2.7	19.5	2.7	19.5	2.7	19.5	2.7	19.6	2.7	19.6	2.7	19.5	2.7	19.5
NC11	18.8	0.5	2.2	20.0	2.2	20.0	2.2	20.0	2.2	20.0	2.2	20.0	2.2	20.0	2.2	20.0	2.2	20.0

Note: The cumulative results columns may not be equal to the sum of the incremental results columns. This is because the incremental results are the maximum 24-hour average predicted over the entire year modelled as a result of the emissions from each source, while the cumulative results are the maximum 24-hour average predicted as a result of the combined emissions from each source. If the maximum incremental 24-hour impacts from each source occur on different days at a given receptor (i.e. under different meteorological conditions), then the maximum cumulative prediction may be lower than the sum of the maximum predicted incremental impacts. For further information, refer to **Table 42**.

The results indicated that the 24-hour average $PM_{2.5}$ concentrations are predicted to be below the criterion of 25 µg/m^3 at all identified sensitive receptor locations around the Newstan Colliery Surface Site for all modelled scenarios.

8.6.2 Cooranbong Entry Site

Table 54 presents the 24-hour average $PM_{2.5}$ concentrations predicted by the dispersion modelling from the Project at each of the identified receptors around Cooranbong Entry Site. The calculated background $PM_{2.5}$ concentrations have been discussed in detail in **Section 7**.

Table 54 Predicted Maximum 24-Hour Average $PM_{2.5}$ Concentrations – Cooranbong Entry Site

Receptor ID	Maximum 24-hour Average $PM_{2.5}$ (µg/m^3)					
	Background		Scenario 5a		Scenario 5b	
	Regional	Power Station	Increment	Cumulative	Increment	Cumulative
22	18.8	0.8	7.4	18.9	2.0	18.9
23	18.8	0.8	5.1	18.9	2.0	18.9
26	18.8	0.8	6.0	18.9	2.4	18.9
28	18.8	0.6	3.7	18.9	1.0	18.9
30	18.8	0.5	3.2	18.9	1.1	18.9
31	18.8	0.6	3.7	18.9	1.4	18.9
32	18.8	0.6	3.3	18.9	1.0	18.9
33	18.8	0.5	2.8	19.1	1.1	18.9
35	18.8	0.4	3.2	18.9	1.1	18.9

Note: Project criterion – 25 µg/m^3

The results indicated that the annual average $PM_{2.5}$ concentrations are predicted to be well below the criterion of 25 µg/m^3 at all identified sensitive receptor locations around Cooranbong Entry Site for both modelled scenarios.

8.7 Odour

Table 55 presents the 99th percentile 1-hour average odour concentrations predicted by the dispersion modelling at each of the nominated residences/properties using the odour emission rates listed in **Section 5** for Project operations. It is noted that the background odour concentration is assumed to be zero.

As discussed in **Section 5.1**, the only odour source from Project operations during all the scenarios, are the mine ventilation fans located at the Newstan Colliery Surface Site and Cooranbong Entry Site. As all the scenarios are differentiated based on the coal handling at the Newstan Colliery Surface Site, it is appropriate to assume that the predicted odour concentrations are the same for all the scenarios. Contour plots of the predicted odour concentrations are presented in **Appendix B**.

Table 55 99th Percentile 1-hour Average Odour Concentrations – Scenario 1, 2a, 2b, 2c, 3a, 3b,3c, 4, 5a and 5b

Receptor ID	Increment	Odour Criteria
NC1	<1	2
NC2	<1	2
NC3	<1	2
NC4	<1	2

Receptor ID	Increment	Odour Criteria
NC5	<1	2
NC6	<1	2
NC7	<1	2
NC8	<1	2
NC9	<1	2
NC10	<1	2
NC11	<1	2
22	<1	4
23	<1	4
26	<1	4
28	<1	4
30	<1	4
31	<1	4
32	<1	4
33	<1	4
35	<1	4

It is noted that the 99th percentile 1-hour average odour concentration is predicted to be below the Project criterion of 2 OU for the receptors surrounding the Newstan Colliery Surface Site and 4 OU for the receptors surrounding Cooranbong Entry Site for all modelled scenarios.

8.8 Assessment of Multiple Scenarios at Newstan Colliery Surface Site

As discussed in **Section 5.2**, to assess the impacts due to the proposed infrastructural changes at the Newstan Colliery Surface Site, a total of eight scenarios have been assessed. The results for the short term (24-hour average) impacts of PM_{10} are discussed in this section. It is considered appropriate to assess the short term (24-hour average) impacts for PM_{10} as the long term (annual averages) impacts are dependent on the short term impacts. As the TSP and $PM_{2.5}$ emissions are based on the PM_{10} emissions (see **Section 5.3**), it is considered that the predicted PM_{10} concentrations will appropriately reflect the air quality impacts in the vicinity of the Newstan Colliery Surface Site.

Also, as the eight scenarios are differentiated based on the activities at the Newstan Colliery Surface Site only, it is considered appropriate to assess the results at the receptors in its vicinity only, namely 'NC1' to 'NC6'.

8.8.1 Scenario 2a, Scenario 2b and Scenario 2c

These three scenarios represent exporting 6 Mtpa of coal from the Newstan Colliery Surface Site. A summary of the three scenarios is shown in **Table 17**.

Table 56 presents the maximum 24-hour average PM_{10} concentrations predicted by the dispersion modelling at each of the nominated residences/properties using the emission rates calculated in **Section 5.5**. The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

Table 56 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Scenario 2a, Scenario 2b and Scenario 2c

Receptor ID	Increment	Increment	Scenario 2a (Exporting 6 Mtpa coal) (Current Infrastructure)		Scenario 2b (Exporting 6 Mtpa coal) (Automatic Coal Handling)		Scenario 2c (Exporting 6 Mtpa coal) (Automatic train loading)	
	Regional Background *Maximum predicted incremental result from background only*	**Power Stations** *Maximum predicted incremental result from power stations only*	**Increment** *Maximum predicted incremental result from current scenario only*	**Cumulative** *Maximum predicted concurrent and cumulative result from background, power stations and project*	**Increment** *Maximum predicted incremental result from current scenario only*	**Cumulative** *Maximum predicted concurrent and cumulative result from background, power stations and project*	**Increment** *Maximum predicted incremental result from current scenario only*	**Cumulative** *Maximum predicted concurrent and cumulative result from background, power stations and project*
	(µg/m^3)	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**
NC1	32.8	1.0	16.7	36.5	16.7	36.0	16.7	36.0
NC2	32.8	1.0	31.5	49.2	31.5	49.1	31.5	48.8
NC3	32.8	1.0	21.9	35.0	17.1	35.0	13.4	35.0
NC4	32.8	1.0	13.0	33.5	11.8	33.5	7.6	33.5
NC5	32.8	1.0	20.0	40.8	13.3	36.2	13.4	33.5
NC6	32.8	1.0	36.5	53.6	27.6	49.4	20.3	40.1

Note: The cumulative results columns may not be equal to the sum of the incremental results columns. This is because the incremental results are the maximum 24-hour average predicted over the entire year modelled as a result of the emissions from each source, while the cumulative results are the maximum 24-hour average predicted as a result of the combined emissions from each source. If the maximum incremental 24-hour impacts from each source occur on different days at a given receptor (i.e. under different meteorological conditions), then the maximum cumulative prediction may be lower than the sum of the maximum predicted incremental impacts. For further information, refer to **Table 42.**
Project Criterion: 50 µg/m^3

It can be seen that when 6 Mtpa of coal is exported using the current infrastructure (Scenario 2a), exceedance of the 24-hour average PM_{10} criterion is predicted at receptor 'NC6' (the Fassifern Primary School). Receptor 'NC6' is located south-east of the rail loop stockpile.

The predicted results for Scenario 2b represent automating the transfer of coal from the CPP to rail loop stockpile. It is noted from **Table 56** that automating the coal transfer from the CPP to rail loop stockpile results in a decrease in the incremental concentrations of up to 25% ('NC6'). However the corresponding predicted cumulative concentration at 'NC6' decreases by just 8% only.

The predicted results for Scenario 2c represent automating the train loading operations. It is noted from **Table 56** that this upgrade would result in a decrease in the incremental concentrations of up to 44% ('NC6') and the corresponding predicted cumulative concentration at 'NC6' decreases by approximately 25%.

Source Contribution Analysis – Scenario 2a (Receptor NC6)

As an exceedance of the 24-hour average criterion was predicted at receptor 'NC6' for Scenario 2a, it is considered appropriate to study the likely cause of exceedance at this receptor. A source contribution analysis is conducted for receptor 'NC6' and shown in **Table 57**.

Table 57 Source Contribution Analysis for Scenario 2a – Receptor 'NC6'

Emission Source	Contribution	Percentage
Cooranbong Entry Site – sources	0.4	0.5%
Newstan Fans	0.4	0.5%
ROM Coal stockpile	0.1	0.1%
Product stockpile (North)	0.7	0.8%
Product Stockpile (South)	0.4	0.5%
Train Wagon Surface	0.2	0.2%
Southern Reject Emplacement Area	9.6	11.9%
Northern Reject Emplacement Area	1.3	1.6%
Hawkmount Quarry	0.1	0.1%
Newstan Raw Coal Stockpile	0.1	0.2%
Reject from CPP loaded to bin	0.0	0.0%
Reject from CPP loaded to trucks	0.0	0.0%
Trucks dumping reject/stone material at SREA	0.0	0.0%
Dozer at SREA	0.6	0.8%
SREA Excavator #1	0.3	0.3%
SREA Excavator #2	0.3	0.4%
SREA Excavator #3	0.3	0.4%
Traxcavator	0.4	0.5%
Trucks dumping reject material at NREA	0.0	0.0%
Dozer at NREA	0.4	0.4%
Trucks dumping reject material at Hawkmount Quarry	0.0	0.0%
Dozer at Hawkmount Quarry	0.1	0.1%
Haul Roads (Newstan to Cooranbong to EPS)	15.6	19.2%
ROM Coal from dump hopper to stacker	0.0	0.1%
ROM Coal from Stacker to Stockpile	0.0	0.0%

Emission Source	Contribution	Percentage
Dozer on ROM Stockpile (push to reclaim stockpile)	1.2	1.5%
Conveyor to CPP Module 1	0.0	0.1%
Conveyor from Newstan drift to Newstan Coal ROM Stockpile	0.0	0.0%
Conveyor drop onto Newstan ROM stockpile	0.0	0.0%
Conveyor from Newstan Drift to CPP Module 2	0.0	0.0%
CPP Module 1 & CPP Module 2 & CHP-Crush/Screen/Wash	0.0	0.0%
Dozer at Product Stockpile (Rail Loop)	9.9	12.2%
FEL # 1 at Product Stockpile (Rail Loop) loading trains	7.2	8.9%
FEL # 2 at Product Stockpile (Rail Loop) loading trains	8.2	10.0%
FEL # 3 at Product Stockpile (Rail Loop) loading trains	7.3	8.9%
Trucks dumping coal to Rail loop stockpile	0.2	0.3%
Trucks dumping coal at Newstan ROM stockpile	0.1	0.1%
Haul road - rail loop stockpile	15.6	19.2%
TOTAL	**81.1**	**100.0%**

It is noted that the total 24-hour average PM_{10} concentrations in **Table 57** is not the same as reported in **Table 56** for receptor 'NC6' because the source contribution analysis assumes that each source is contributing at its peak, whereas in reality this might not be the case.

From the source contribution analysis, it can be seen that:

- the combined contribution of the dozer and FELs operating on rail loop stockpile is 40.0%; and
- the contribution of trucks transporting coal to and dumping coal at the rail loop stockpile is 19.5%.

Summary

Scenario 2a represents air quality impacts due to exportation of 6 Mtpa of coal from the Newstan Colliery Surface Site. Exceedance of the 24-hour average PM_{10} criterion is predicted at the receptor 'NC6' if current coal handling operations are continued. A source contribution analysis was conducted and it was shown that the combined coal handling using bulldozer and FELs during manual train loading at the rail loop stockpile was the largest contributor of PM_{10} emissions.

Scenario 2b represents the air quality impacts resulting after automating the transfer of coal from the CPP to the rail loop stockpile. This automation of coal transfer provides a minor improvement in the predicted air quality impacts resulting in the air quality criteria being achieved at all sensitive receivers surrounding the Newstan Colliery Surface Site.

Scenario 2c represents the air quality impacts after automation of train loading operations. The automation of train loading operations provides a significant improvement in the predicted air quality impacts resulting in the air quality criteria being achieved at all sensitive receivers surrounding the Newstan Colliery Surface Site.

8.8.2 Scenario 3a, Scenario 3b and Scenario 3c

These three scenarios represent exporting 8 Mtpa of coal from the Newstan Colliery Surface Site. A summary of the three scenarios is shown in **Table 17**.

Table 58 presents the maximum 24-hour average PM_{10} concentrations predicted by the dispersion modelling at each of the nominated residences/properties using the emission rates calculated in **Section 5.5**. The calculated background PM_{10} concentrations have been discussed in detail in **Section 7**.

Table 58 Predicted Maximum 24-Hour Average PM_{10} Concentrations – Scenario 3a, Scenario 3b and Scenario 3c

Receptor ID	Increment	Increment	Scenario 3a (Exporting 6 Mtpa coal) (Current Infrastructure)		Scenario 3b (Exporting 6 Mtpa coal) (Automatic Coal Handling)		Scenario 3c (Exporting 6 Mtpa coal) (Automatic train loading)	
	Regional Background *Maximum predicted incremental result from background only*	**Power Stations** *Maximum predicted incremental result from power stations only*	**Increment** *Maximum predicted incremental result from current scenario only*	**Cumulative** *Maximum predicted concurrent and cumulative result from background, power stations and project*	**Increment** *Maximum predicted incremental result from current scenario only*	**Cumulative** *Maximum predicted concurrent and cumulative result from background, power stations and project*	**Increment** *Maximum predicted incremental result from current scenario only*	**Cumulative** *Maximum predicted concurrent and cumulative result from background, power stations and project*
	(µg/m^3)	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**	**(µg/m^3)**
NC1	32.8	1.0	20.4	40.2	16.7	36.2	16.7	36.0
NC2	32.8	1.0	31.5	49.5	31.5	49.2	31.5	48.8
NC3	32.8	1.0	26.0	39.4	19.6	35.1	14.7	35.0
NC4	32.8	1.0	16.9	33.9	15.2	33.5	8.1	33.5
NC5	32.8	1.0	31.0	45.1	21.7	39.0	15.8	34.3
NC6	32.8	1.0	56.9	72.0	44.9	60.0	23.8	41.6

Note: The cumulative results columns may not be equal to the sum of the incremental results columns. This is because the incremental results are the maximum 24-hour average predicted over the entire year modelled as a result of the emissions from each source, while the cumulative results are the maximum 24-hour average predicted as a result of the combined emissions from each source. If the maximum incremental 24-hour impacts from each source occur on different days at a given receptor (i.e. under different meteorological conditions), then the maximum cumulative prediction may be lower than the sum of the maximum predicted incremental impacts. For further information, refer to **Table 42.**
Project Criterion: 50 µg/m^3

It can be seen that when 8 Mtpa of coal is exported using the current infrastructure (Scenario 3a), exceedance of the 24-hour average PM_{10} criterion is predicted at receptor 'NC6'.

The predicted results for Scenario 3b represent automating the transfer of coal from the CPP to rail loop stockpile. It is noted from **Table 58** that automating the coal transfer from CPP to rail loop stockpile results in a decrease in the incremental concentrations of up to 21% ('NC6'). However the corresponding predicted cumulative concentration at 'NC6' decreases by just 16% only and is still predicted to exceed the 24-hour average PM_{10} criterion.

The predicted results for Scenario 3c represent automating the train loading operations. It is noted from **Table 58** that that this upgrade would result in a decrease in the incremental concentrations of up to 58% ('NC6') and the corresponding predicted cumulative concentration at 'NC6' decreases by approximately 42%.

Source Contribution Analysis – Scenario 3a (Receptor NC6)

As an exceedance of the 24-hour average criterion was predicted at receptor 'NC6' for Scenario 3a, it is considered appropriate to study the likely cause of exceedance at this receptor. A source contribution analysis is conducted for receptor 'NC6' and shown in **Table 59**.

Table 59 Source Contribution Analysis for Scenario 3a – Receptor 'NC6'

Emission Source	Contribution	Percentage
Cooranbong Entry Site - sources	0.4	0.4%
Newstan Fans	0.4	0.4%
ROM Coal stockpile	0.1	0.1%
Product stockpile (North)	0.7	0.7%
Product Stockpile (South)	0.4	0.4%
Train Wagon Surface	0.2	0.2%
Southern Reject Emplacement Area	9.6	9.4%
Northern Reject Emplacement Area	1.3	1.3%
Hawkmount Quarry	0.1	0.1%
Newstan Raw Coal Stockpile	0.1	0.1%
Reject from CPP loaded to bin	0.0	0.0%
Reject from CPP loaded to trucks	0.0	0.0%
Trucks dumping reject/stone material at SREA	0.0	0.0%
Dozer at SREA	0.6	0.6%
SREA Excavator #1	0.3	0.3%
SREA Excavator #2	0.3	0.3%
SREA Excavator #3	0.3	0.3%
Traxcavator	0.4	0.4%
Trucks dumping reject material at NREA	0.0	0.0%
Dozer at NREA	0.4	0.3%
Trucks dumping reject material at Hawkmount Quarry	0.0	0.0%
Dozer at Hawkmount Quarry	0.1	0.1%
Haul Roads (Newstan to Cooranbong to EPS)	15.6	15.2%
ROM Coal from dump hopper to stacker	0.0	0.0%
ROM Coal from Stacker to Stockpile	0.0	0.0%

Emission Source	Contribution	Percentage
Dozer on ROM Stockpile (push to reclaim stockpile)	1.2	1.2%
Conveyor to CPP Module 1	0.0	0.0%
Conveyor from Newstan drift to Newstan Coal ROM Stockpile	0.0	0.0%
Conveyor drop onto Newstan ROM stockpile	0.0	0.0%
Conveyor from Newstan Drift to CPP Module 2	0.0	0.0%
CPP Module 1 & CPP Module 2 & CHP-Crush/Screen/Wash	0.0	0.0%
Dozer at Product Stockpile (Rail Loop)	18.2	17.8%
FEL # 1 at Product Stockpile (Rail Loop) loading trains	9.6	9.4%
FEL # 2 at Product Stockpile (Rail Loop) loading trains	10.9	10.6%
FEL # 3 at Product Stockpile (Rail Loop) loading trains	9.7	9.4%
Trucks dumping coal to Rail loop stockpile	0.5	0.5%
Trucks dumping coal at Newstan ROM stockpile	0.1	0.1%
Haul road - rail loop stockpile	20.8	20.3%
TOTAL	**102.5**	**100.0%**

It is noted that the total 24-hour average PM_{10} concentrations in **Table 59** is not the same as reported in **Table 58** for receptor 'NC6' because the source contribution analysis assumes that each source is contributing at its peak, whereas in reality this might not be the case.

From the source contribution analysis, it can be seen that:

- the combined contribution of the dozer and FELs operating on rail loop stockpile is 47.2%; and
- the contribution of trucks transporting coal to and dumping coal at the rail loop stockpile is 20.8%.

Summary

Scenario 3a represents air quality impacts due to exportation of 8 Mtpa of coal from the Newstan Colliery Surface Site. Exceedance of the 24-hour average PM_{10} criterion is predicted at the receptor 'NC6'. A source contribution analysis was conducted and was shown that the combined coal handling using bulldozer and FELs during manual train loading at the rail loop stockpile was the largest contributor to PM_{10} concentrations.

Scenario 3b represents the air quality impacts resulting after automating the transfer of coal from the CPP to the rail loop stockpile. This automation of coal transfer provides a minor improvement in the predicted air quality impacts, however still results in exceedance of the 24-hour average PM_{10} criterion at NC6.

Scenario 3c represents the air quality impacts after automation of train loading operations. The automation of train loading operations provides a significant improvement in the predicted air quality impacts resulting in the air quality criteria being achieved at all sensitive receivers surrounding the Newstan Colliery Surface Site.

8.8.3 Scenario 4

Scenario 4 represents the exportation of 8 Mtpa of coal from the Newstan Colliery Surface Site and is designed to assess the benefits of installing a dump hopper in reducing air quality impacts from the operations at the Newstan Colliery Surface Site. As can be seen in Table 51, when compared to Scenario 3C, very little benefit is gained by the installation and operation of a dump hopper at the Newstan Colliery Surface Site with only up to a 0.4% reduction in the predicted air quality impacts being achieved at the nearest sensitive receptors.

8.8.4 Discussion/Analysis

A summary of the predicted incremental and cumulative 24-hour average PM_{10} concentrations for the seven scenarios is presented in **Figure 40** and **Figure 41** respectively.

Figure 40 Summary of Incremental 24-hour Average PM_{10} Concentrations – NC1 to NC6

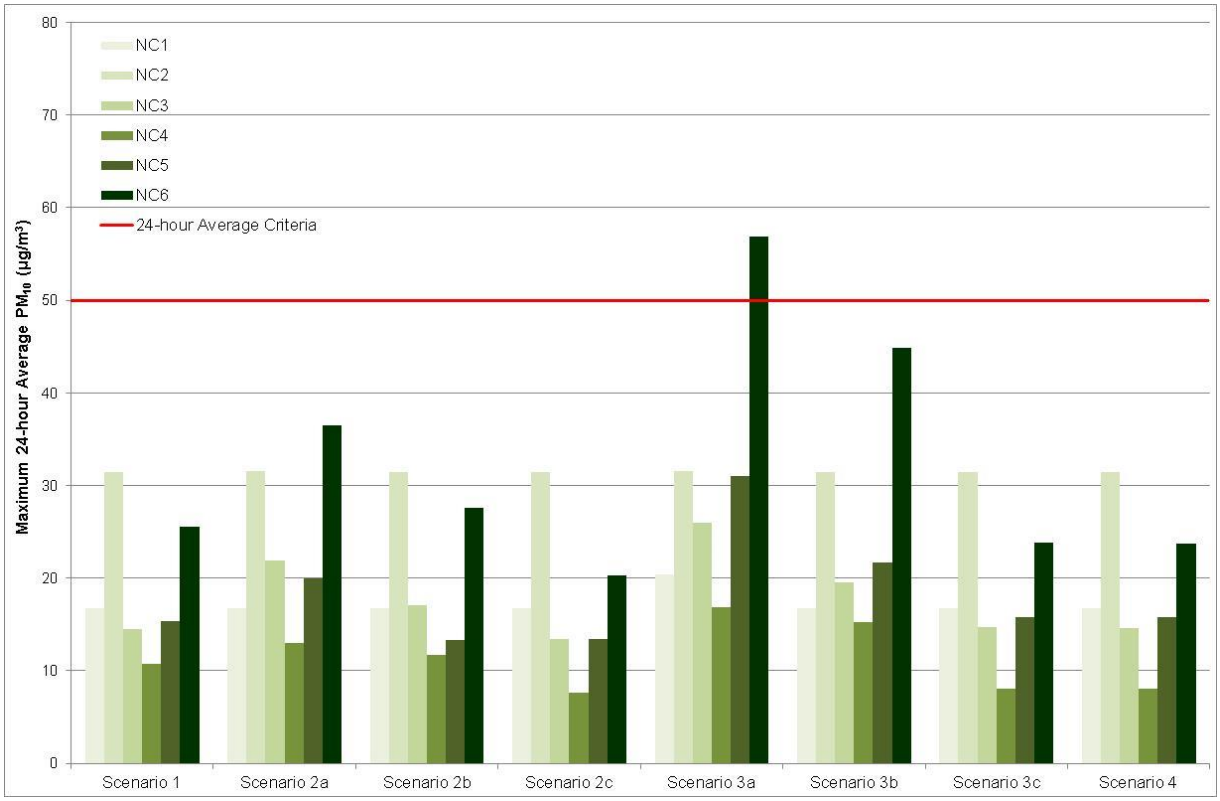
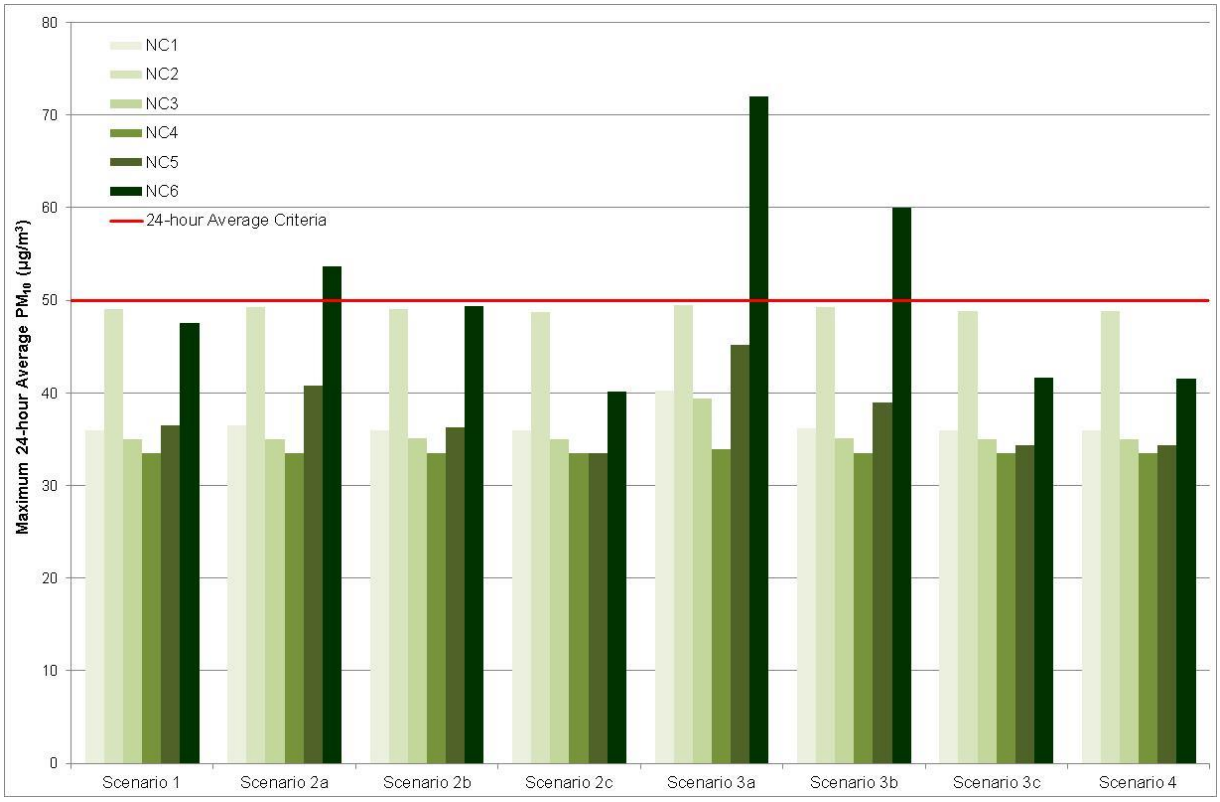


Figure 41 Summary of Cumulative 24-hour Average PM_{10} Concentrations - NC1 to NC6



The predicted results for Scenario 1, Scenario 2a and Scenario 3a represent the air quality impacts due to export of 4 Mtpa, 6 Mtpa and 8 Mtpa using the existing coal handling methods at the Newstan Colliery Surface Site. It can be seen from **Figure 41** that using the existing coal handling systems, export of 6 Mtpa and 8 Mtpa will result in exceedance of the 24-hour average PM_{10} criterion at receptor 'NC6'.

The automation of coal transfers between the CPP and the rail loop stockpile decreases the cumulative 24-hour average PM_{10} concentrations to below the relevant criterion for Scenario 2b however still results in exceedances when throughput increases to 8 Mtpa (Scenario 3b).

The predicted results for Scenario 2c, and Scenario 3c represent the air quality impacts due to export of 6 Mtpa and 8 Mtpa using the automation of train loading operations. It can be seen from **Figure 41** that automating train loading operations result in the decrease of cumulative 24-hour average PM_{10} concentrations at receptor 'NC6' and it is predicted to be below the relevant criterion for both scenarios 2c and 3c.

As discussed in the previous section, it is predicted that the export of 6 Mtpa coal can be achieved with automation of coal transfers between the CPP and rail loop stockpile, however to export 8 Mtpa of coal, automation of train loading operations would be required.

It can be seen from the analysis, that the handling of ROM coal is predicted to contribute only a small percentage to the overall predicted concentrations. As such, the installation of a ROM coal dump hopper may be installed to improve the operational efficiency at the Newstan Colliery Surface Site however is not required to achieve air quality criteria.

In order to achieve the air quality criteria at the Newstan Colliery Surface Site for the life of the Project, it is recommended that:

- Train loading operations are automated once it is proposed to export 6 Mtpa from the Newstan Colliery Surface Site; and
- Coal transfers between the CPP and the rail loop stockpile are automated once it is proposed to export 6 Mtpa AND train loading operations are automated once it is proposed to export 8 Mtpa from the Newstan Colliery Surface Site.

8.9 Dust Management and Mitigation

8.9.1 Construction

The following procedures and requirements should be followed during the life of the Project to minimise the impact of dust generated in association with the proposed Project:

- Watering of roads and sealing of roads where possible;
- Trucks entering and leaving the site should be well maintained in accordance with the manufacturer's specification to comply with all relevant regulations. Truck movement should be controlled on site and restricted to designated roadways. All loaded trucks should be covered to minimise transport of dust offsite; and,
- If necessary, modifying construction activities during periods of high wind.

The following are general, basic procedures which are designed to control dust and other emissions from construction operations and on-site equipment. The aim of these procedures is to minimise off-site dust nuisance and air quality impacts. Consideration should be given to adopt measures appropriate to the proposed project.

- Activities carried out on site should be such as to ensure that all equipment used and all facilities erected are designed and operated to control the emission of smoke, dust, fume and other objectionable matter into the atmosphere.
- Precautions to be taken include spraying of earthworks, roads and other surfaces as necessary with water or other suitable liquids, providing dust suppression equipment to any onsite materials batching plant and the modification of operations during high or unfavourable wind conditions.
- Working areas and access roads should be stabilised as soon as practicable to prevent or minimise windblown dust.
- All disturbed areas should be stabilised as soon as practicable to prevent or minimise windblown dust.
- All unsealed trafficable areas be kept sufficiently damp during working hours to minimise windblown or traffic generated dust emissions. Continued use of water on dirt roads helps the formation of a crust so that dust is not as easily generated.
- Water sprays, sprinklers and water carts are to be employed if needed to adequately dampen stockpiles, work areas and exposed soils to prevent the emissions of dust from the site. Water carts and other equipment are to be available to enable watering at least at an hourly rate of 2 litres per square metre.
- Stockpiles and handling areas should be maintained in a condition which minimises windblown or traffic generated dust. Areas that may be inaccessible by water carts should be kept in a condition which minimises windblown or traffic generated dust using other means.
- All equipment for dust control will be kept in good operating condition. The equipment will be operable at all times with the exception of shutdowns required for maintenance. Construction equipment will be properly maintained to ensure exhaust emissions comply with relevant regulatory requirements.
- Cleared vegetation, demolition materials and other combustible waste material should not be burnt on site.
- Silt should be removed from behind filter fences and other erosion control structures on a regular basis, so that collected silt does not become a source of dust.
- Any dust, soil or mud deposited on public roads by sub-contractors construction activities and vehicle movements should be removed as soon as practicable.

8.9.2 Operation

In order to achieve the air quality criteria at the sensitive receptors surrounding Newstan Colliery Surface Site for the life of the Project, it is recommended that:

- Train loading operations are automated once it is proposed to export 6 Mtpa from the Newstan Colliery Surface Site; and
- Coal transfers between the CPP and the rail loop stockpile are automated once it is proposed to export 6 Mtpa AND train loading operations are automated once it is proposed to export 8 Mtpa from the Newstan Colliery Surface Site.

Continue to utilise E5 European standard engines for coal haulage trucks that operate on the private haul roads linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and the Eraring Power Station.

Following Project approval, air quality management plans for the Newstan Colliery Surface Site, Cooranbong Entry Site and private haul roads are to be updated to reflect the upgraded operations.

8.9.3 Air Quality Monitoring

Dust deposition monitoring is performed around the Newstan Colliery Surface Site and Cooranbong Entry Site, as discussed in **Section 7.1** and **Section 7.2**.

Dust deposition, TSP, PM_{10} and $PM_{2.5}$ monitoring is performed around the Newstan Colliery Surface Site, and PM_{10} monitoring (in additional to dust deposition monitoring) has recently commenced around the Cooranbong Entry Site as discussed in **Section 7.1**. The monitoring program currently in operation at Newstan Colliery Surface Site and Cooranbong Entry Site are to continue for the Project following development consent.

It is considered that real time monitoring by TEOM at Newstan Colliery Surface Site represents best practice management and it will be continued as part of the Project.

9 CONCLUSION

SLR Consulting was commissioned by Northern Coal Services to conduct an Air Quality Impact Assessment for the Northern Coal Logistics Project located between Fassifern and Dora Creek on the western side of Lake Macquarie, New South Wales.

The Northern Coal Logistics Project comprises of the operations at Newstan Colliery Surface Site, Hawkmount Quarry, Cooranbong Entry Site and the private haul roads. As part of the Project, various upgrades have been proposed to the operations at the Newstan Colliery Surface Site. The aim of this AQIA was to assess the air quality impacts on surrounding sensitive receivers associated with the Project.

Dispersion modelling was conducted for the identified sources at contributing operations for particulates (TSP, PM_{10} and $PM_{2.5}$) and odour for ten scenarios:

- eight scenarios associated with the operations at the Newstan Colliery Surface Site; and
- two scenarios associated with the operations at the Cooranbong Entry Site.

In order to assess the background air quality of the region a number of industrial facilities with the potential to have a cumulative impact on the local airshed were identified. A dispersion modelling exercise was performed to determine suitable background levels of pollutants in order to assess the cumulative impacts.

The dispersion modelling exercise for the Project indicates that:

- The annual average deposited dust concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The annual average TSP concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The annual average PM_{10} concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The annual average $PM_{2.5}$ concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.
- The 24-hour average PM_{10} concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for the Cooranbong Entry Site. The 24-hour average PM_{10} concentrations were likely to exceed the relevant criterion for three scenarios at the receptor 'NC6' surrounding the Newstan Colliery Surface Site. To achieve the relevant PM_{10} criterion at all of the identified sensitive receptors surrounding the Newstan Colliery Surface Site, it was recommended that:
    - Train loading operations are automated prior to the export of greater than 6 Mtpa from the Newstan Colliery Surface Site; or
    - The automation of coal transfers between the CPP and the rail loop stockpile is implemented prior to the export of greater than 6 Mtpa and train loading operations are automated prior to the export of greater than 8 Mtpa from the Newstan Colliery Surface Site.
- The 24-hour average $PM_{2.5}$ concentrations were unlikely to exceed the relevant criterion at any of the identified sensitive receptors for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.

- The 99th percentile odour concentrations were predicted to be below the relevant criterion at all the identified sensitive receptors during Project operations for all modelled scenarios for both the Newstan Colliery Surface Site and the Cooranbong Entry Site.

10 REFERENCES

- Centennial 2012, Northern Coal Services – Northern Coal Logistics Project, Project Description (for specialist consultants), Centennial Coal, October 2012.
- DSEWPC, 2012, National Pollutant Inventory Emission Estimation Technique Manual for Mining version 3.1 published by the Department of Sustainability, Environment, Water, Population and Communities. January 2012.
- DECC 2009, NSW Annual Compliance Report 2009, National Environment Protection (Ambient Air Quality) Measure (NEPM), Department of Environment, Climate Change and Water 30 November 2010.
- Fernandez et al 2007, Sensitivity of the MM5 mesoscale model to physical parameterizations for regional climate studies: Annual Cycle, published 16 February 2007, Journal of Geophysical Research, Volume 112, D04101.
- MRI 2006, *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors*, prepared by: Midwest Research Institute, prepared for: Western Governors Association – Western Regional Air Partnership (WRAP), MRI Project number 110397, dated: 1 November 2006.
- NSW DEC 2005, NSW Department of Environment and Conservation, "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", 26 August 2005.
- SLR 2011a, Air Quality Assessment, Teralba Quarry Extensions, Specialist Consultant Studies Compendium Volume 2, Part 7, prepared by SLR Consulting Pty Ltd, November 2011.
- SLR 2011b, Awaba Underground Coal Mine – Part 3A Application – Air Quality Impact Assessment, Report number 30-2497-R1, prepared by SLR Consulting, 7 May 2010.
- SLR 2011c, Mandalong Mine – Cooranbong Entry Site – Air Quality Impact Assessment and Greenhouse Gas Assessment, report number 670.10120-R2, 16 November 2011.
- SLR 2012a, Mandalong Mine – Cooranbong Entry Site – Air Quality Impact Assessment and Greenhouse Gas Assessment, report number 670.10120-R2, dated 30 April 2012.
- SLR 2012b, Odour Monitoring – Ventilation Shaft Mandalong Mine, report number 610.11503-R1, 9 August 2012.
- SLR 2012c, Test Report 610.11731 – Particulate Testing, 22 August 2012.
- SLR 2013, Mandalong Southern Extension Project – Air Quality Impact Assessment, Report number 630.10123-R1, dated: 1 March 2013.
- Umwelt 2010, Environmental Assessment - West Wallsend Colliery Continued Operations Project, prepared by Umwelt (Australia) Pty Ltd on behalf of Oceanic Coal Australia Limited, May 2010.
- USEPA 2006, Compilation of Air Pollutant Emission Factors AP-42 - Chapter 13.2.4 Aggregate Handling and Storage Piles, United States Environmental Protection Authority, 11/2006.
- USEPA 2011, Compilation of Air Pollutant Emission Factors AP-42 - Chapter 13.2.1 Paved Roads, United States Environmental Protection Authority, 01/2011.

SCENARIO 1														
						Uncontrolled Emissions					Controlled Emissions			
Site	Activity	Annual	Units	Notes	EF	TSP	PM_{10}	$PM_{2.5}$	Controls		TSP	PM_{10}	$PM_{2.5}$
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer at Product Stockpile (Rail Loop)	2,920	hrs	None	NPI Dozer on Coal	53,153	16,178	1,618	None	0	53,153	16,178	1,618
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	1,333,333	tpa	None	NPI FEL on Coal	68,912	9,721	972	None	0	68,912	9,721	972
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	1,333,333	tpa	None	NPI FEL on Coal	68,912	9,721	972	None	0	68,912	9,721	972
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	1,333,333	tpa	None	NPI FEL on Coal	68,912	9,721	972	None	0	68,912	9,721	972
NS	Trucks dumping coal to Rail loop stockpile	4,000,000	tpa	None	AP42 Batch drop	833	394	60	None	0	833	394	60
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Misc Tran Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884
NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402
NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491

SCENARIO 2a														
						Uncontrolled Emissions					Controlled Emissions			
Site	Activity	Annual	Units	Notes	EF	TSP	PM_{10}	$PM_{2.5}$	Controls		TSP	PM_{10}	$PM_{2.5}$
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer at Product Stockpile (Rail Loop)	4,380	hrs	None	NPI Dozer on Coal	79,730	24,267	2,427	None	0	79,730	24,267	2,427
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,000,000	tpa	None	NPI FEL on Coal	103,368	14,581	1,458	None	0	103,368	14,581	1,458
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,000,000	tpa	None	NPI FEL on Coal	103,368	14,581	1,458	None	0	103,368	14,581	1,458
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,000,000	tpa	None	NPI FEL on Coal	103,368	14,581	1,458	None	0	103,368	14,581	1,458
NS	Trucks dumping coal to Rail loop stockpile	4,000,000	tpa	None	AP42 Batch drop	833	394	60	None	0	833	394	60
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884
NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402
NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491

SCENARIO 2b														
						Uncontrolled Emissions					Controlled Emissions			
Site	Activity	Annual	Units	Notes	EF	TSP	PM_{10}	$PM_{2.5}$	Controls		TSP	PM_{10}	$PM_{2.5}$
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer at Product Stockpile (Rail Loop)	4,380	hrs	None	NPI Dozer on Coal	79,730	24,267	2,427	None	0	79,730	24,267	2,427
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,000,000	tpa	None	NPI FEL on Coal	103,368	14,581	1,458	None	0	103,368	14,581	1,458
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,000,000	tpa	None	NPI FEL on Coal	103,368	14,581	1,458	None	0	103,368	14,581	1,458
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,000,000	tpa	None	NPI FEL on Coal	103,368	14,581	1,458	None	0	103,368	14,581	1,458
NS	Conveyor to Product Stockpile via Skyline Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor drop onto Product Stockpile	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Water Sprays on Skyline Stacker (50%)	50	625	296	30
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884
NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402

NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491
SCENARIO 2c													
						Uncontrolled Emissions					**Controlled Emissions**		
Site	**Activity**	**Annual**	**Units**	**Notes**	**EF**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Controls**		**TSP**	**PM_{10}**	**$PM_{2.5}$**
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer on Product Stockpile	4,380	hrs	None	NPI Dozer on Coal	79,730	24,267	2,427	None	0	79,730	24,267	2,427
NS	Conveyor to Train Loading Bin	6,000,000	tpa	None	NPI FEL on Coal	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Loading Train Loading Bin	6,000,000	tpa	None	NPI FEL on Coal	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Loading Trains	6,000,000	tpa	None	NPI FEL on Coal	2,400	1,020	102	Enclosure on Loading trains (70%)	70	720	306	31
NS	Trucks dumping coal to Rail loop stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884
NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402

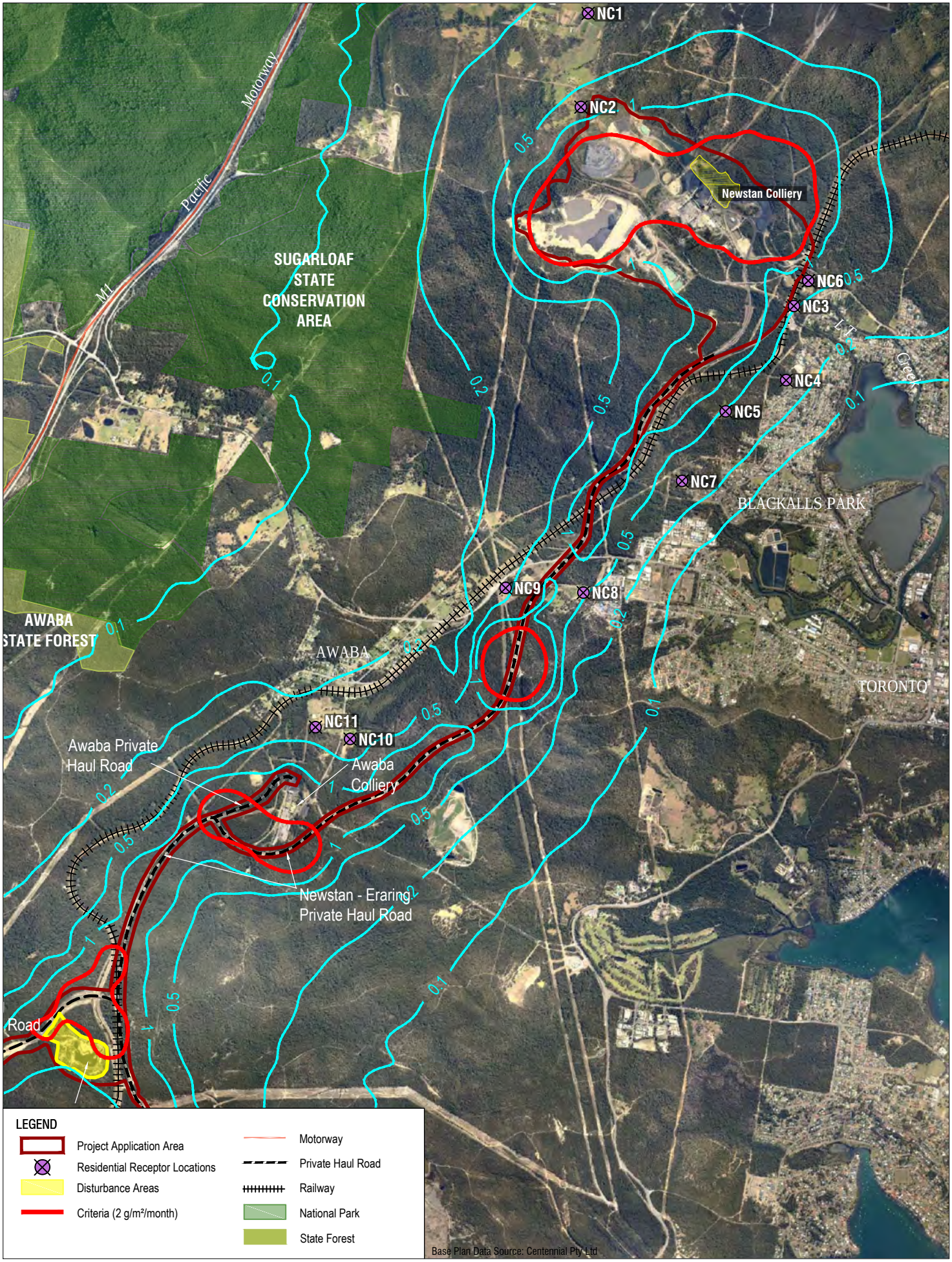
NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491
SCENARIO 3a													
						Uncontrolled Emissions					**Controlled Emissions**		
Site	**Activity**	**Annual**	**Units**	**Notes**	**EF**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Controls**		**TSP**	**PM_{10}**	**$PM_{2.5}$**
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer at Product Stockpile (Rail Loop)	5,840	hrs	None	NPI Dozer on Coal	106,306	32,356	3,236	None	0	106,306	32,356	3,236
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,666,667	tpa	None	NPI FEL on Coal	137,823	19,441	1,944	None	0	137,823	19,441	1,944
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,666,667	tpa	None	NPI FEL on Coal	137,823	19,441	1,944	None	0	137,823	19,441	1,944
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,666,667	tpa	None	NPI FEL on Coal	137,823	19,441	1,944	None	0	137,823	19,441	1,944
NS	Trucks dumping coal to Rail loop stockpile	8,000,000	tpa	None	AP42 Batch drop	1,667	788	119	None	0	1,667	788	119
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884
NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402

NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491
SCENARIO 3b													
						Uncontrolled Emissions					**Controlled Emissions**		
Site	**Activity**	**Annual**	**Units**	**Notes**	**EF**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Controls**		**TSP**	**PM_{10}**	**$PM_{2.5}$**
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer at Product Stockpile (Rail Loop)	5,840	hrs	None	NPI Dozer on Coal	106,306	32,356	3,236	None	0	106,306	32,356	3,236
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,666,667	tpa	None	NPI FEL on Coal	137,823	19,441	1,944	None	0	137,823	19,441	1,944
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,666,667	tpa	None	NPI FEL on Coal	137,823	19,441	1,944	None	0	137,823	19,441	1,944
NS	Front End Loader at Product Stockpile (Rail Loop) loading trains	2,666,667	tpa	None	NPI FEL on Coal	137,823	19,441	1,944	None	0	137,823	19,441	1,944
NS	Conveyor to Product Stockpile via Skyline Stacker	8,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,667	788	79	Enclosed conveyor (70%)	70	500	237	24
NS	Conveyor drop onto Product Stockpile	8,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,667	788	79	Water Sprays on Skyline Stacker (50%)	50	833	394	39
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884

NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402
NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491
SCENARIO 3c													
						Uncontrolled Emissions					**Controlled Emissions**		
Site	**Activity**	**Annual**	**Units**	**Notes**	**EF**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Controls**		**TSP**	**PM_{10}**	**$PM_{2.5}$**
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan ROM stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Dozer on Product Stockpile	4,380	hrs	None	NPI Dozer on Coal	79,730	24,267	2,427	None	0	79,730	24,267	2,427
NS	Conveyor to Train Loading Bin	8,000,000	tpa	None	NPI FEL on Coal	1,667	788	79	Enclosed conveyor (70%)	70	500	237	24
NS	Loading Train Loading Bin	8,000,000	tpa	None	NPI FEL on Coal	1,667	788	79	Enclosed conveyor (70%)	70	500	237	24
NS	Loading Trains	8,000,000	tpa	None	NPI FEL on Coal	3,200	1,360	136	Enclosure on Loading trains (70%)	70	960	408	41
NS	Trucks dumping coal to Rail loop stockpile	8,000,000	tpa	None	AP42 Batch drop	1,667	788	119	None	0	1,667	788	119
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884

NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402
NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491
SCENARIO 4													
						Uncontrolled Emissions					**Controlled Emissions**		
Site	**Activity**	**Annual**	**Units**	**Notes**	**EF**	**TSP**	**PM_{10}**	**$PM_{2.5}$**	**Controls**		**TSP**	**PM_{10}**	**$PM_{2.5}$**
NS	Trucks transporting coal and/or reject material from Cooranbong to Mandalong Coal ROM Stockpile	4,793,472	VKT	15km, 16 trucks/hr (max), 8760hrs/yr (24hrs/day) 1 loop (1 loop is from Newstan to Eraring, From Eraring to Cooranbong, Cooranbong to Newstan).	AP42 WGD	525,920	100,951	24,424	USEPA Paved road emission factor used	0	525,920	100,951	24,424
NS	ROM Coal from Dump Hopper to Stacker	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	ROM Coal from Stacker to Stockpile	600,000	tpa	None	NPI Miscellaneous Transfer Point	125	59	6	Water Sprays on skyline stacker (50%)	50	63	30	3
NS	Dozer on ROM Stockpile (push to reclaim tunnel)	876	hrs	10% of time, Only 2 dozers on whole site so assumed 1 on ROM	NPI Dozer on Coal	15,946	4,853	485	None	0	15,946	4,853	485
NS	Conveyor to CPP Module 1	6,000,000	tpa	None	NPI Miscellaneous Transfer Point	1,250	591	59	Enclosed conveyor (70%)	70	375	177	18
NS	Conveyor from Newstan Drift to Newstan Coal ROM Stockpile	450,000	tpa	10% of coal to Stockpile	NPI Miscellaneous Transfer Point	94	44	4	Enclosed conveyor (70%)	70	28	13	1
NS	Conveyor drop onto Newstan ROM Stockpile	450,000	tpa	None	NPI Miscellaneous Transfer Point	94	44	4	Water Sprays on skyline Stacker (50%)	50	47	22	2
NS	Conveyor from Newstan Drift to CPP Module 2	4,050,000	tpa	90% of coal direct to CPP	NPI Miscellaneous Transfer Point	844	399	40	Enclosed conveyor (70%)	70	253	120	12
NS	CPP Module 1 & CPP Module 2 & CHP- Crush/Screen/Wash	8,000,000	tpa	Maximum of 8Mtpa through CPP	NPI Prim Crush, NPI Screen	720,000	512,000	51,200	Enclosed (100%)	100	0	0	0
NS	Trucks dumping coal at Newstan Dump Hopper	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	375	177	27
NS	Dozer on Product Stockpile	4,380	hrs	None	NPI Dozer on Coal	79,730	24,267	2,427	None	0	79,730	24,267	2,427
NS	Conveyor to Train Loading Bin	6,000,000	tpa	None	NPI FEL on Coal	1,250	591	59	None	0	375	177	18
NS	Loading Train Loading Bin	6,000,000	tpa	None	NPI FEL on Coal	1,250	591	59	None	0	375	177	18
NS	Loading Trains	6,000,000	tpa	None	NPI FEL on Coal	2,400	1,020	102	None	0	720	306	31
NS	Trucks dumping coal to Rail loop stockpile	6,000,000	tpa	None	AP42 Batch drop	1,250	591	90	None	0	1,250	591	90
NS	Reject from CPP loaded to bin	1,073,100	tpa	Assumed 6 truck load per hour 35t truck payload and 14hrs/day operation	NPI Miscellaneous Transfer Point	149	71	11	Enclosed conveyor (70%)		45	21	3
NS	Reject from CPP loaded to trucks	1,000,000	tpa	None	AP42 Batch drop	149	71	11	None	0	149	71	11
NS - SREA	Trucks dumping reject/stone material at SREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	7	1
NS - SREA	Dozer at SREA	1022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Excavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NS - SREA	Traxcavator	1,000,000	tpa	Operating hours are from 6am to 5pm Monday to Friday 10 hrs per day on overburden - 2600 hrs	NPI Excavator on Coal	36,596	5,627	563	Water Sprays (50%)	50	18,298	2,814	281
NREA	Trucks dumping reject material at NREA	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
NREA	Dozer at NREA	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
HQ	Trucks dumping reject material at HQ	1,000,000	tpa	None	AP42 Batch drop	139	66	10	None	0	139	66	10
HQ	Dozer at HQ	1,022	hrs	20% of time	NPI Dozer on Coal	12,436	3,785	379	None	0	12,436	3,785	379
NS	ROM Coal Stockpile	0.8	ha	None	NPI Wind Erosion	2,803	1,402	140	Water Sprays (50%)	50	1,402	701	70
NS	Product Stockpile (North)	2.2	ha	None	NPI Wind Erosion	7,709	3,854	385	Water Sprays (50%)	50	3,854	1,927	193
NS	Product Stockpile (South)	2.4	ha	None	NPI Wind Erosion	8,410	4,205	420	Water Sprays (50%)	50	4,205	2,102	210
NS	Train Wagon Surface	0.4	ha	None	NPI Wind Erosion	1,346	673	67	None	0	1,346	673	67
NS - SREA	Southern Reject Emplacement Area	45	ha	Total area 57 ha, but 45 ha as active area	NPI Wind Erosion	157,680	78,840	7,884	None	0	157,680	78,840	7,884

NS - NREA	Northern Reject Emplacement Area	8	ha	Total area 37 ha, but 8 ha as active area	NPI Wind Erosion	28,032	14,016	1,402	None	0	28,032	14,016	1,402
NS - HMQ	Hawkmount Quarry	2.8	ha	None	NPI Wind Erosion	9,811	4,906	491	None	0	9,811	4,906	491



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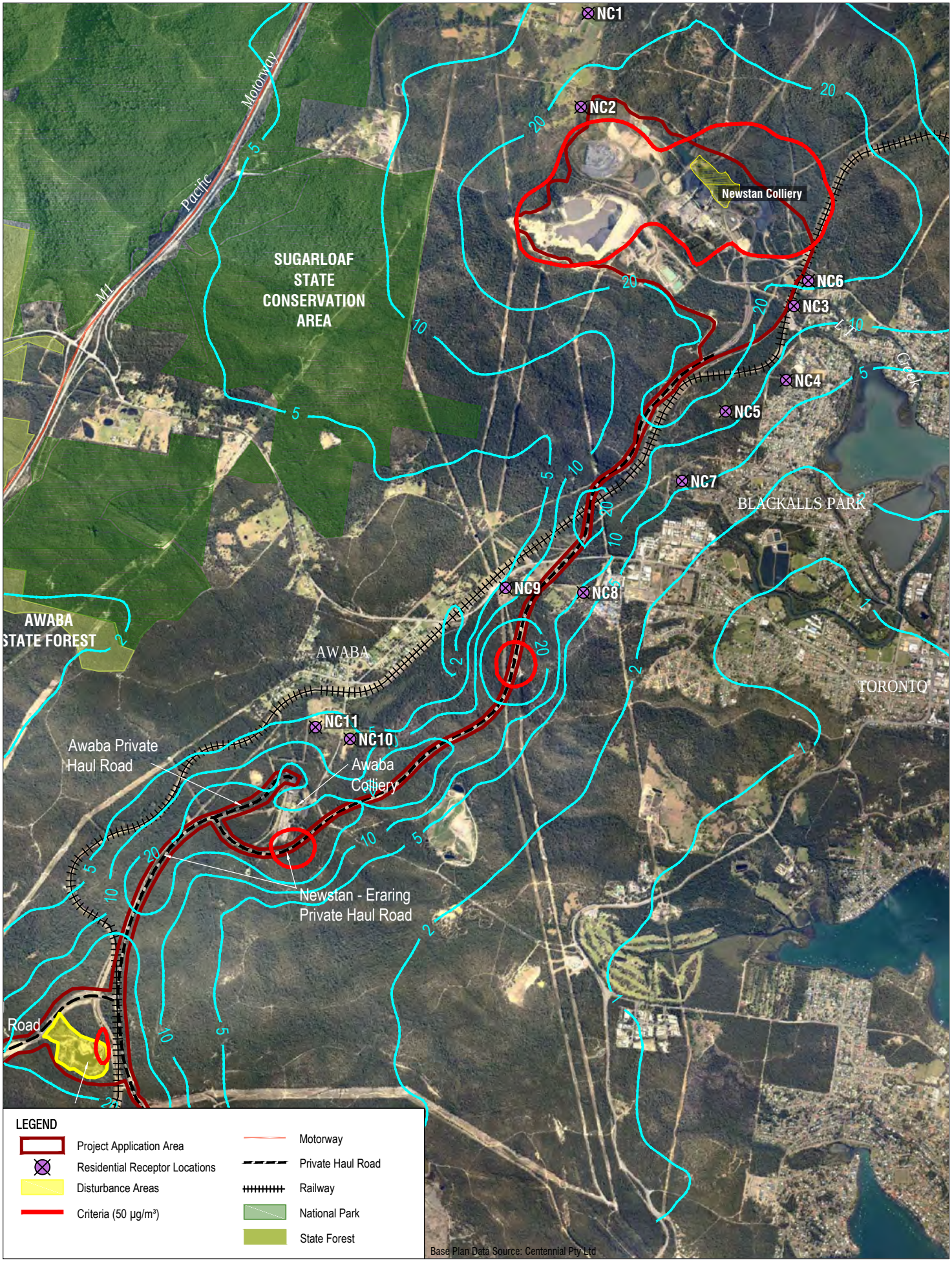
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 1
Increment Only

APPENDIX B



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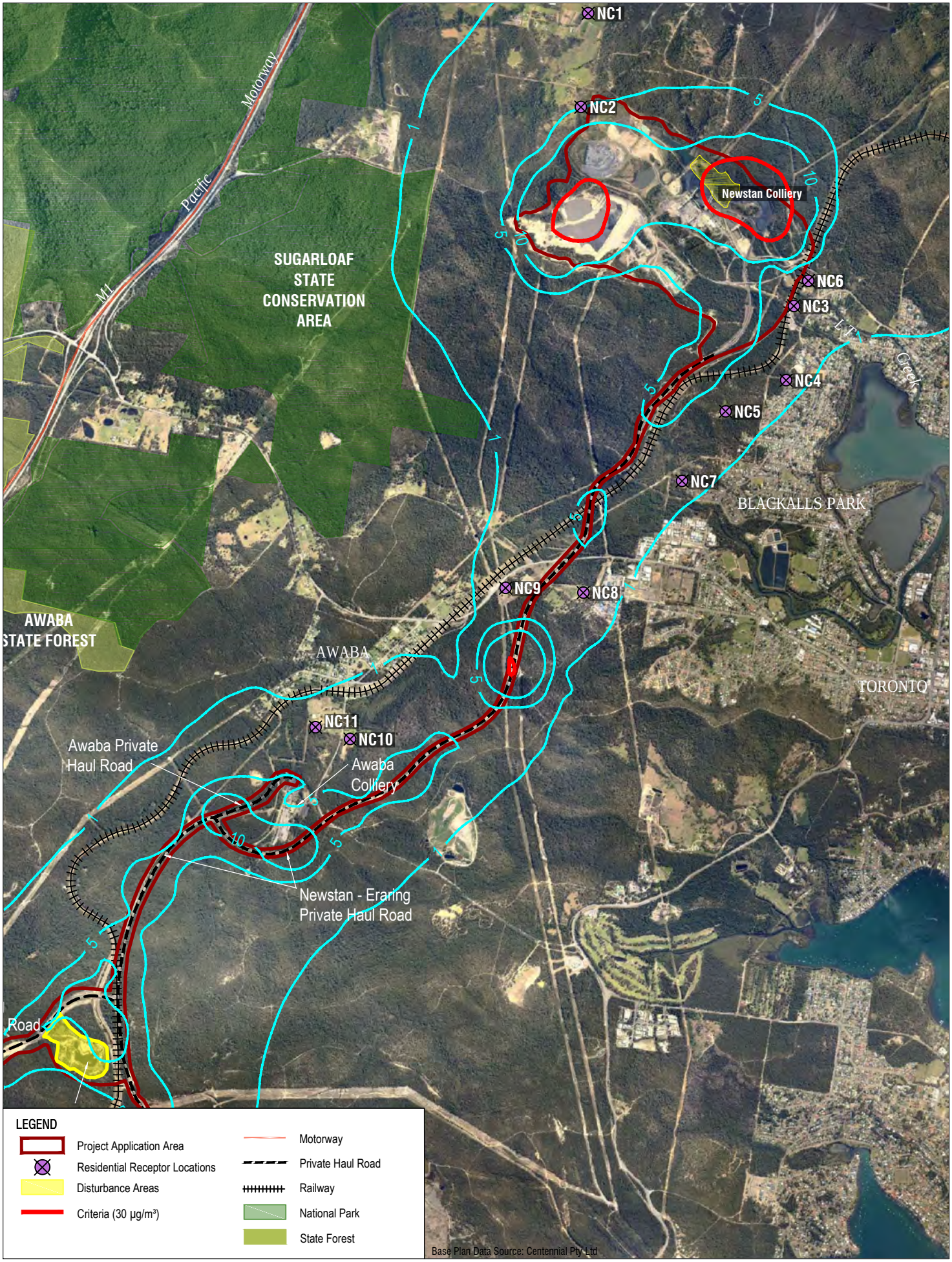
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 1
Increment Only

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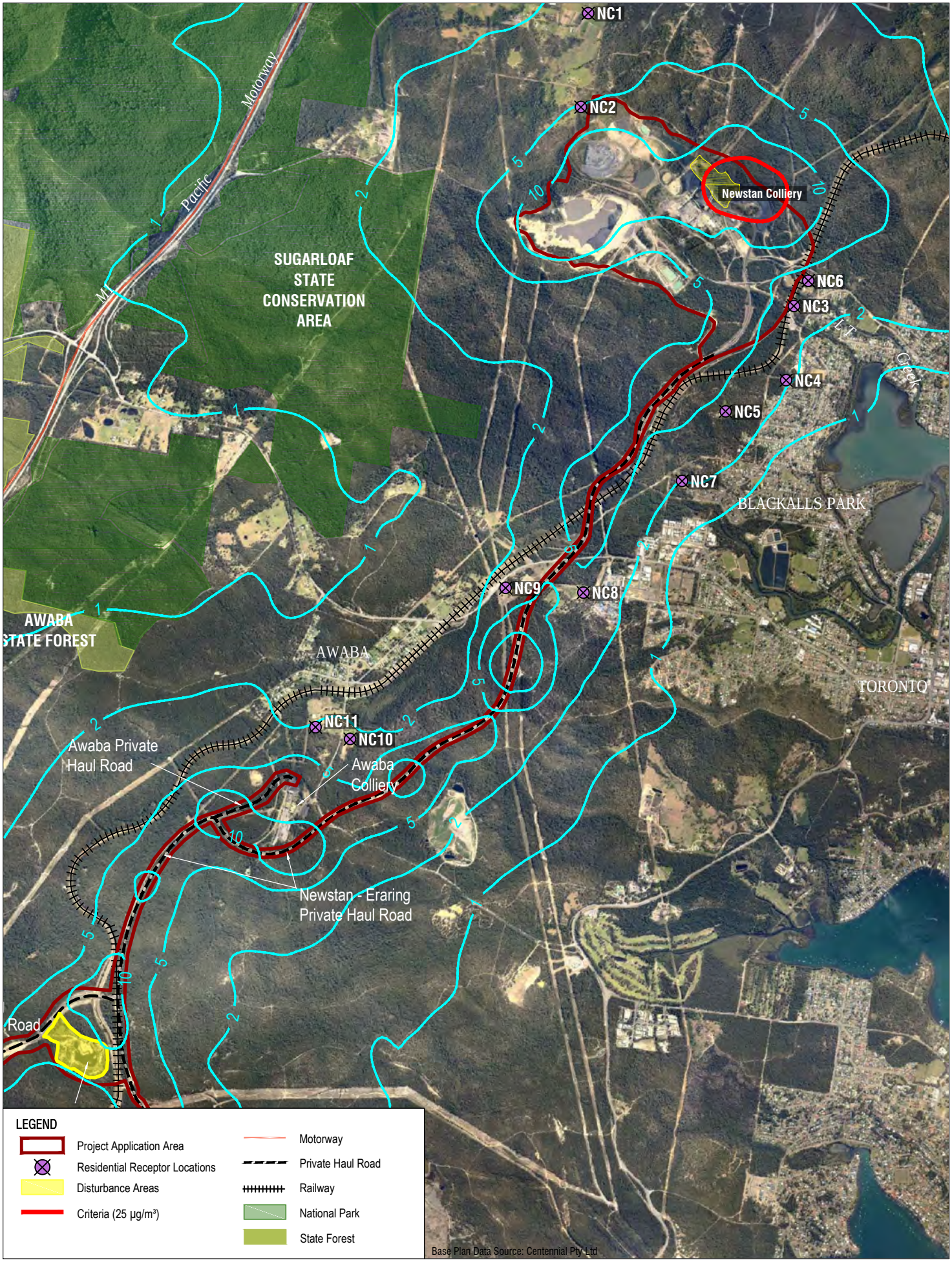
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 1
Increment Only

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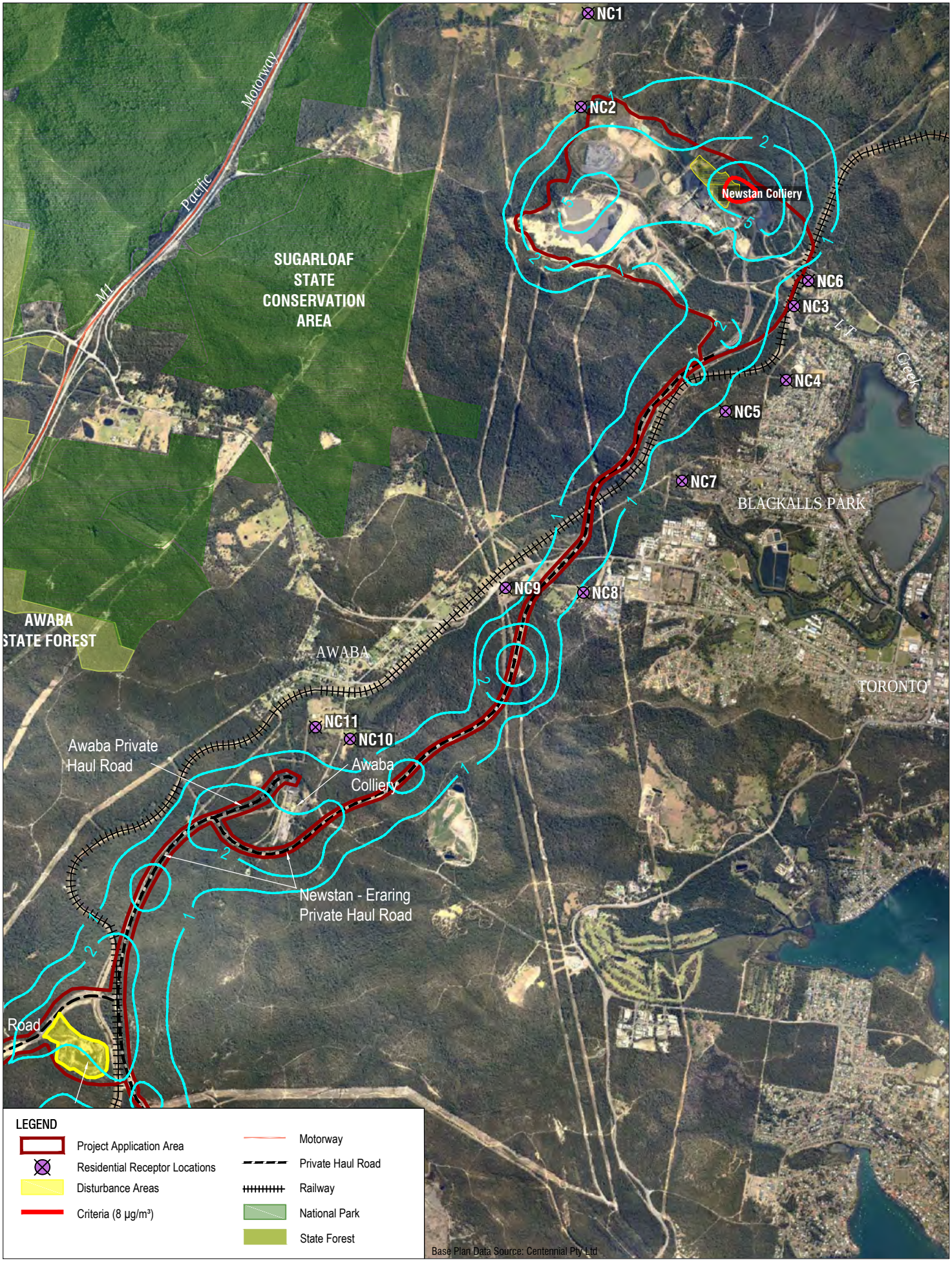
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 1
Increment Only

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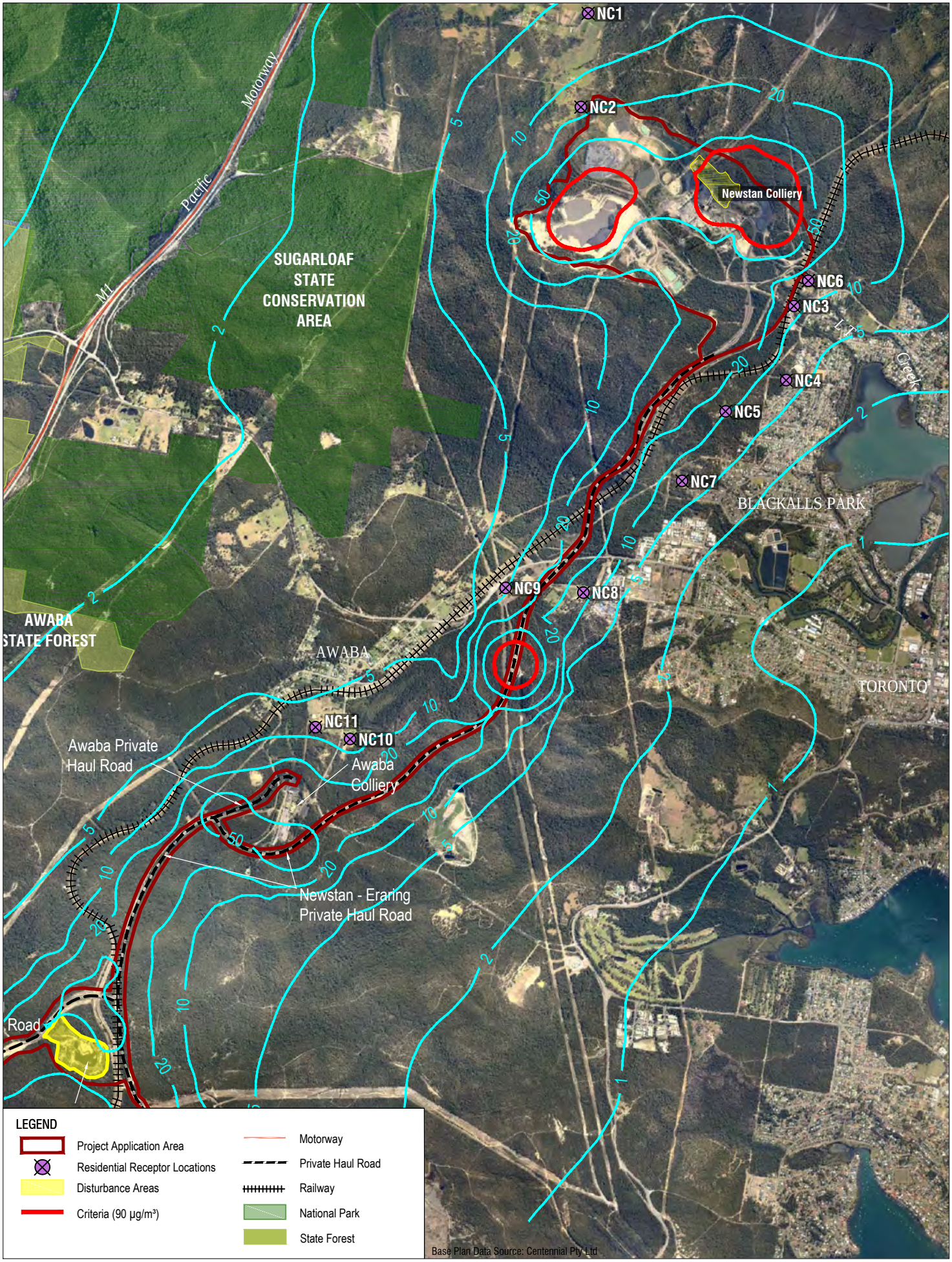
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 1
Increment Only

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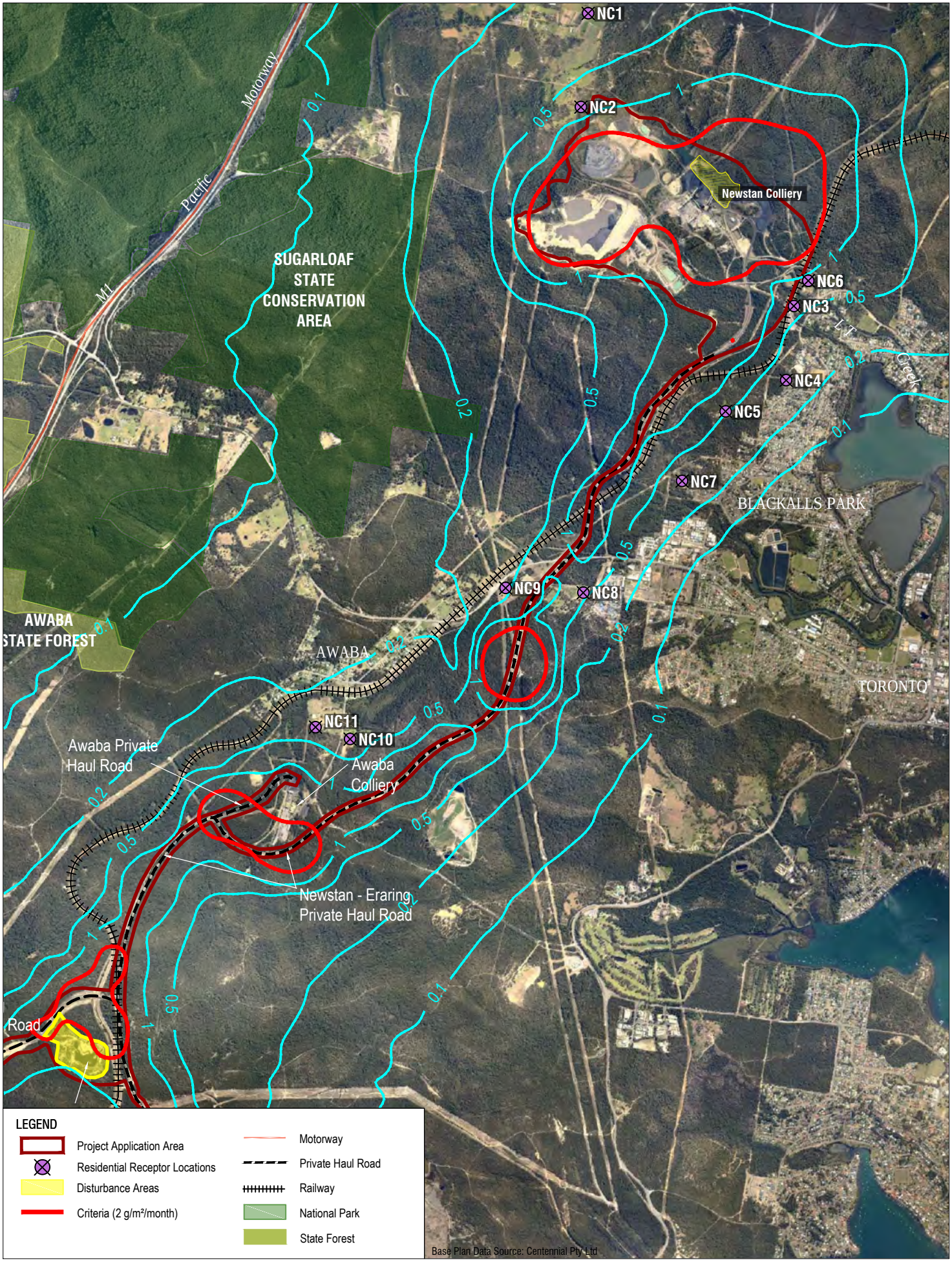
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 1
Increment Only

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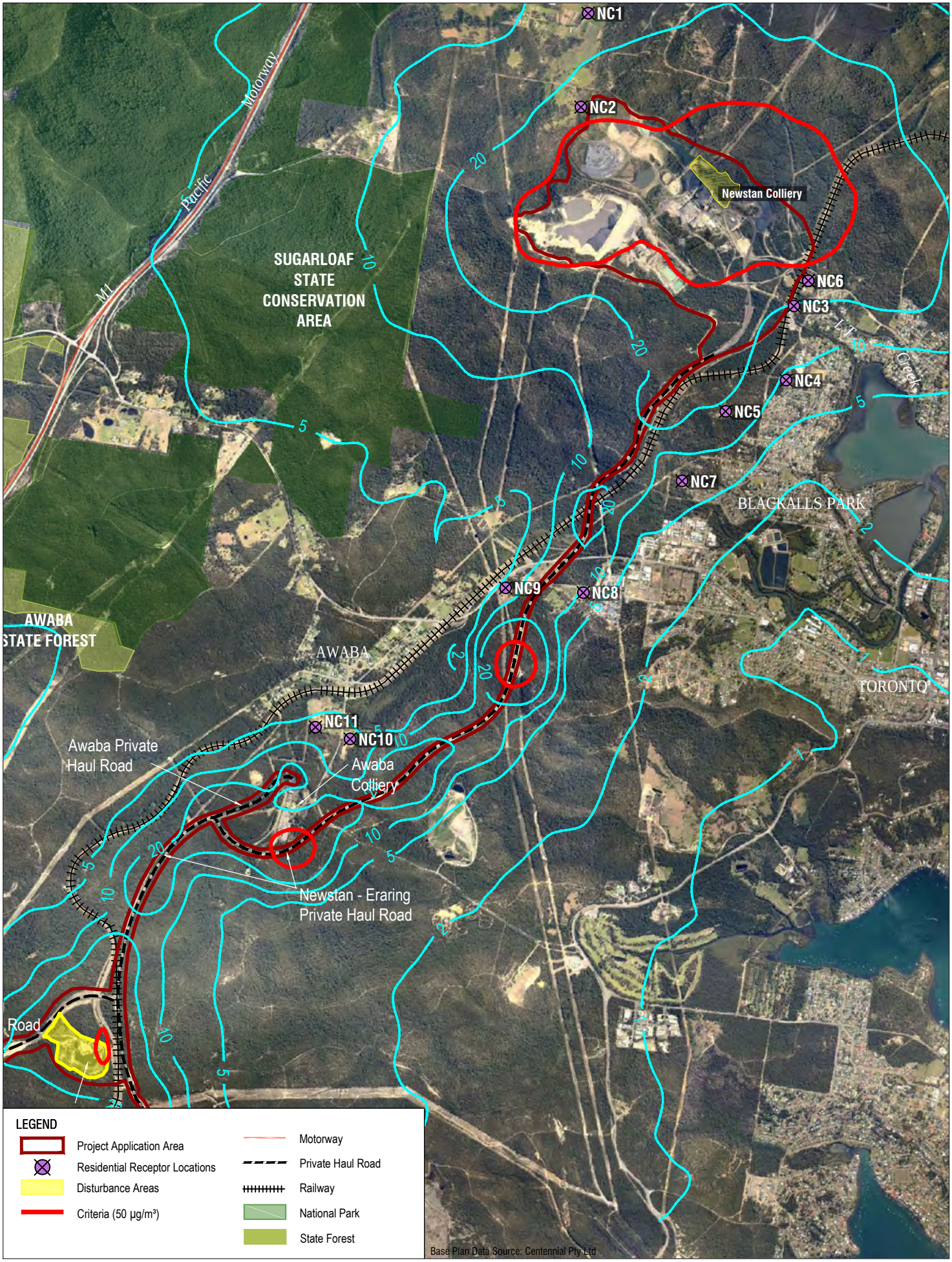
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 2a
Increment Only

APPENDIX B



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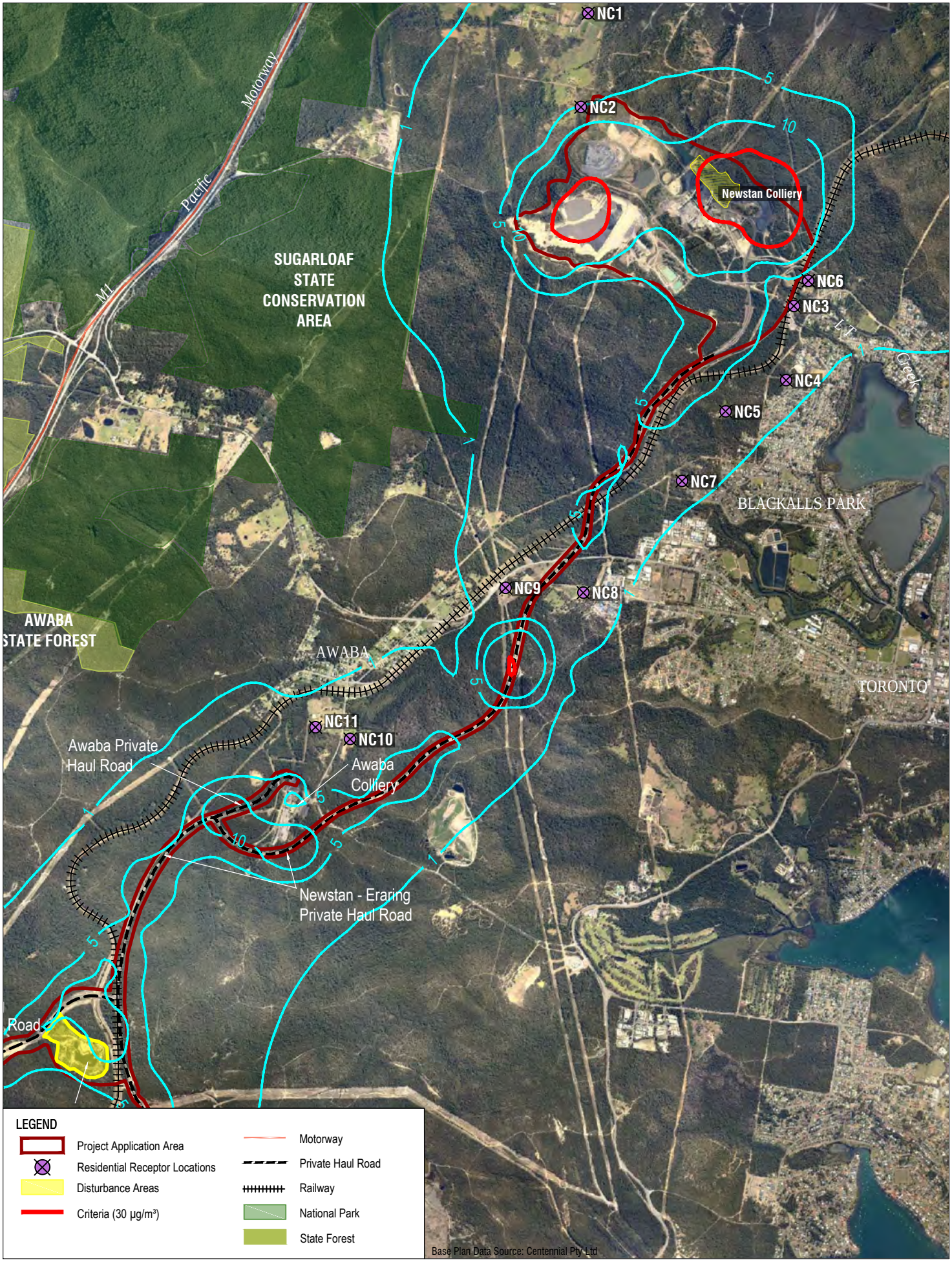
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 2a
Increment Only

APPENDIX B



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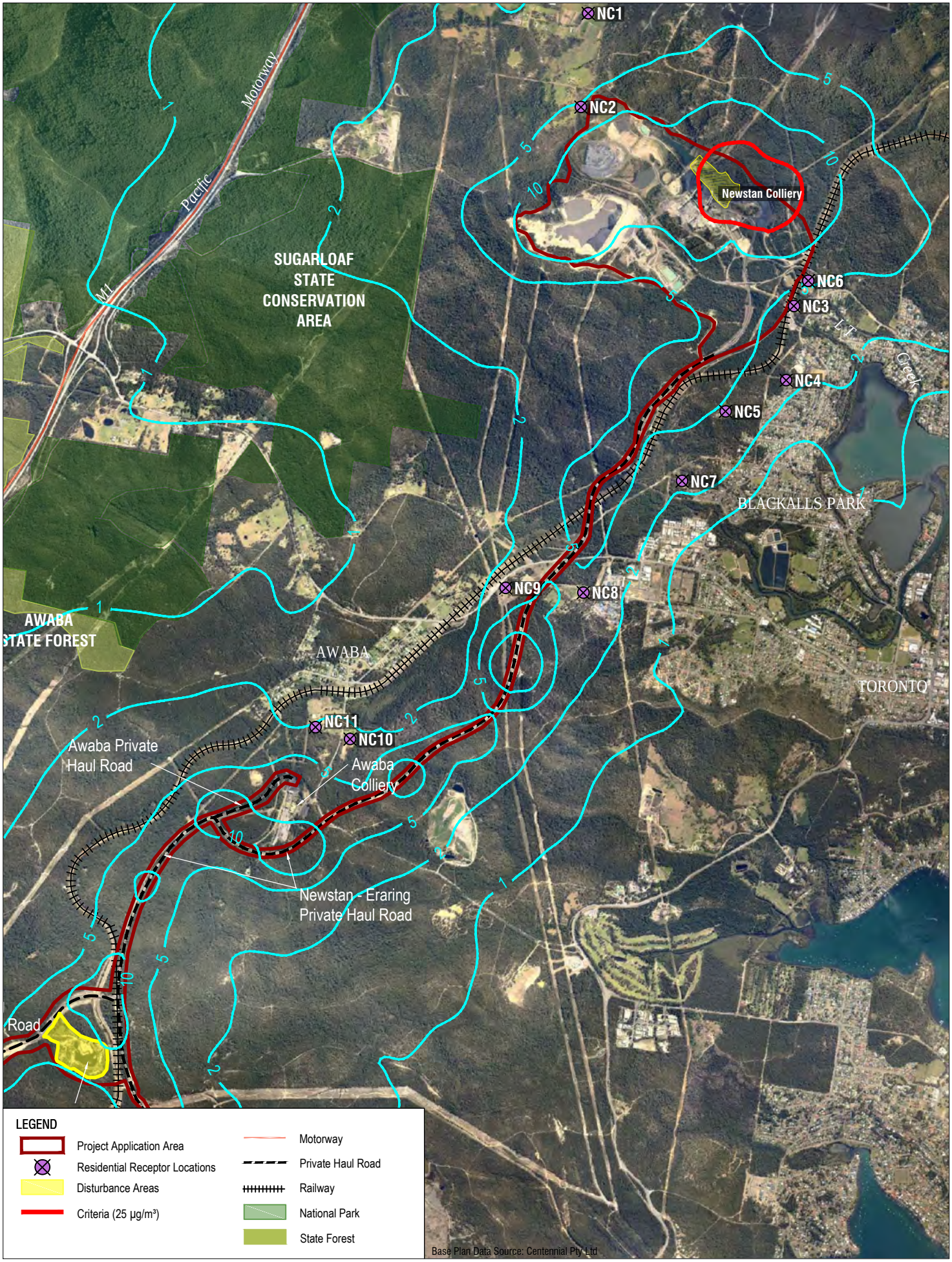
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 2a
Increment Only

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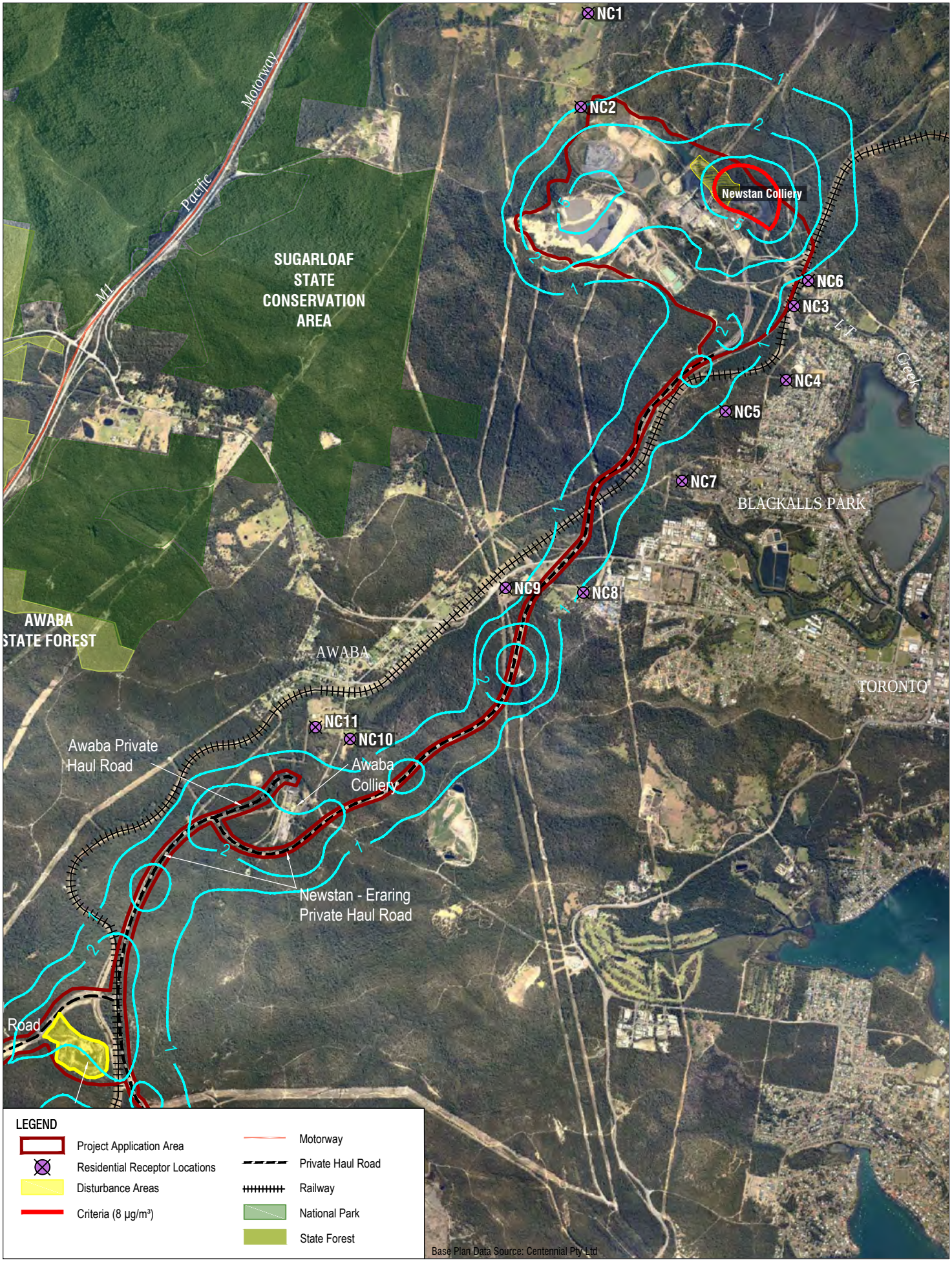
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 2a
Increment Only

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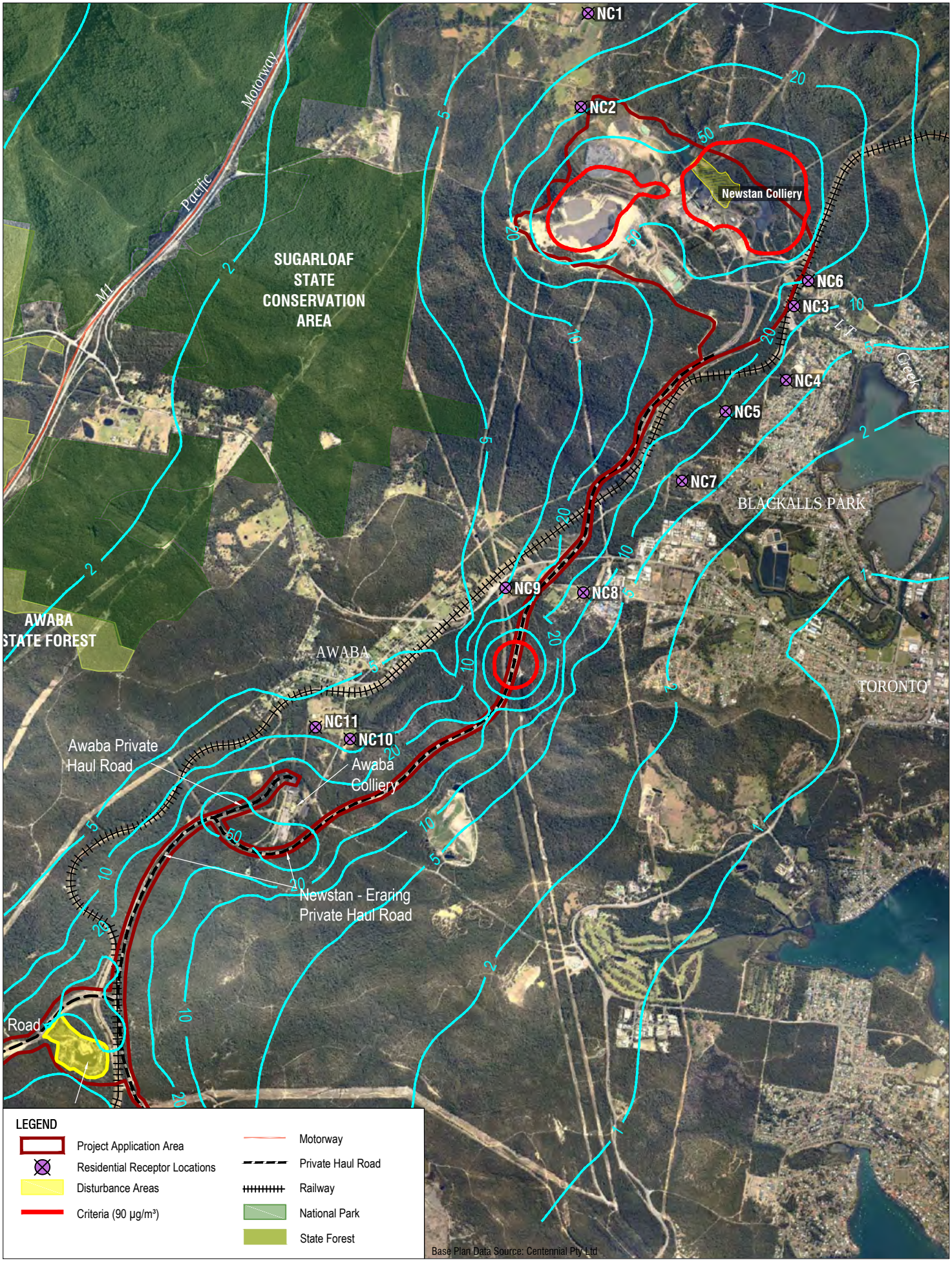
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 2a
Increment Only

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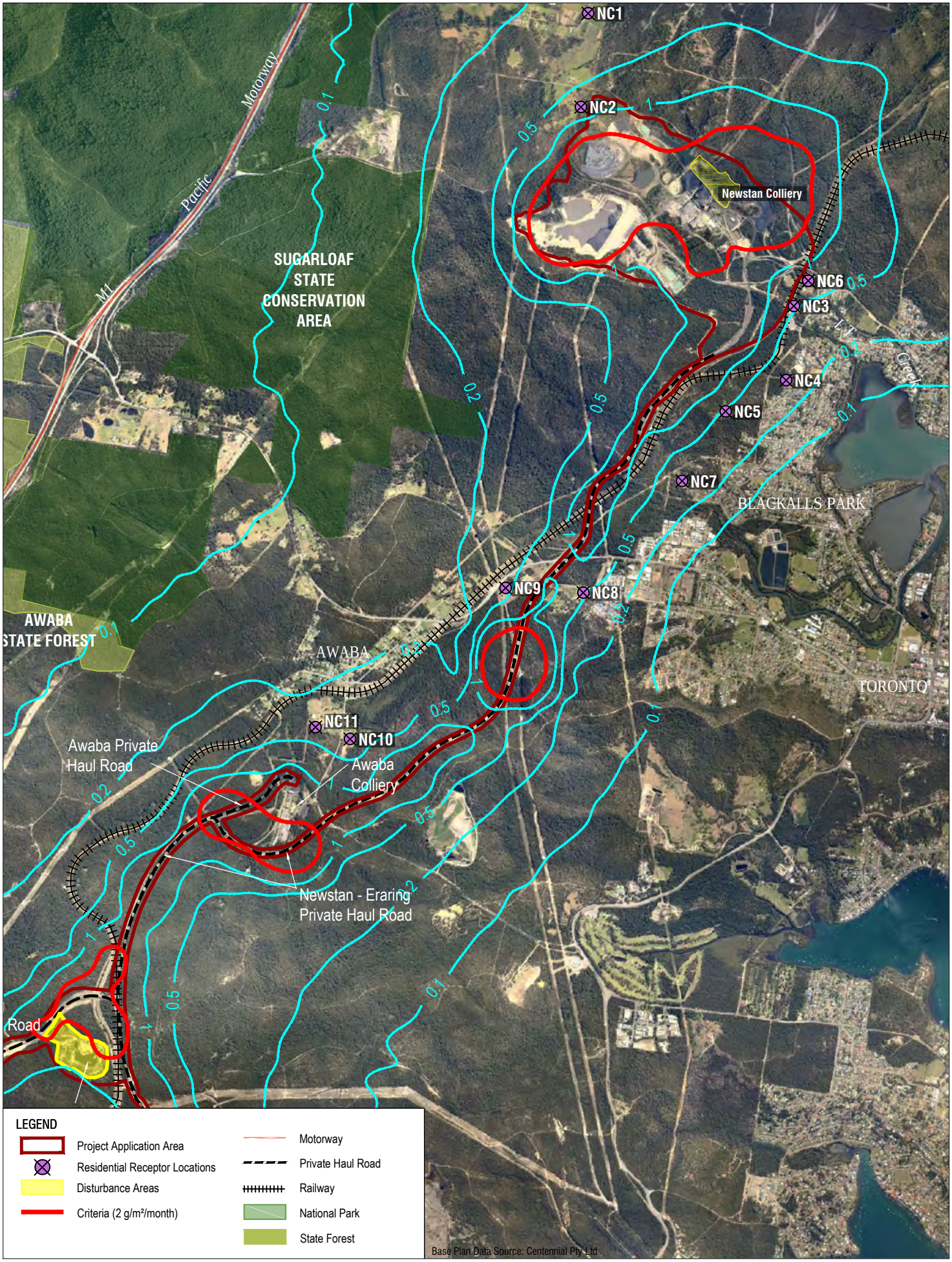
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 2a
Increment Only

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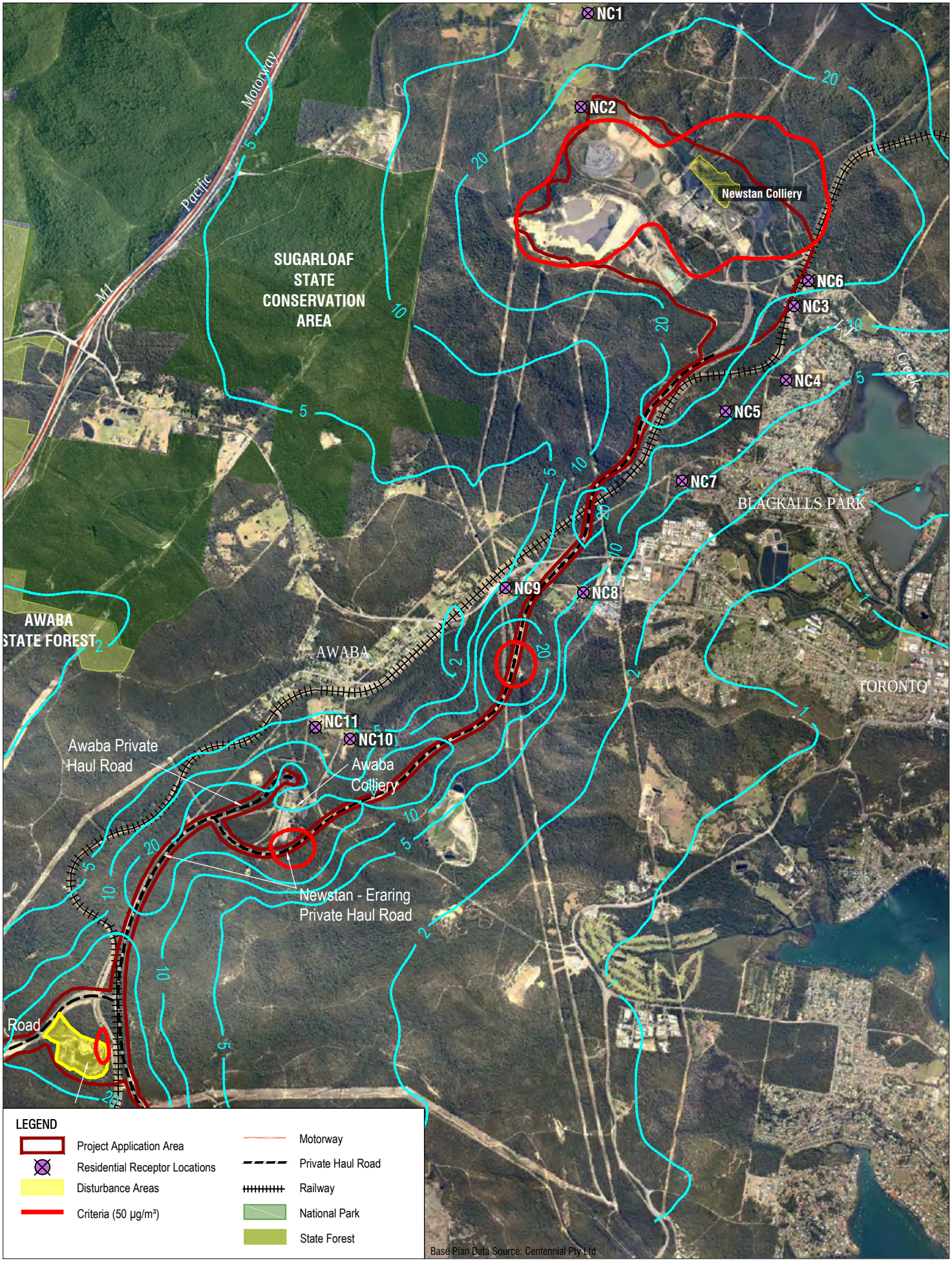
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 2b
Increment Only

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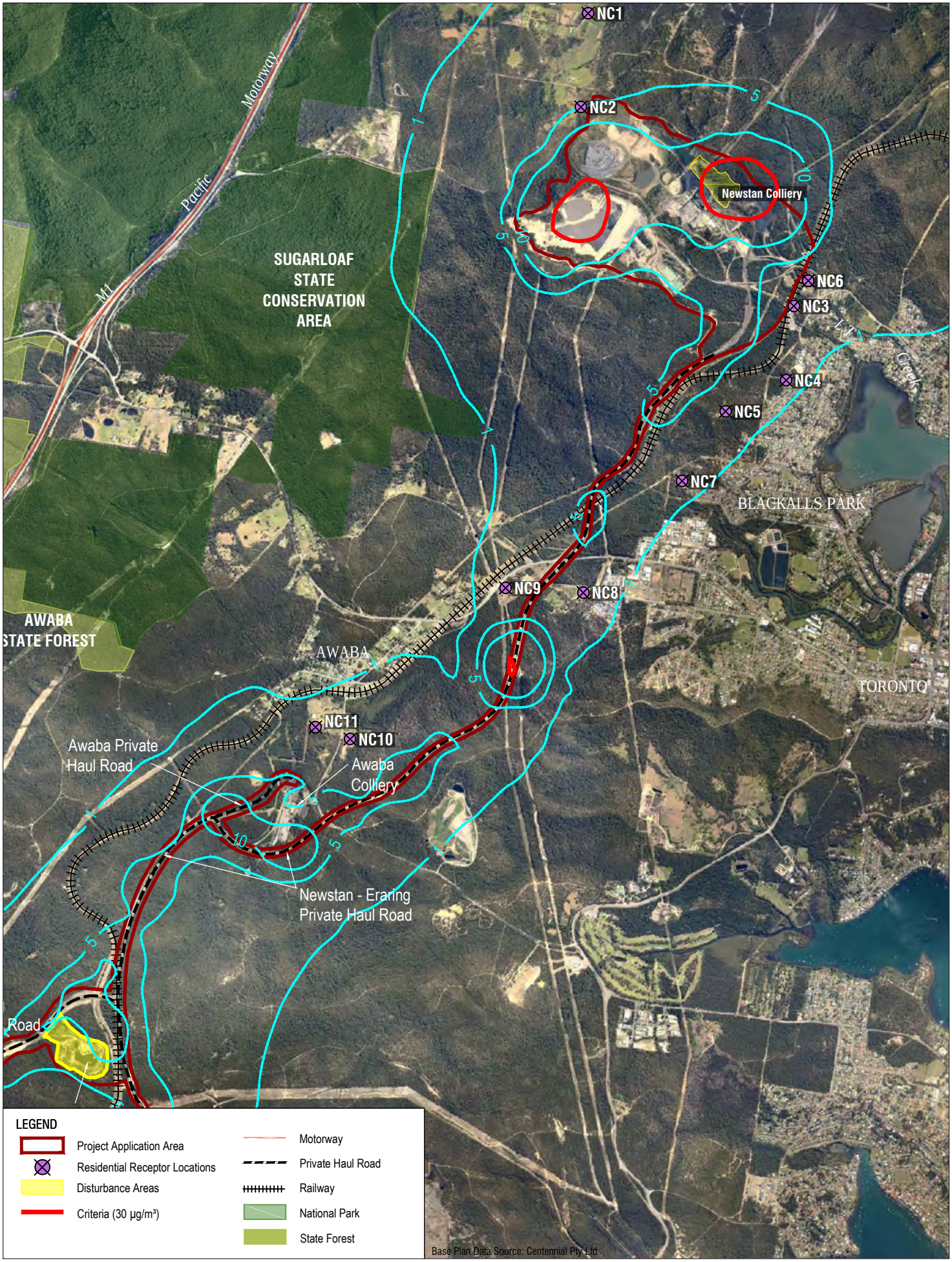
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 2b
Increment Only

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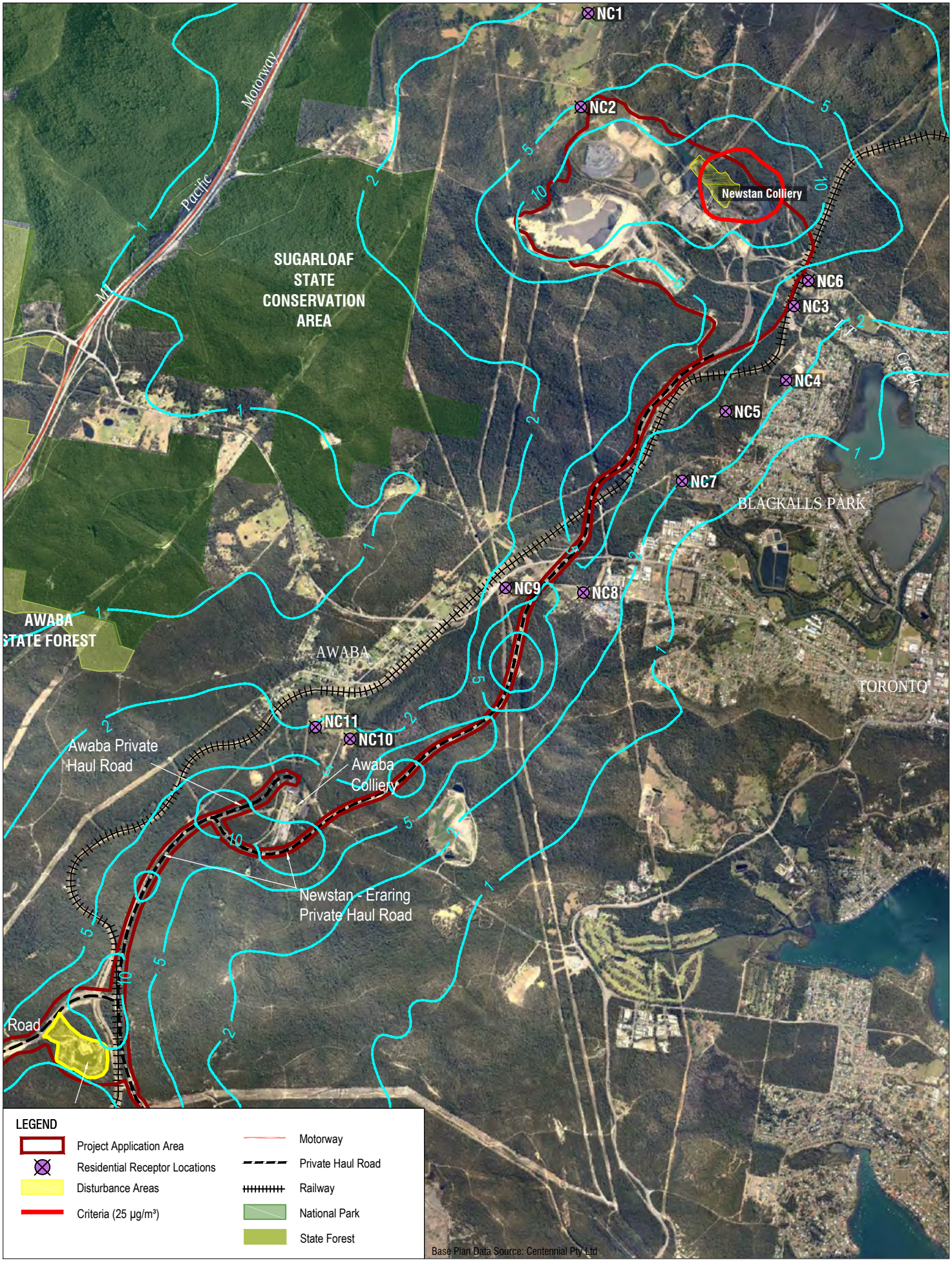
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 2b
Increment Only

APPENDIX B



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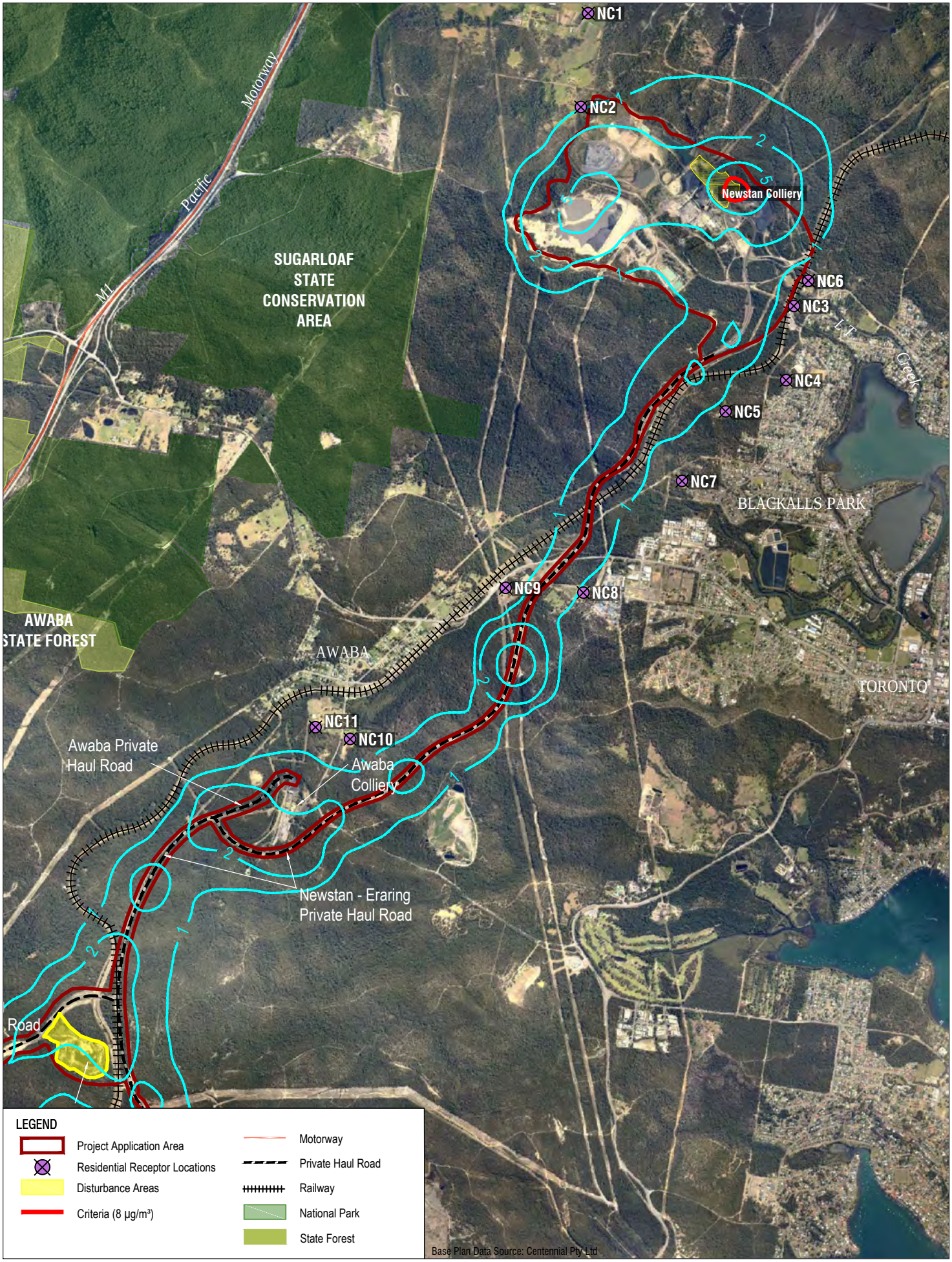
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 2b
Increment Only

APPENDIX B



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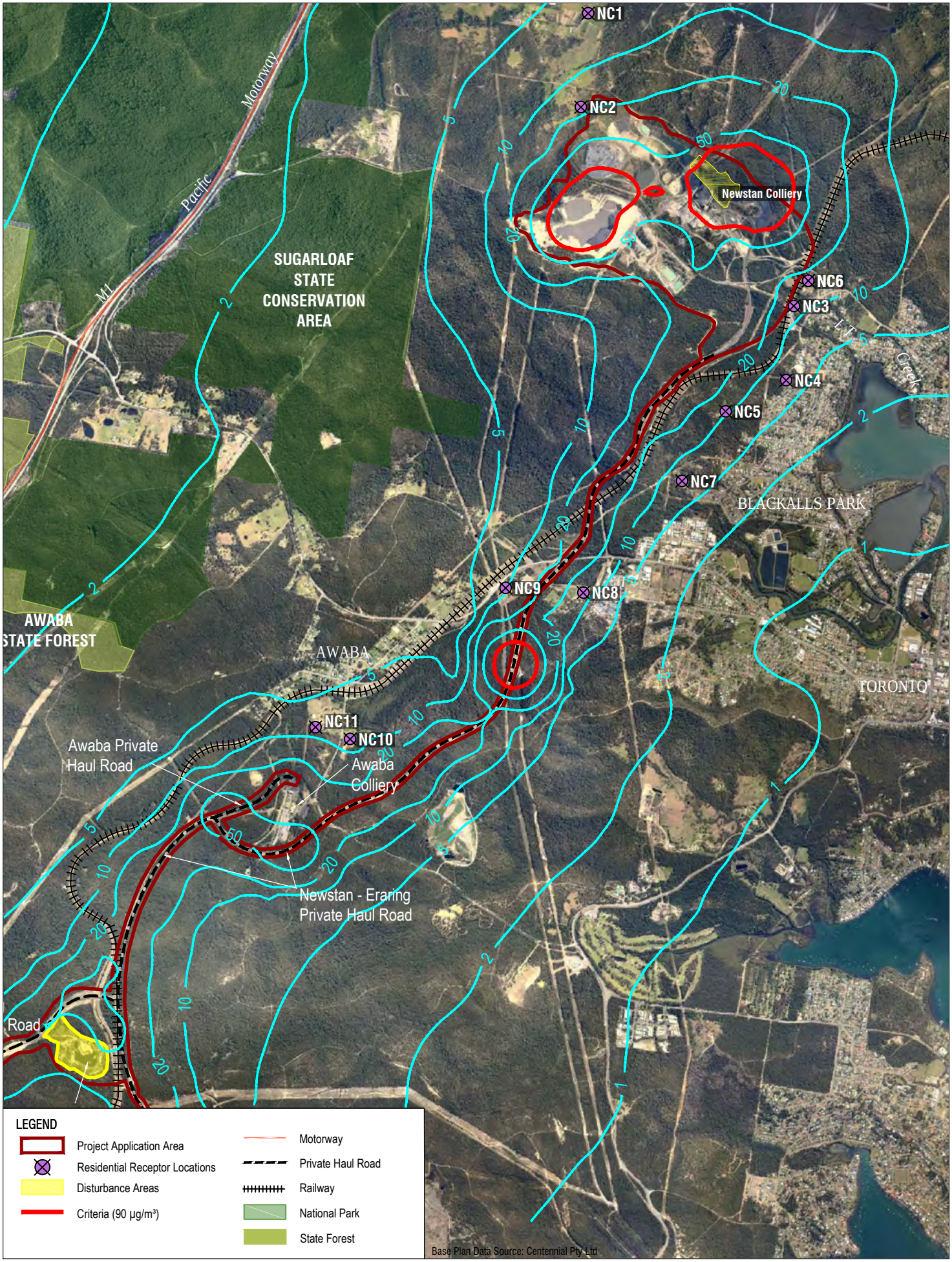
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 2b
Increment Only

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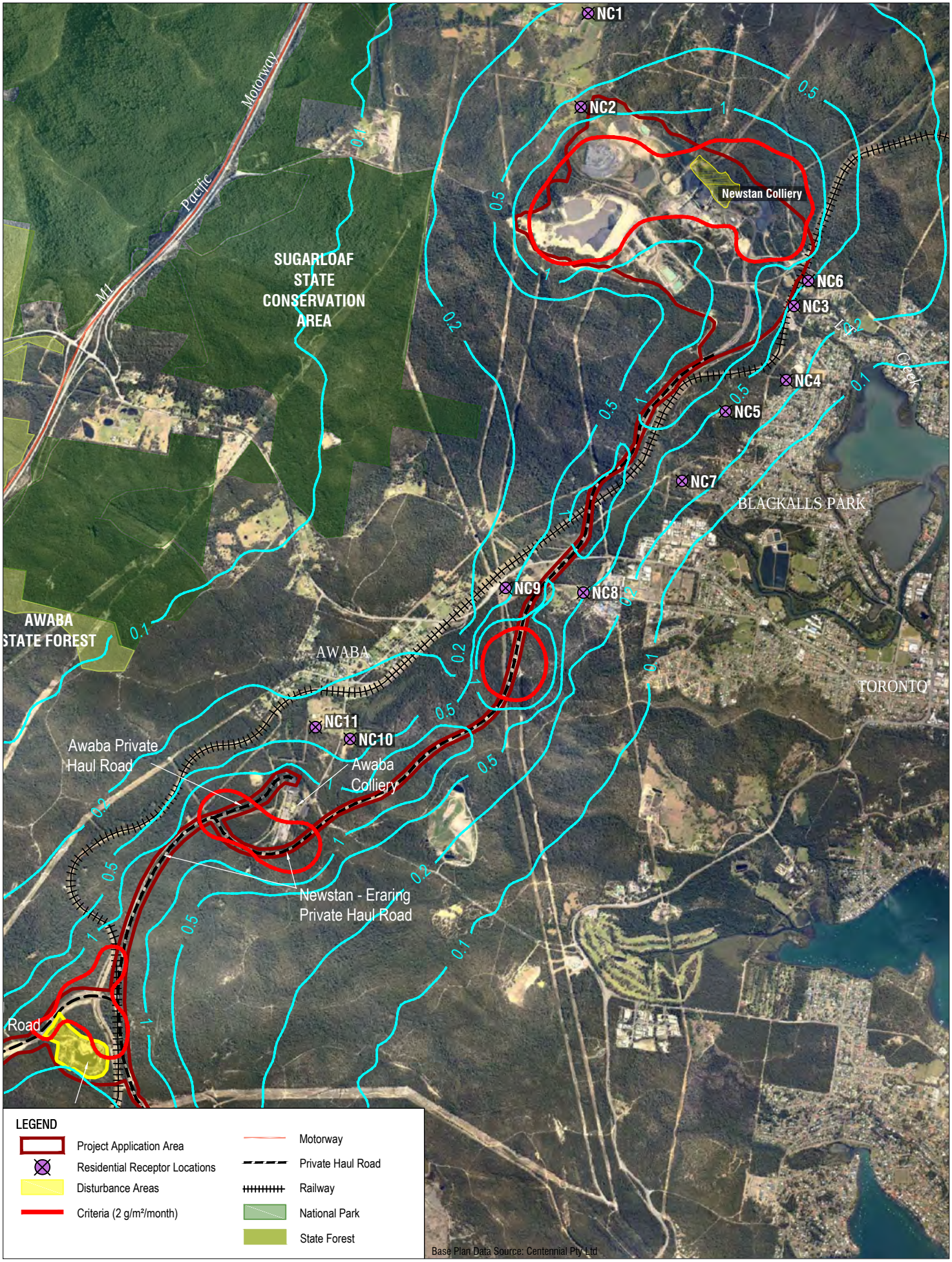
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 2b
Increment Only

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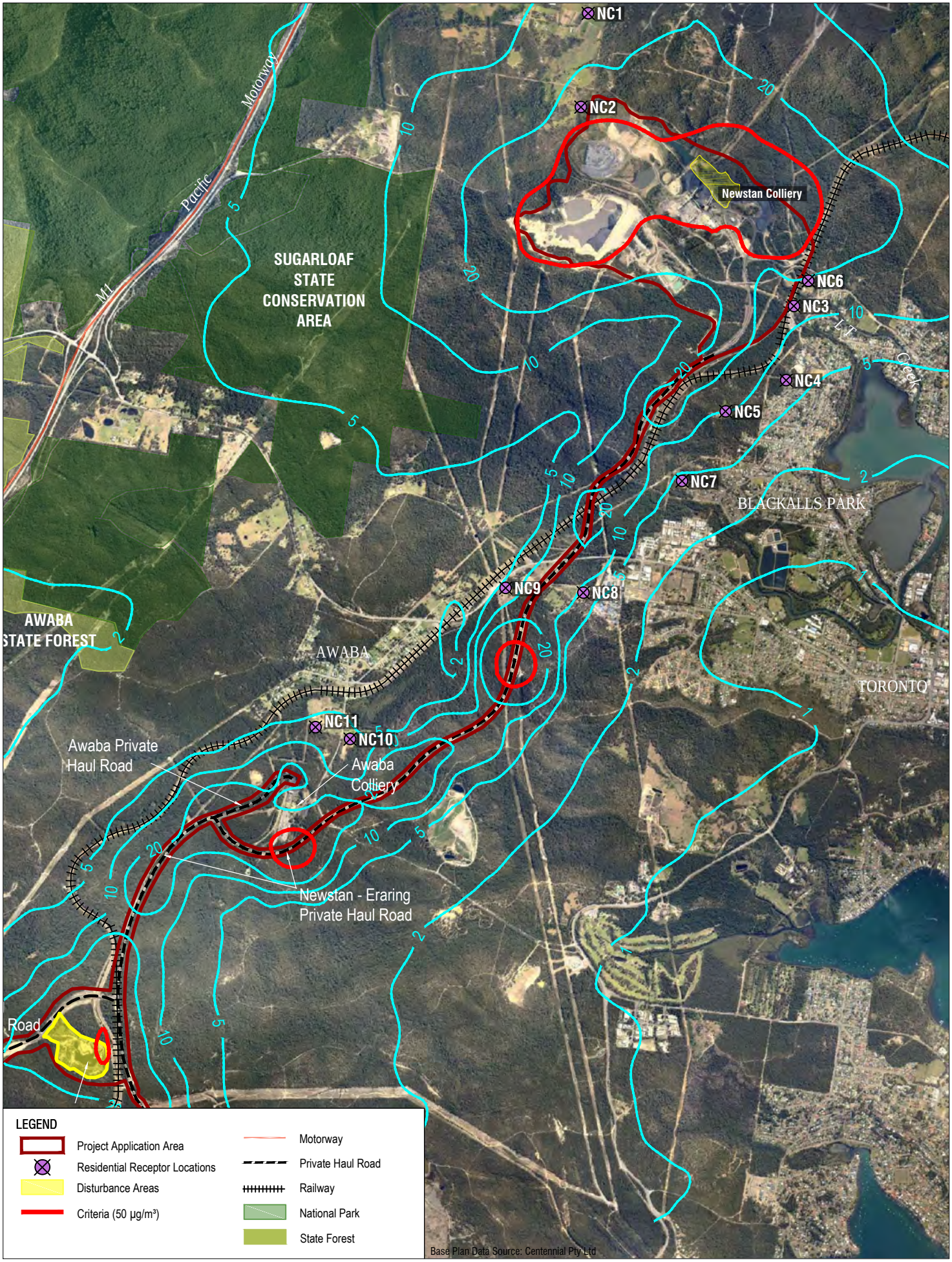
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 2c
Increment Only

APPENDIX B



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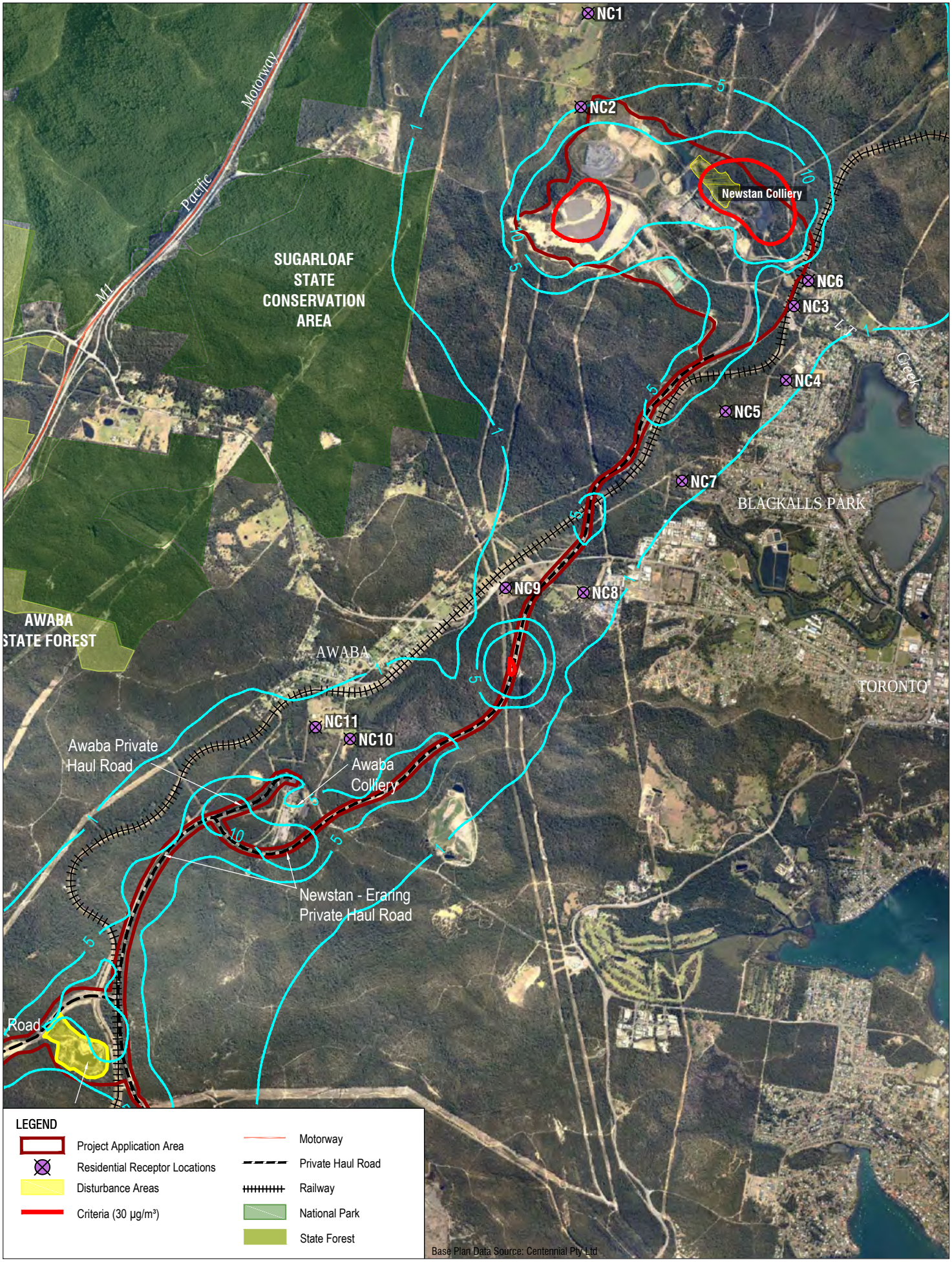
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 2c
Increment Only

APPENDIX B



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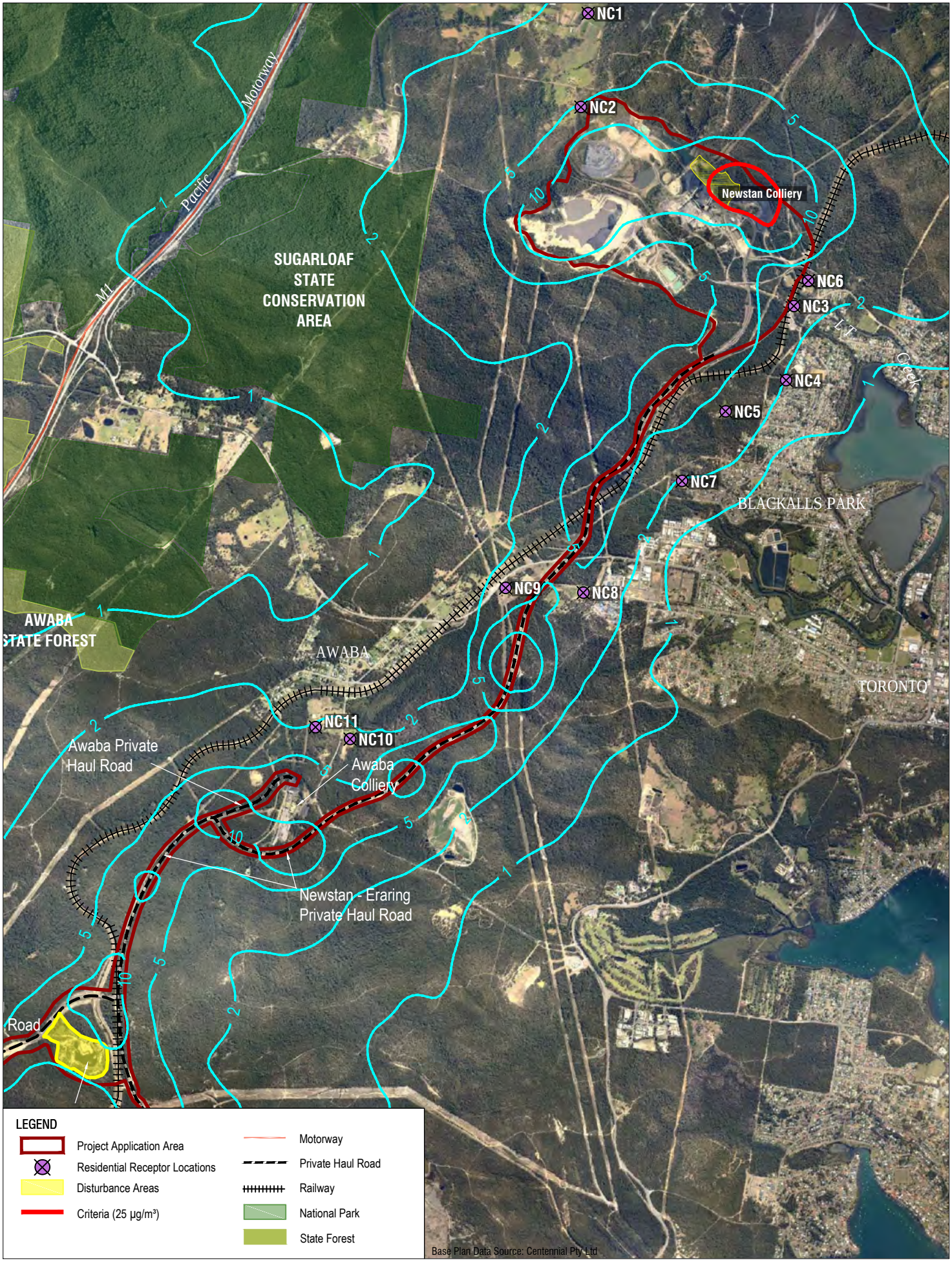
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 2c
Increment Only

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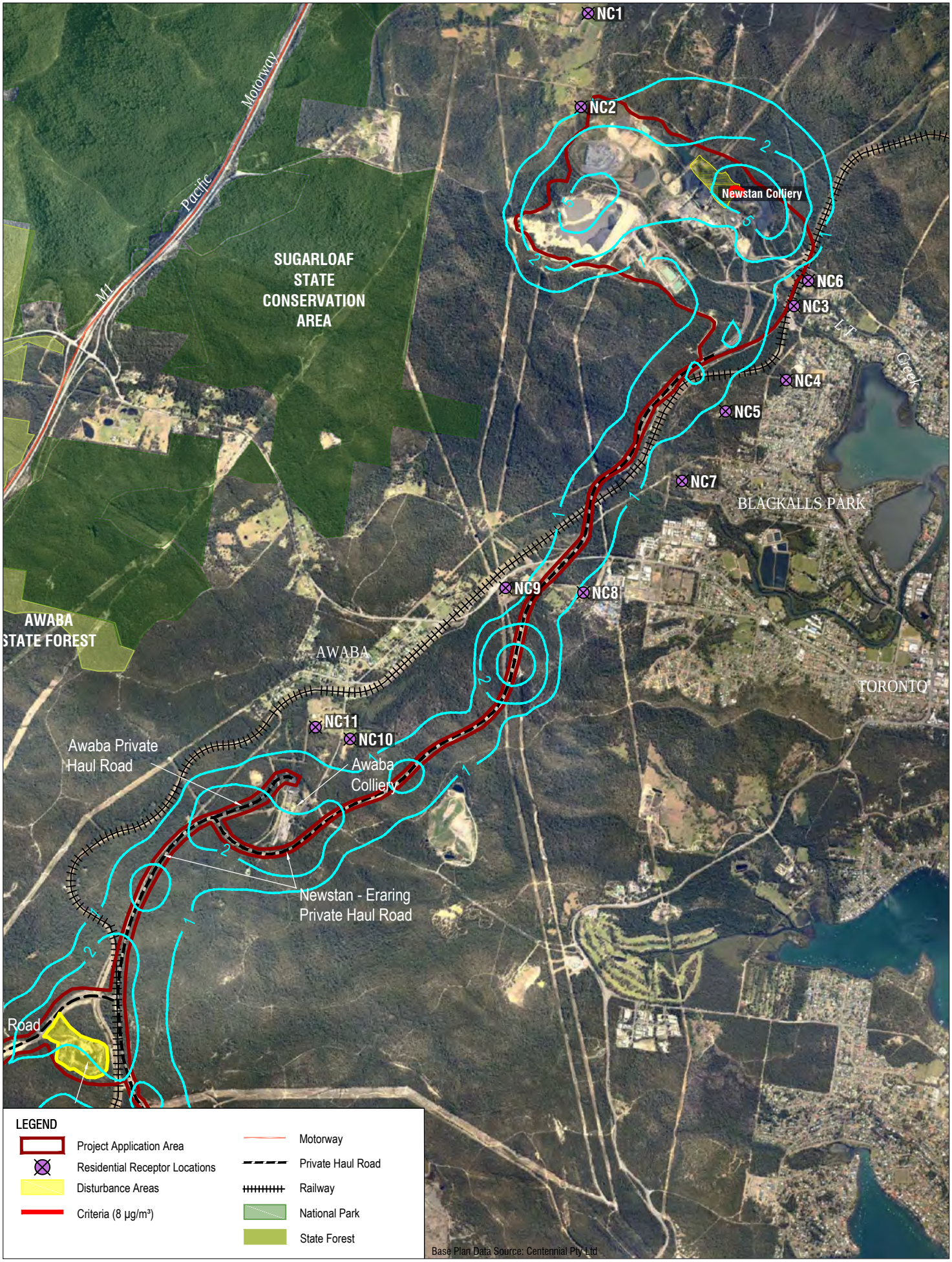
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 2c
Increment Only

APPENDIX B



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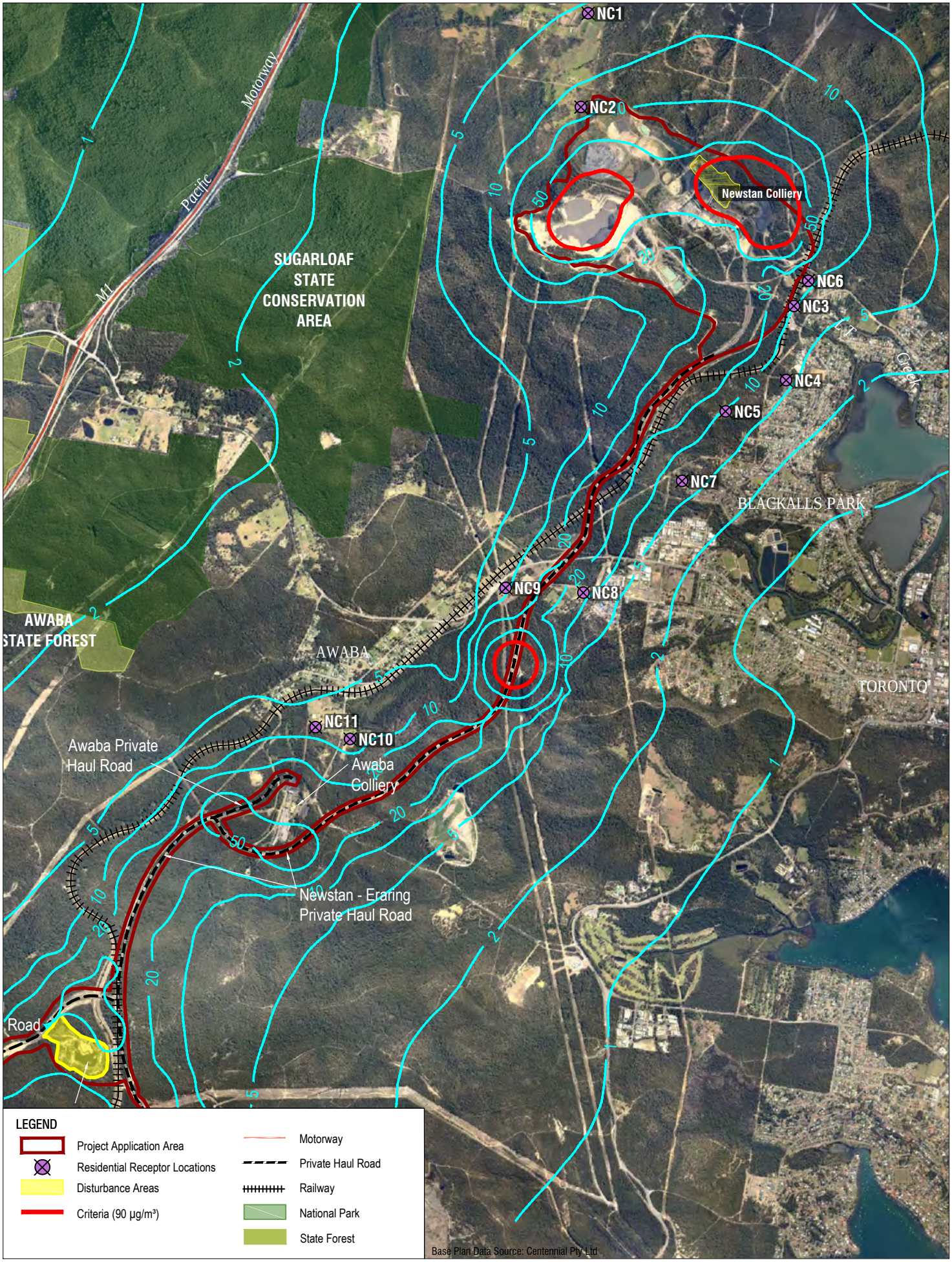
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 2c
Increment Only

APPENDIX B



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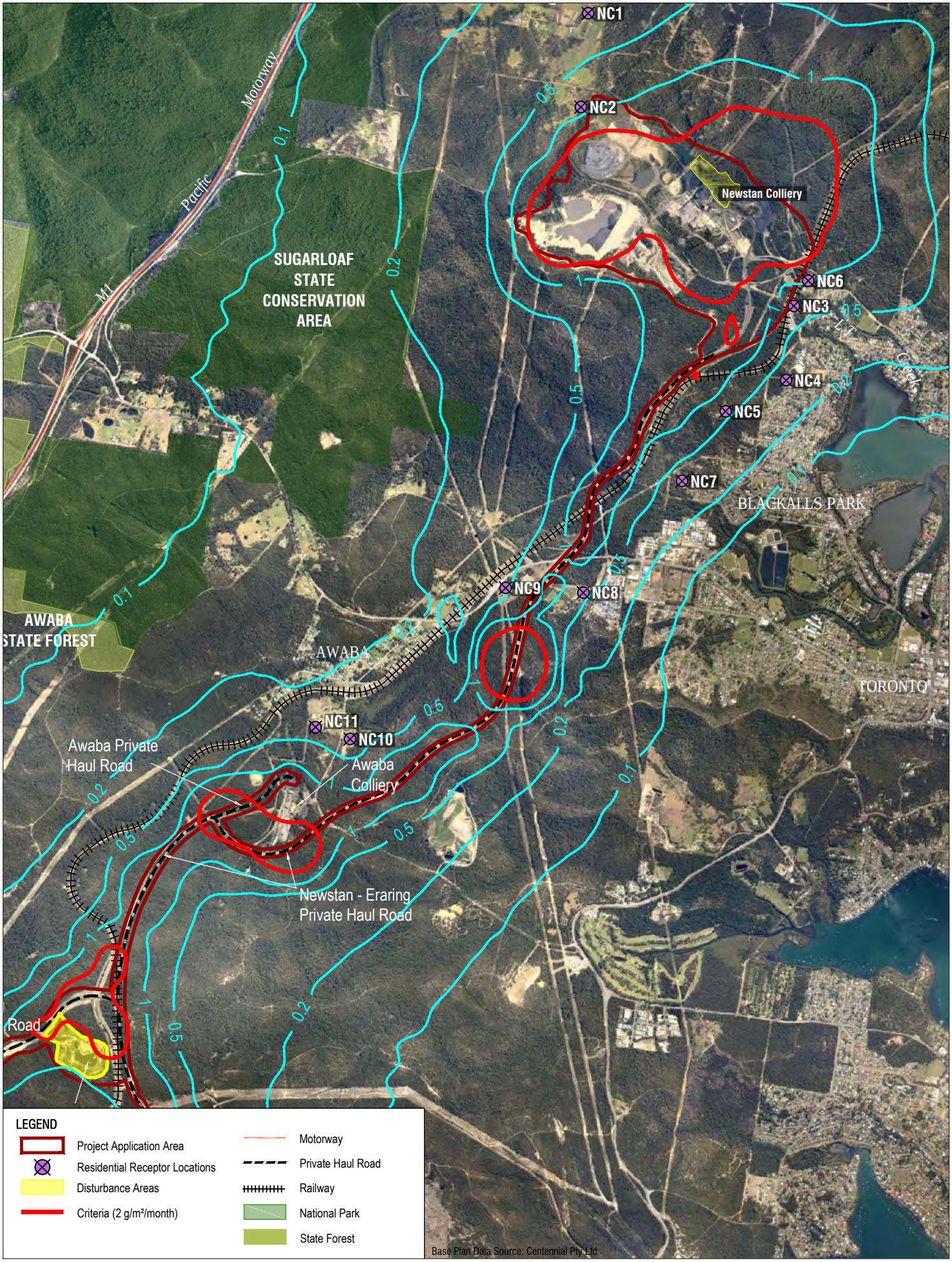
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 2c
Increment Only

APPENDIX B



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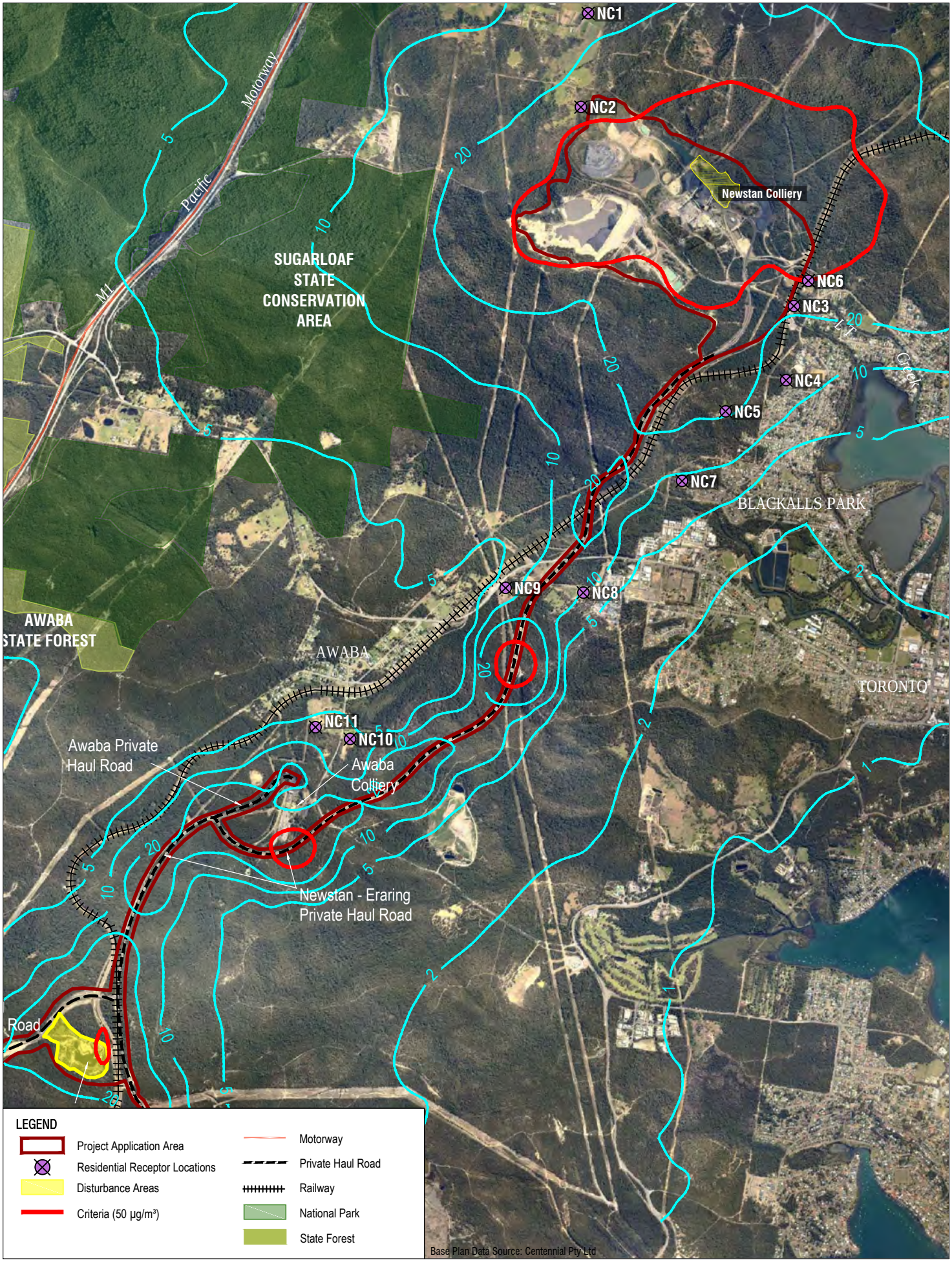
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 3a
Increment Only

APPENDIX B



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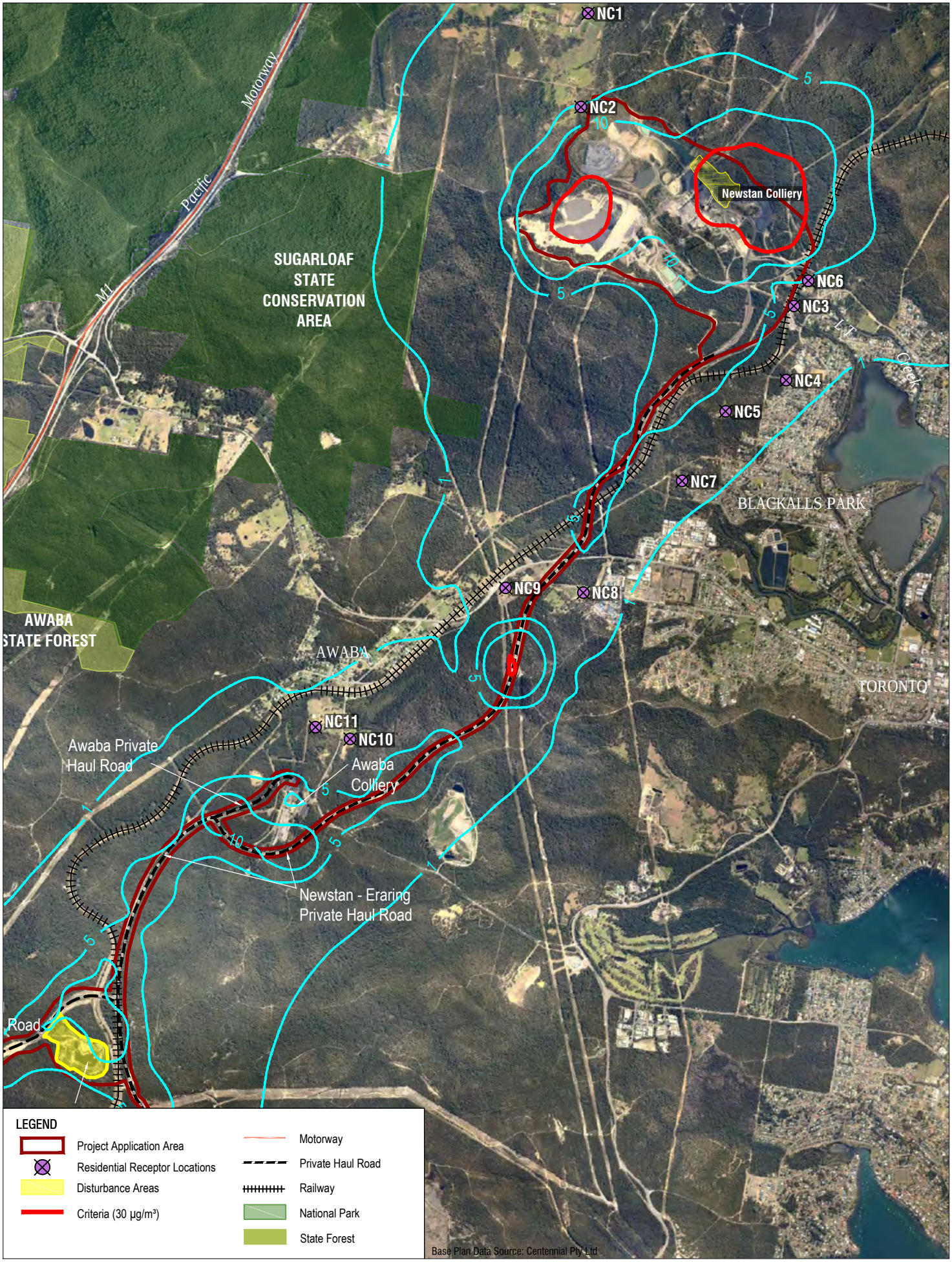
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 3a
Increment Only

APPENDIX B



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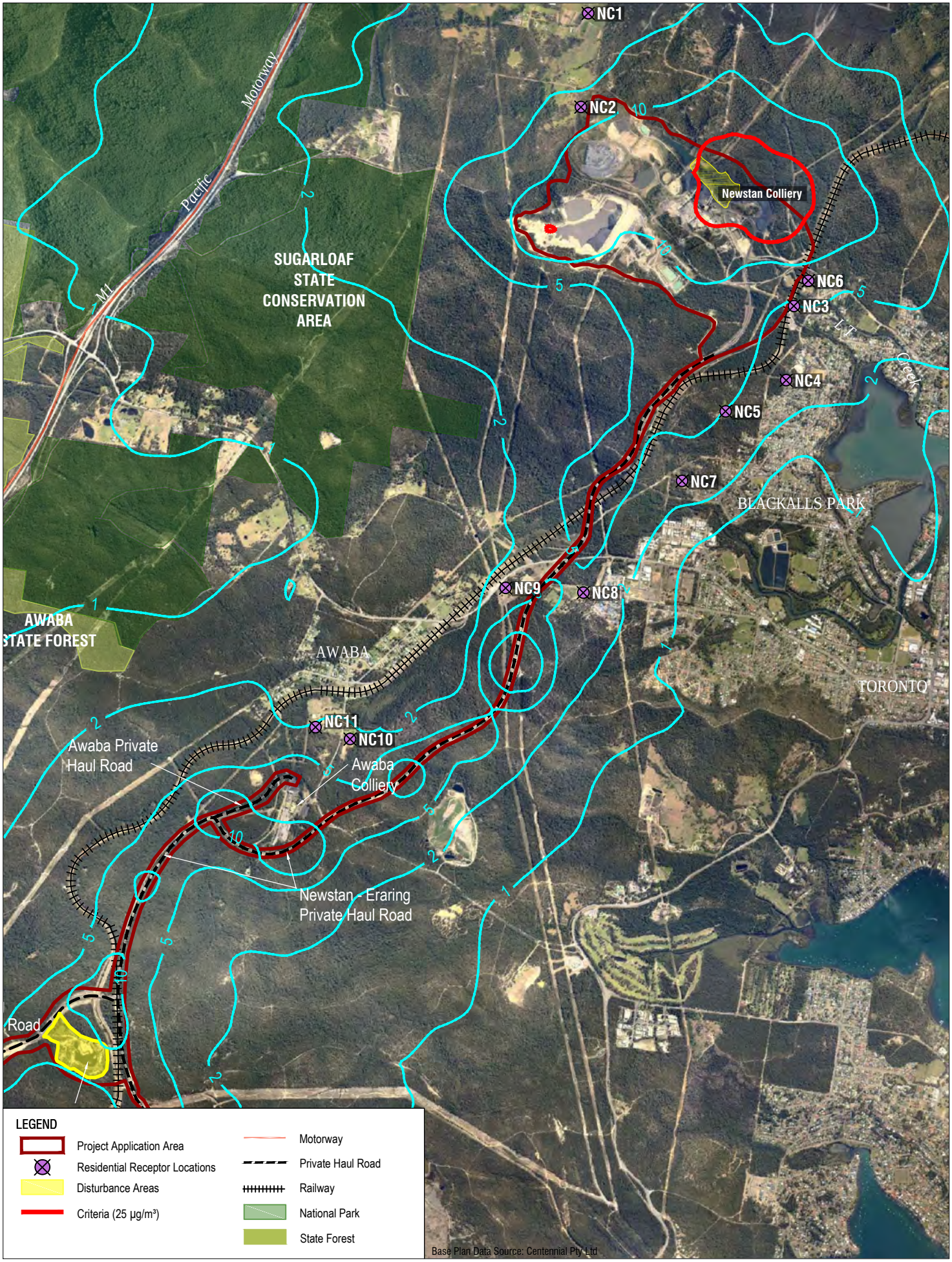
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 3a
Increment Only

APPENDIX B



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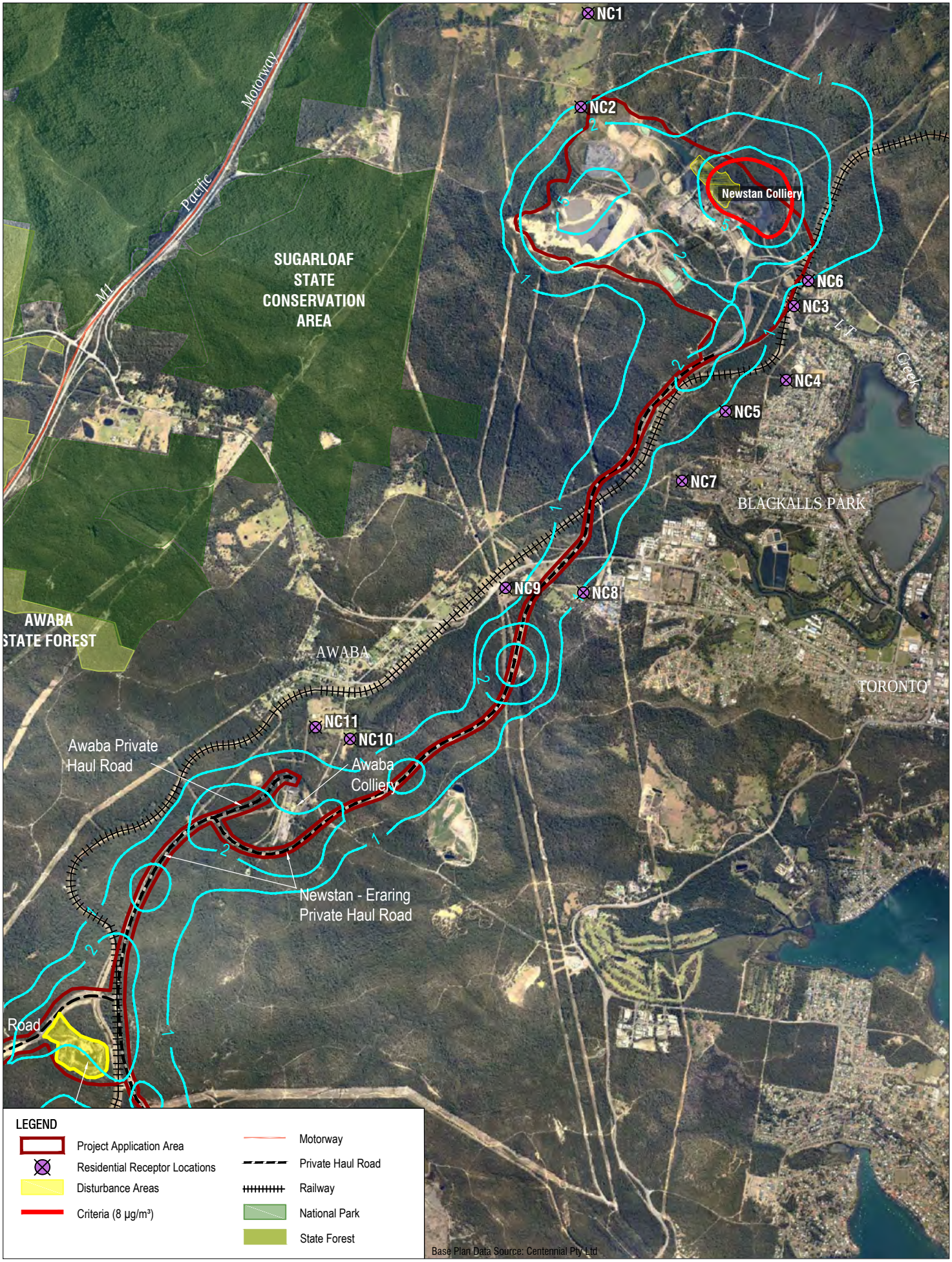
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 3a
Increment Only

APPENDIX B



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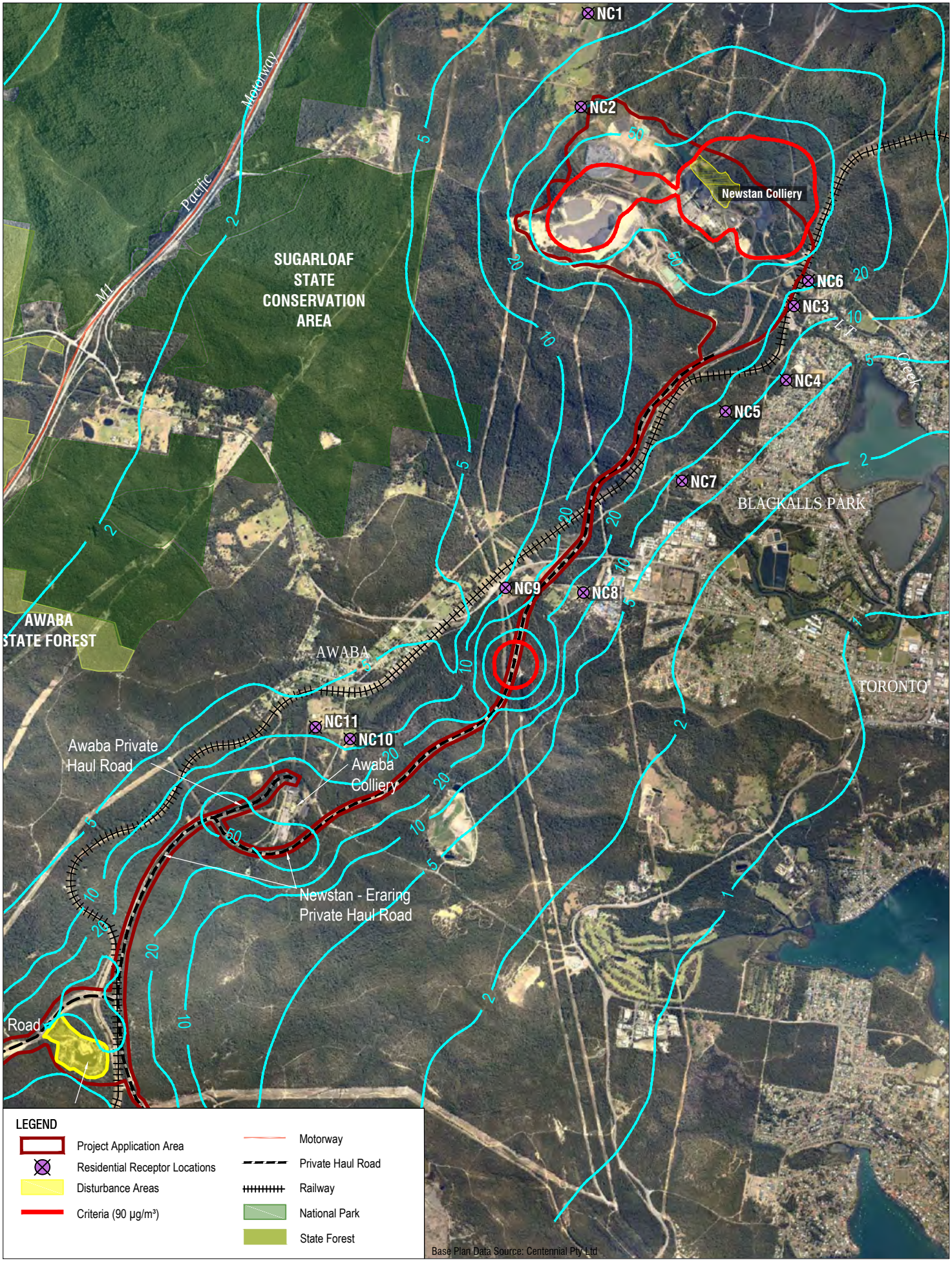
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 3a
Increment Only

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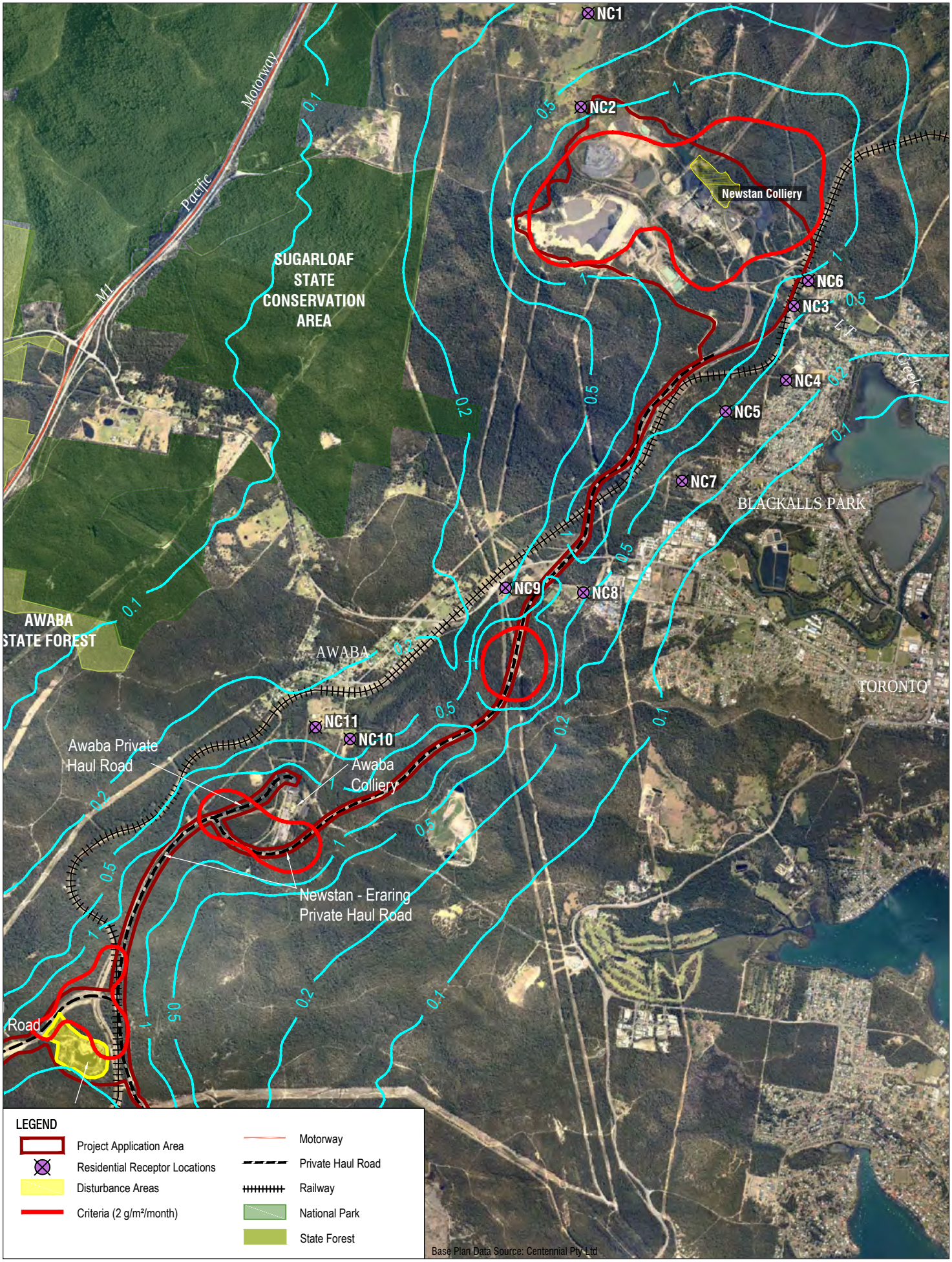
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 3a
Increment Only

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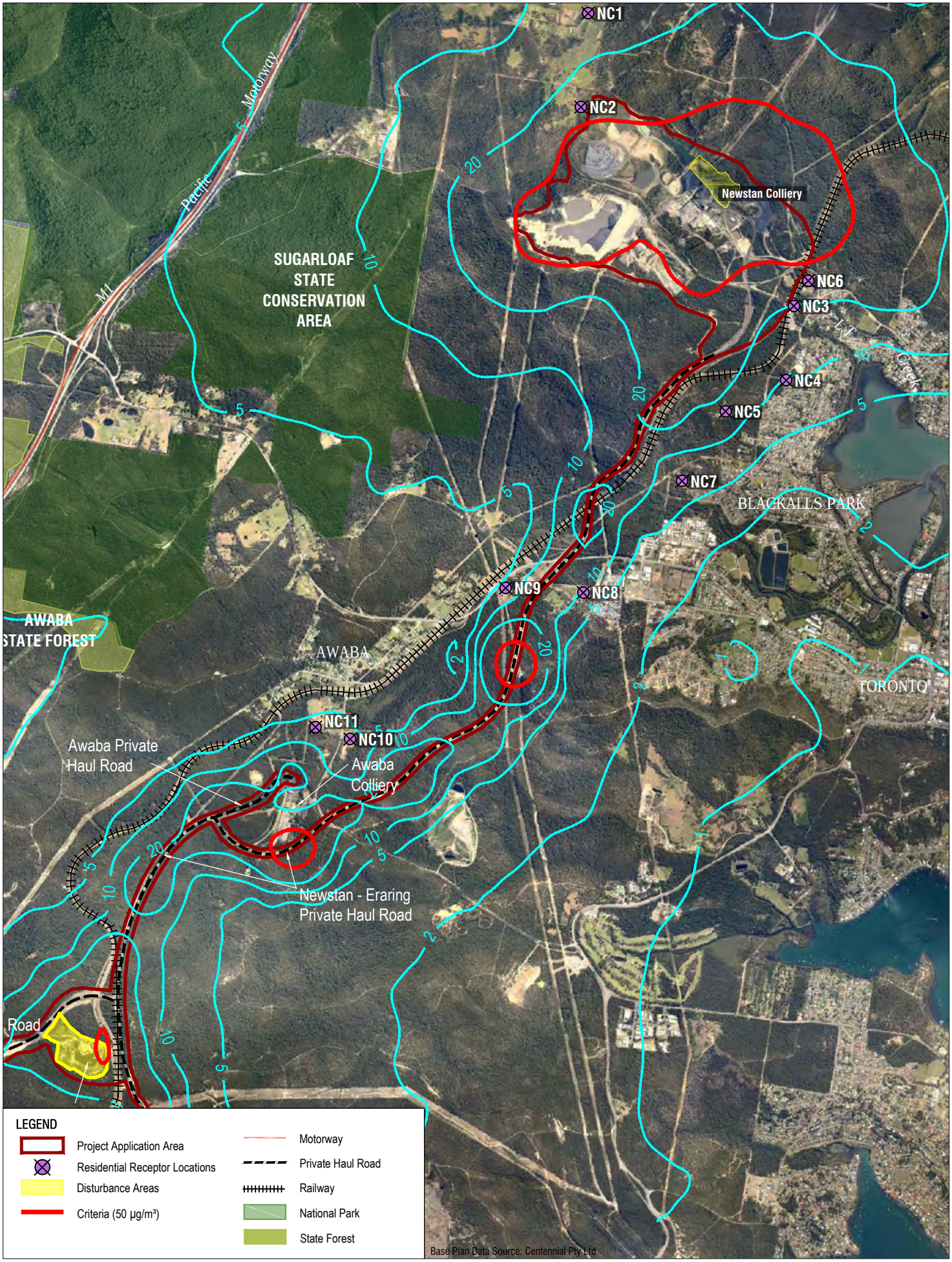
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 3b
Increment Only

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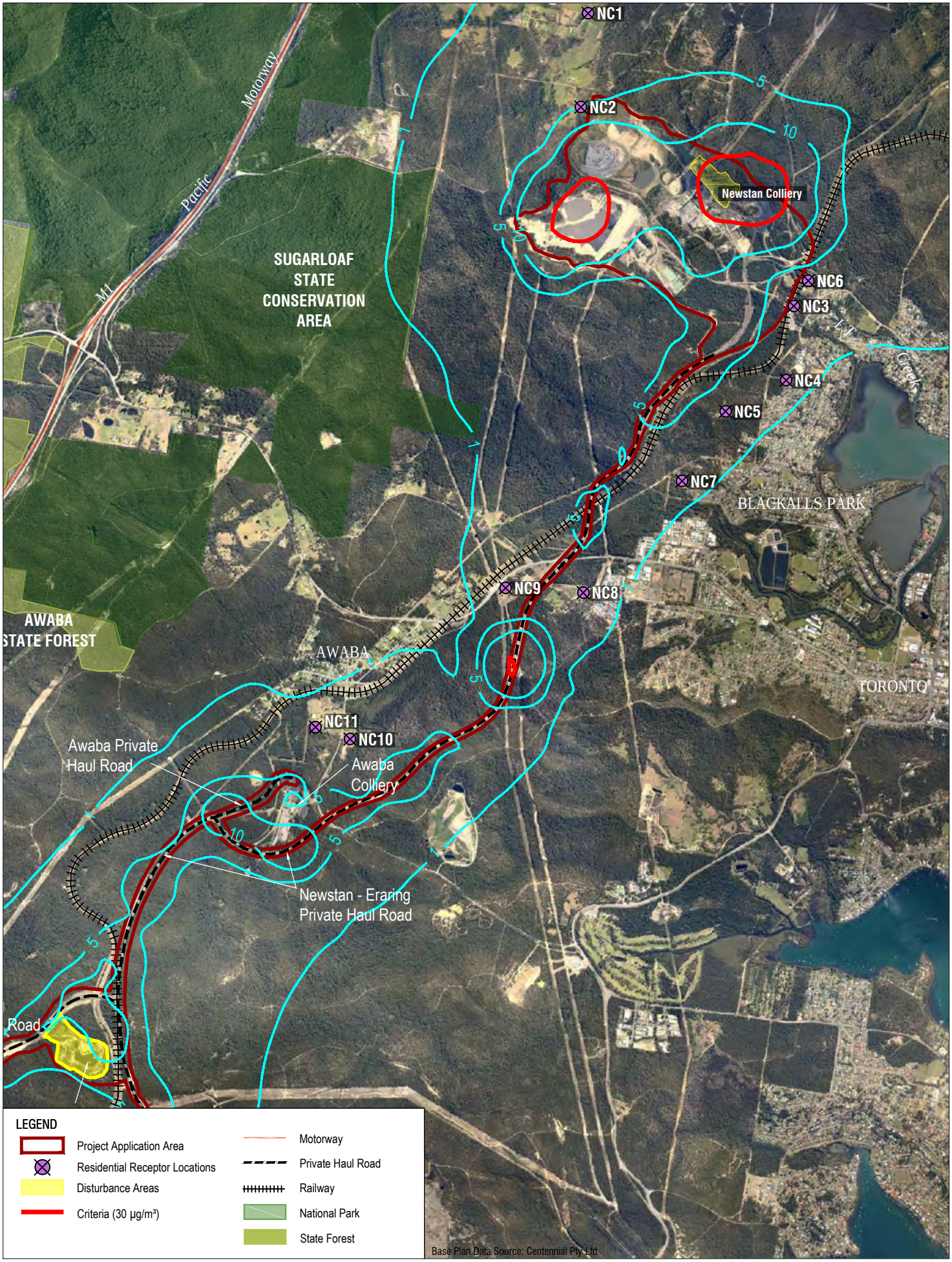
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 3b
Increment Only

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Date:	24.02.2014
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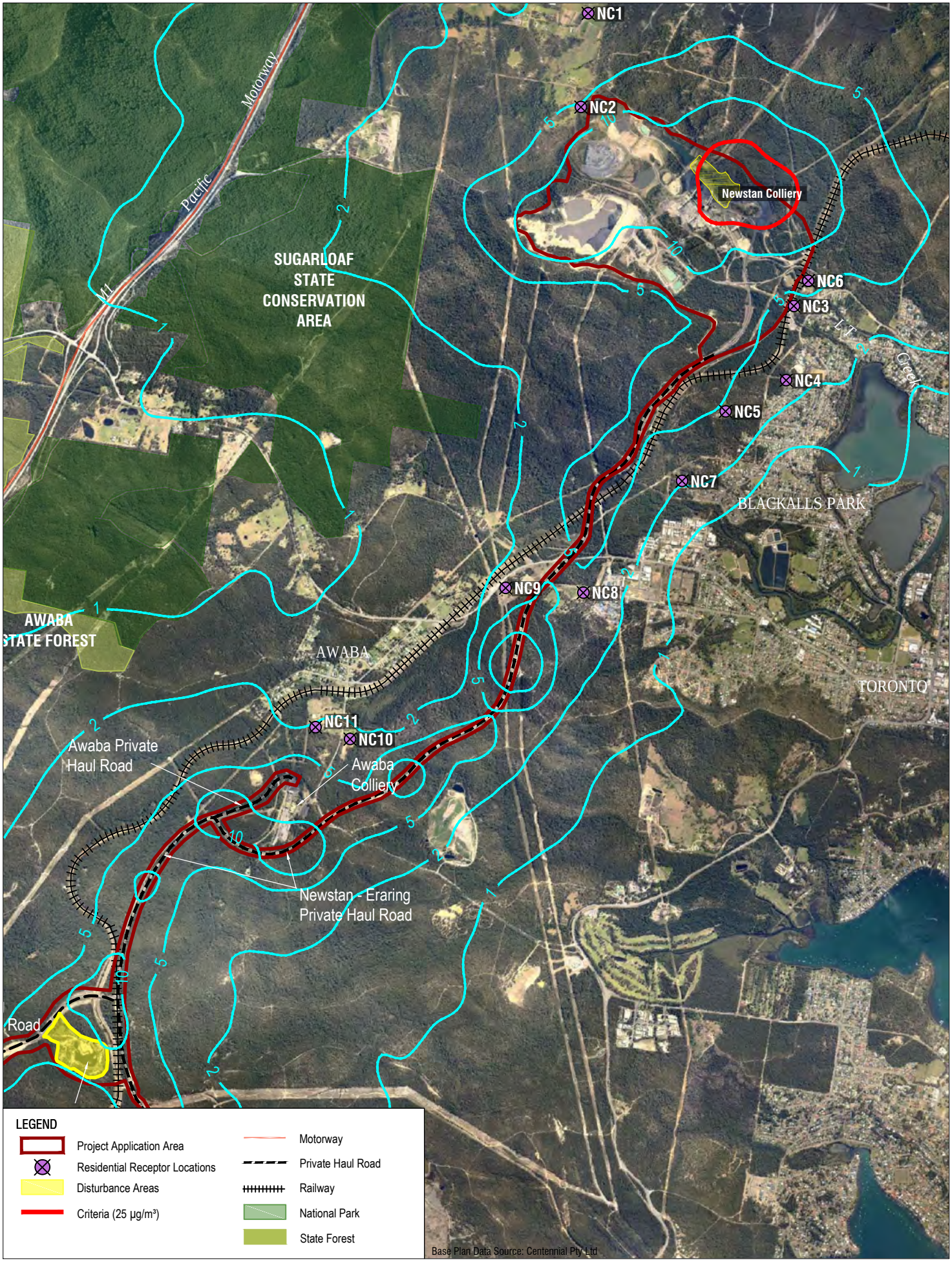
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 3b
Increment Only

APPENDIX B



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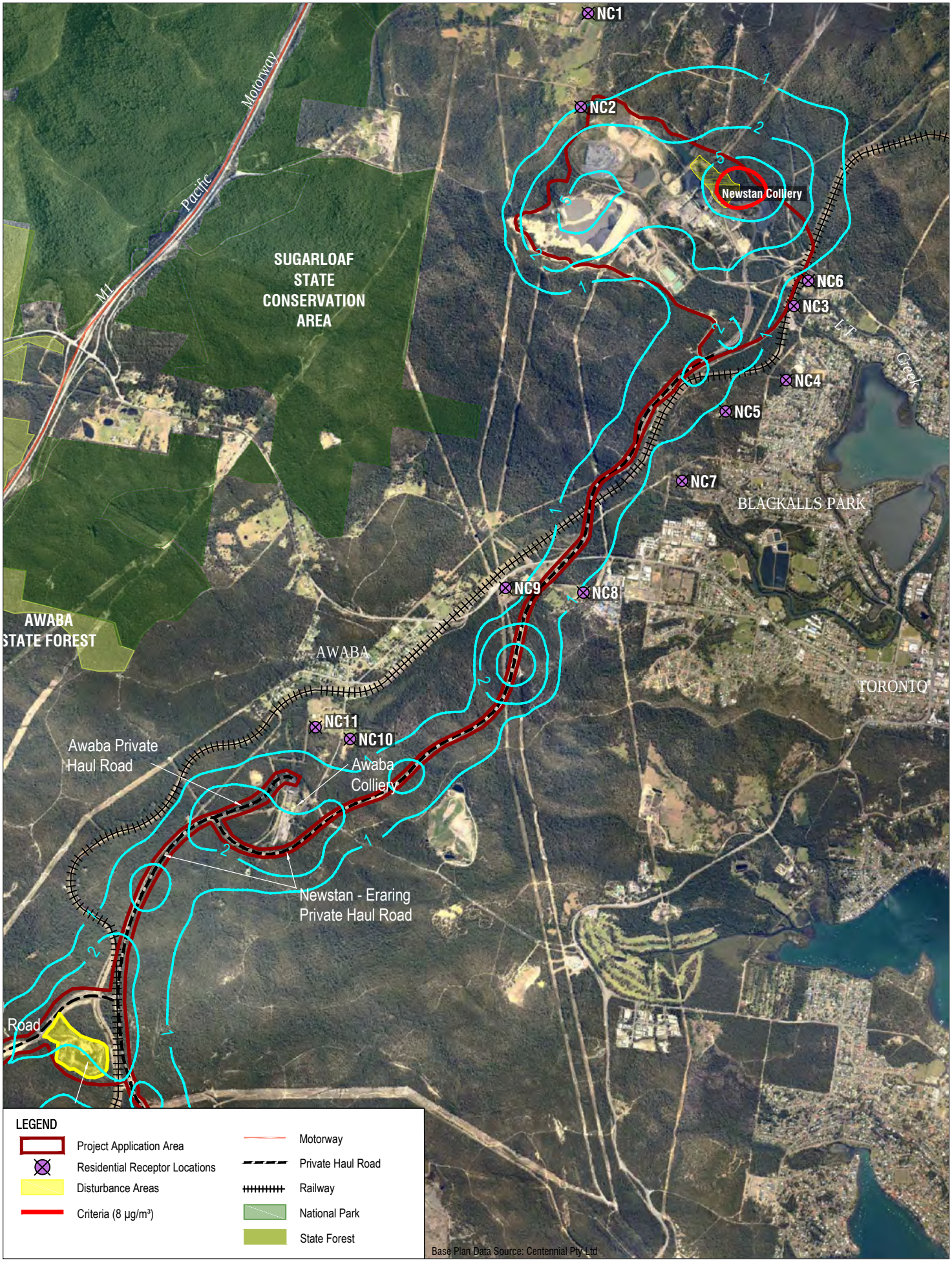
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 3b
Increment Only

APPENDIX B



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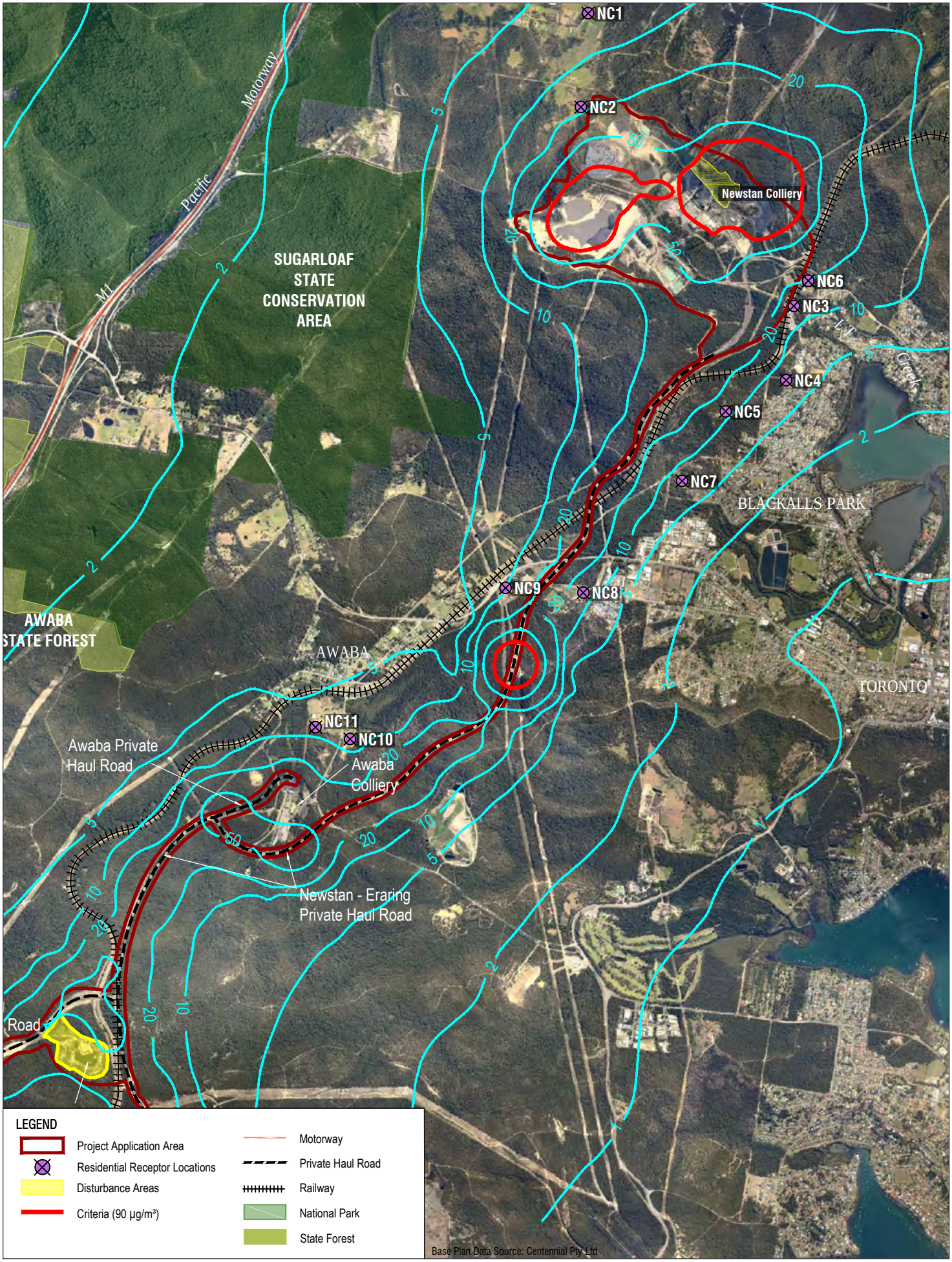
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 3b
Increment Only

APPENDIX B



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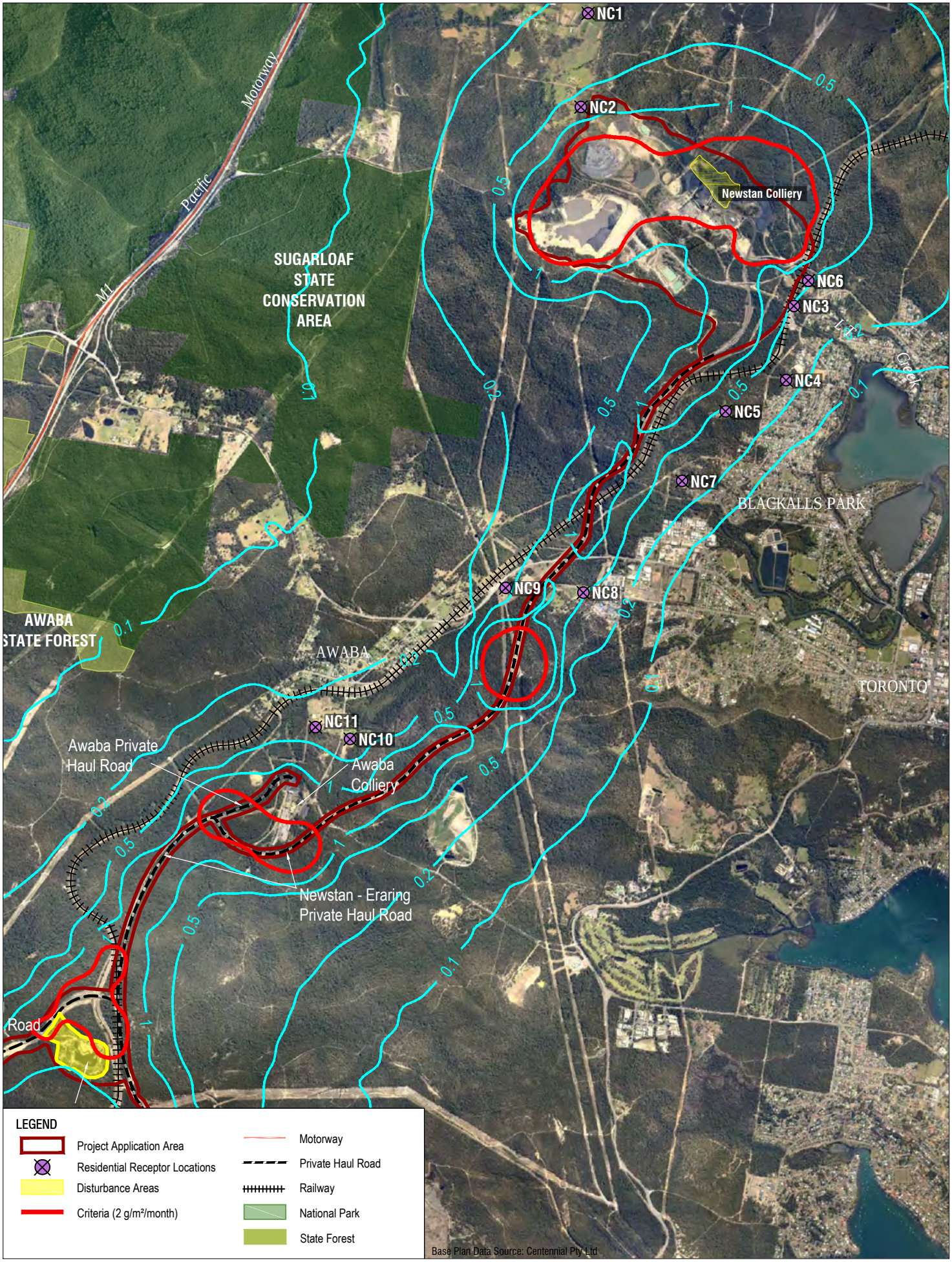
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 3b
Increment Only

APPENDIX B



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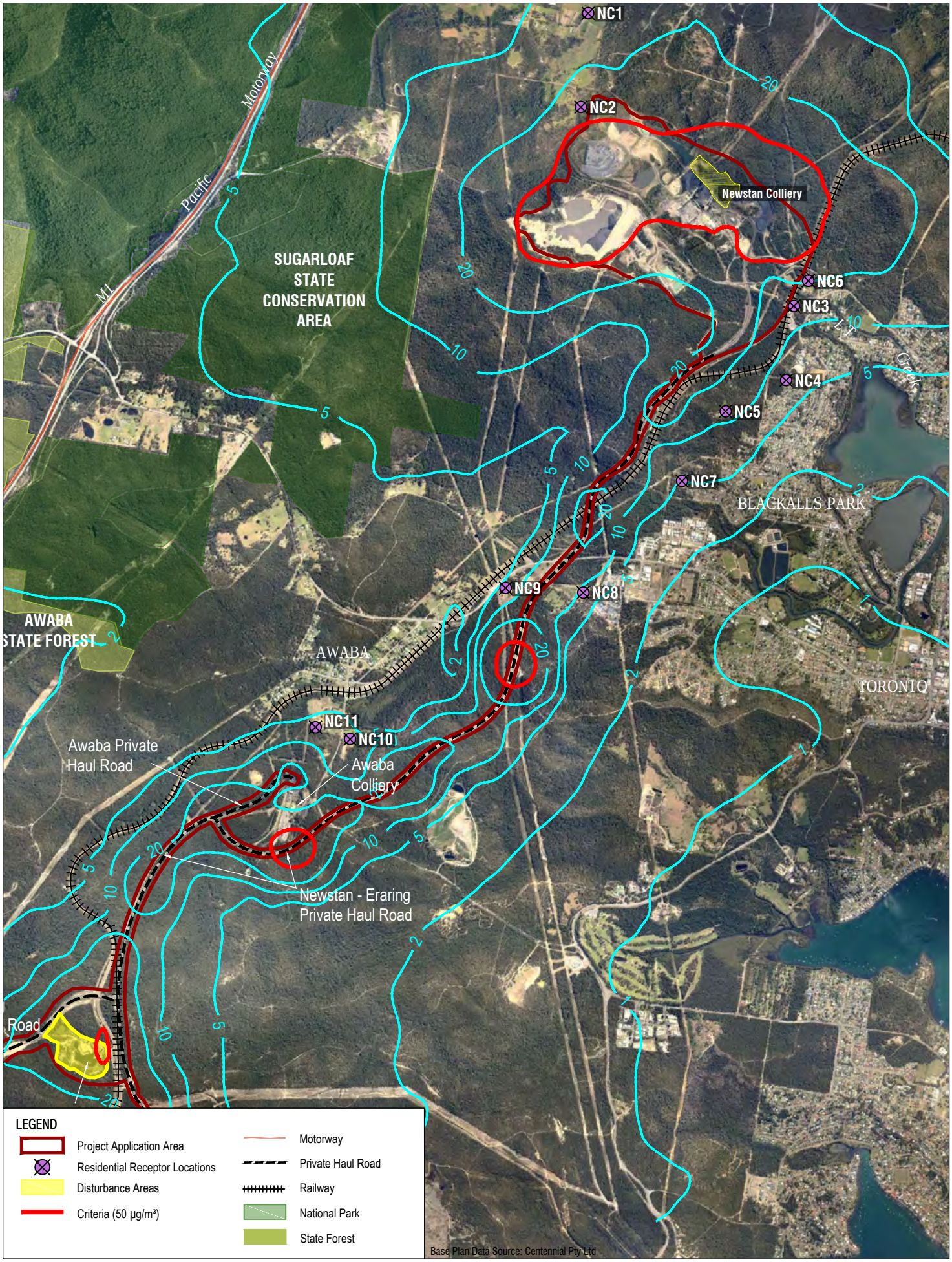
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 3c
Increment Only

APPENDIX B



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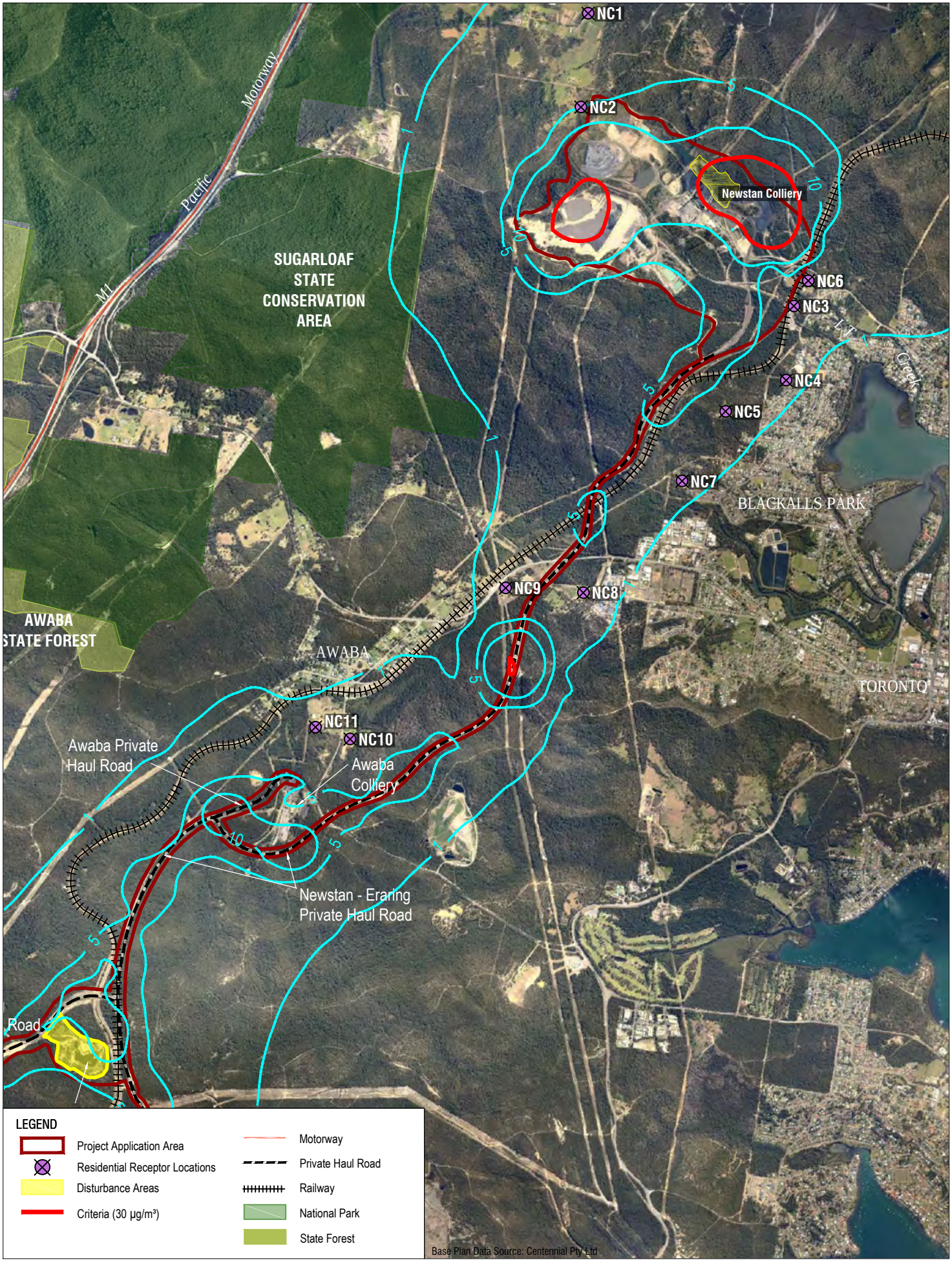
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 3c
Increment Only

APPENDIX B



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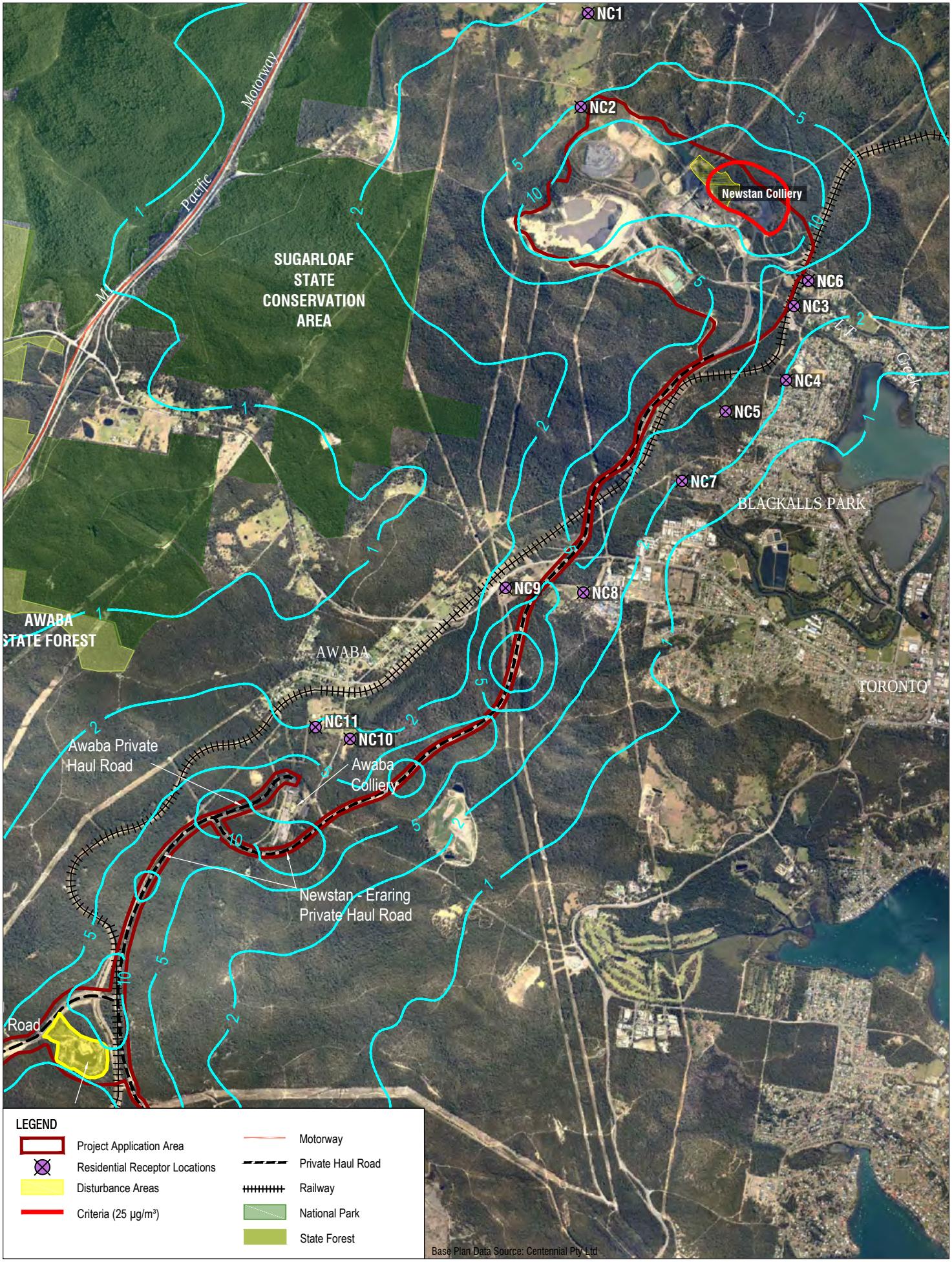
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 3c
Increment Only

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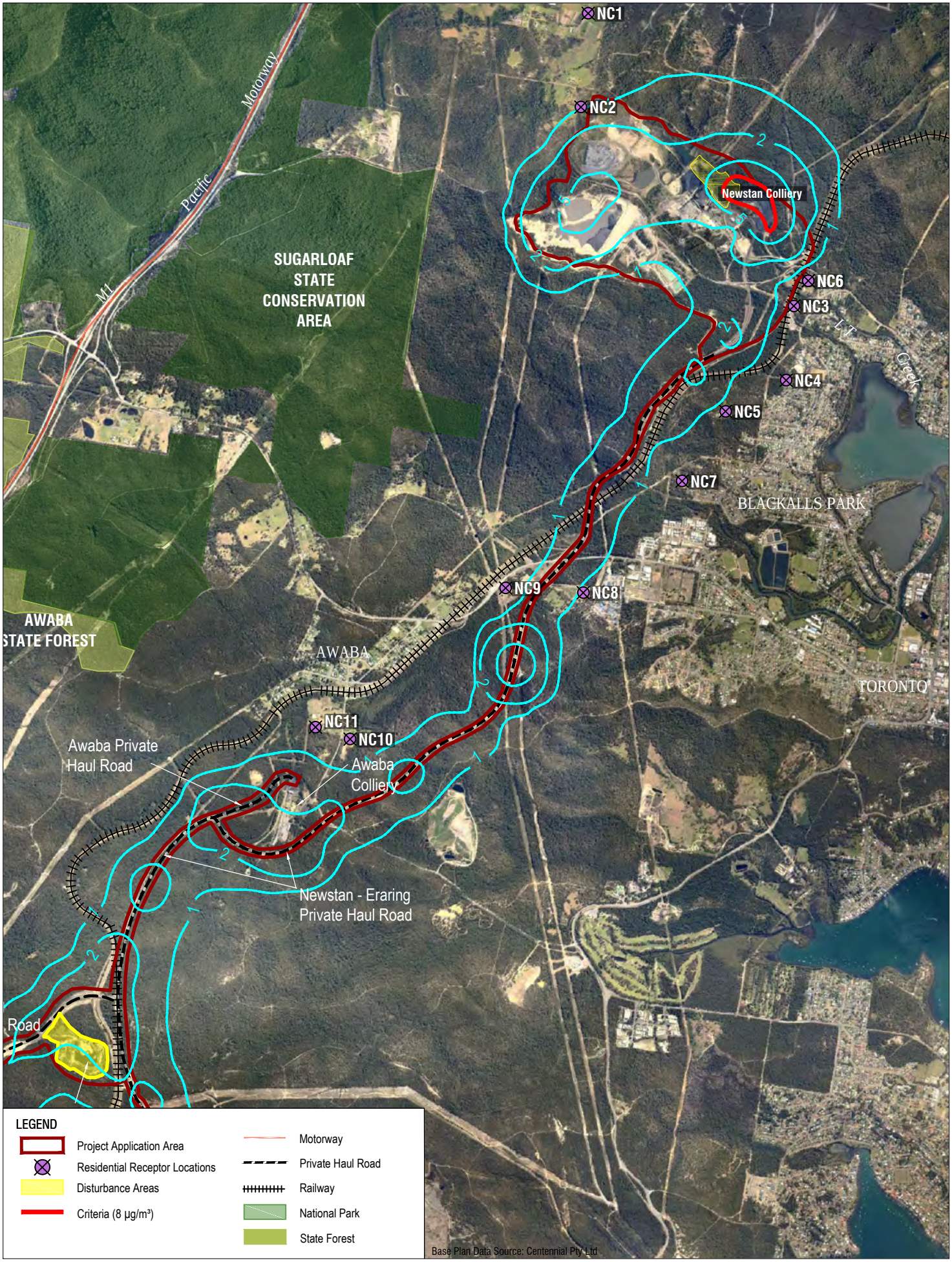
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 3c
Increment Only

APPENDIX B



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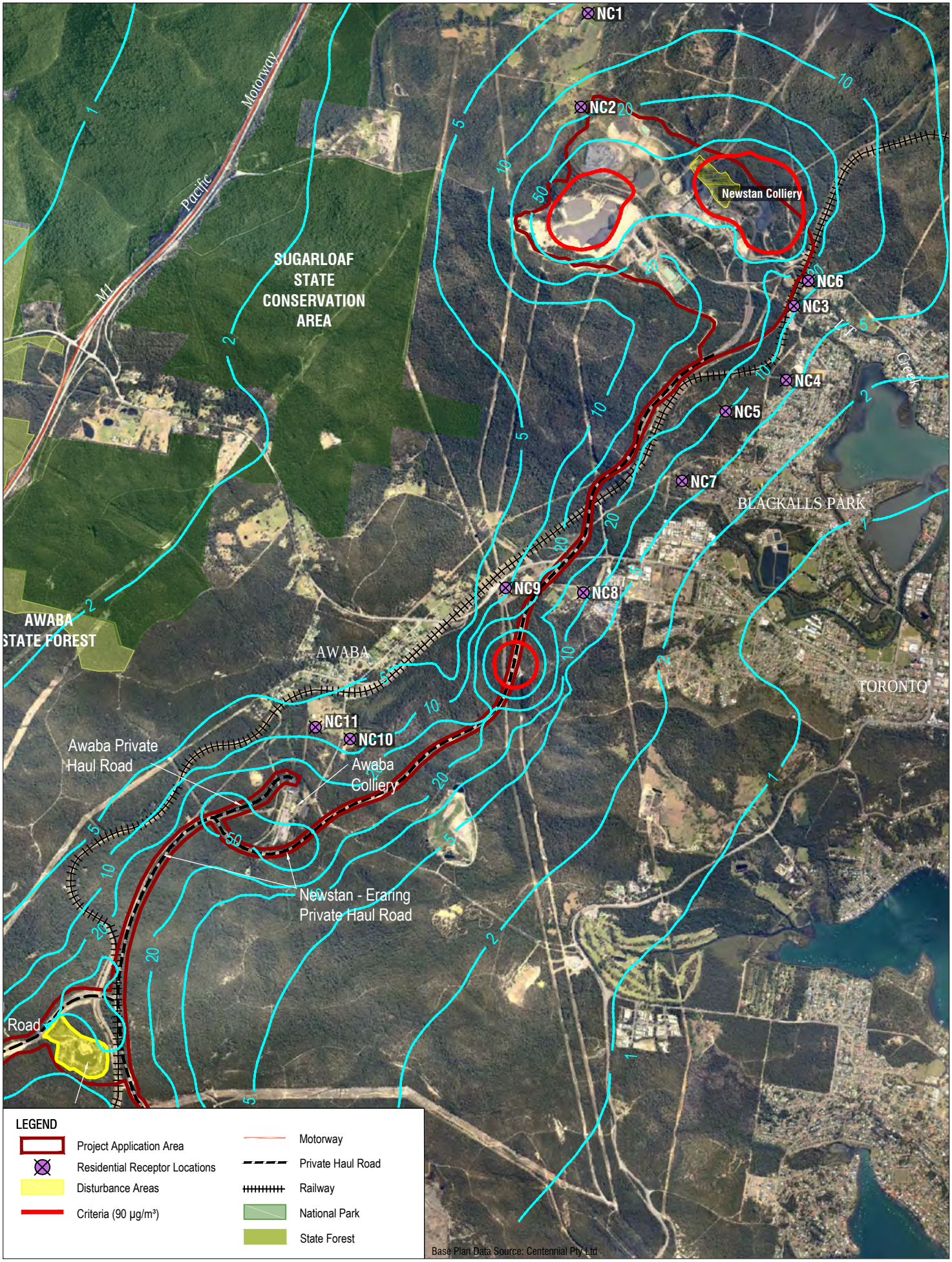
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 3c
Increment Only

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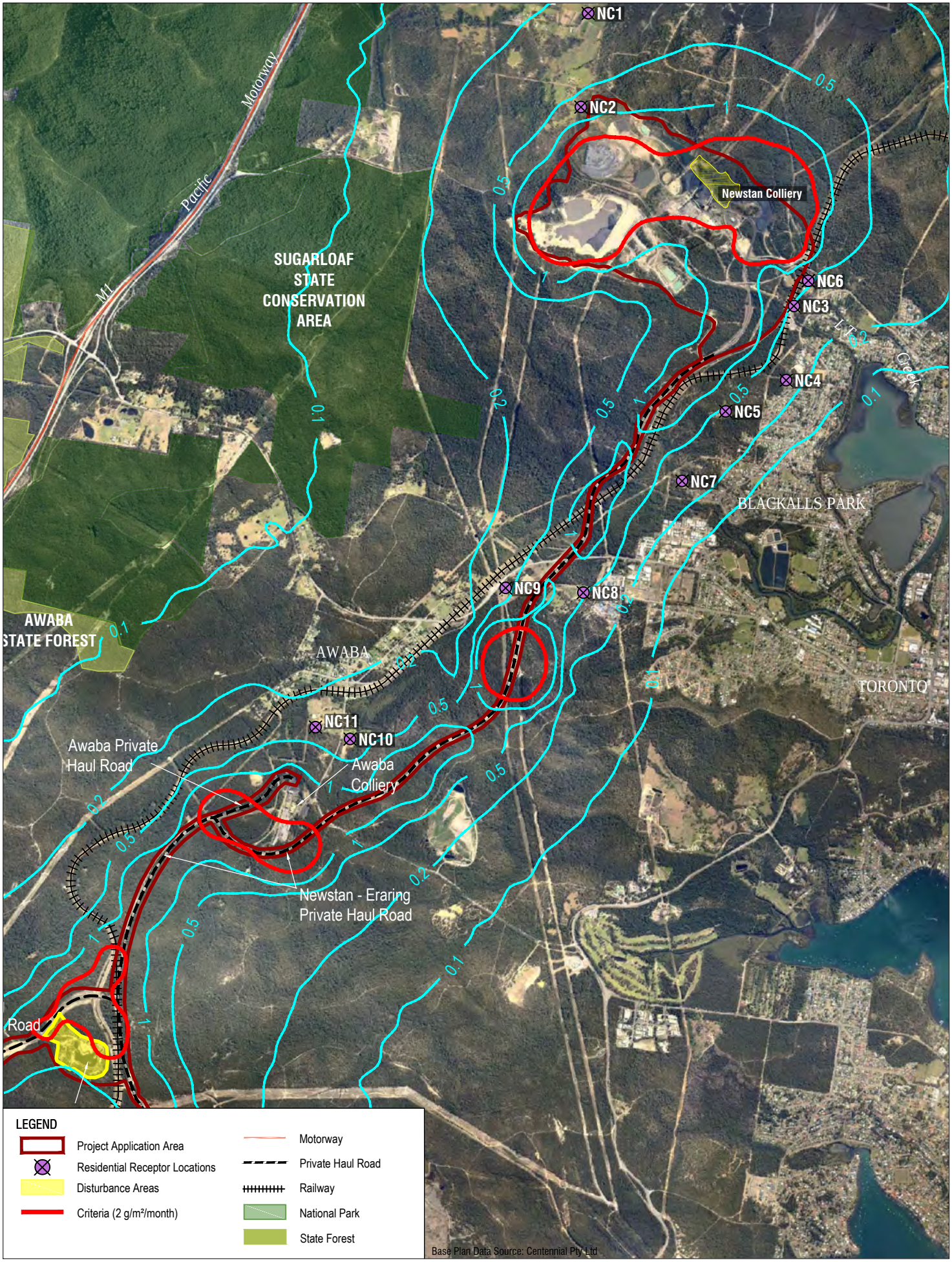
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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 3c
Increment Only

APPENDIX B



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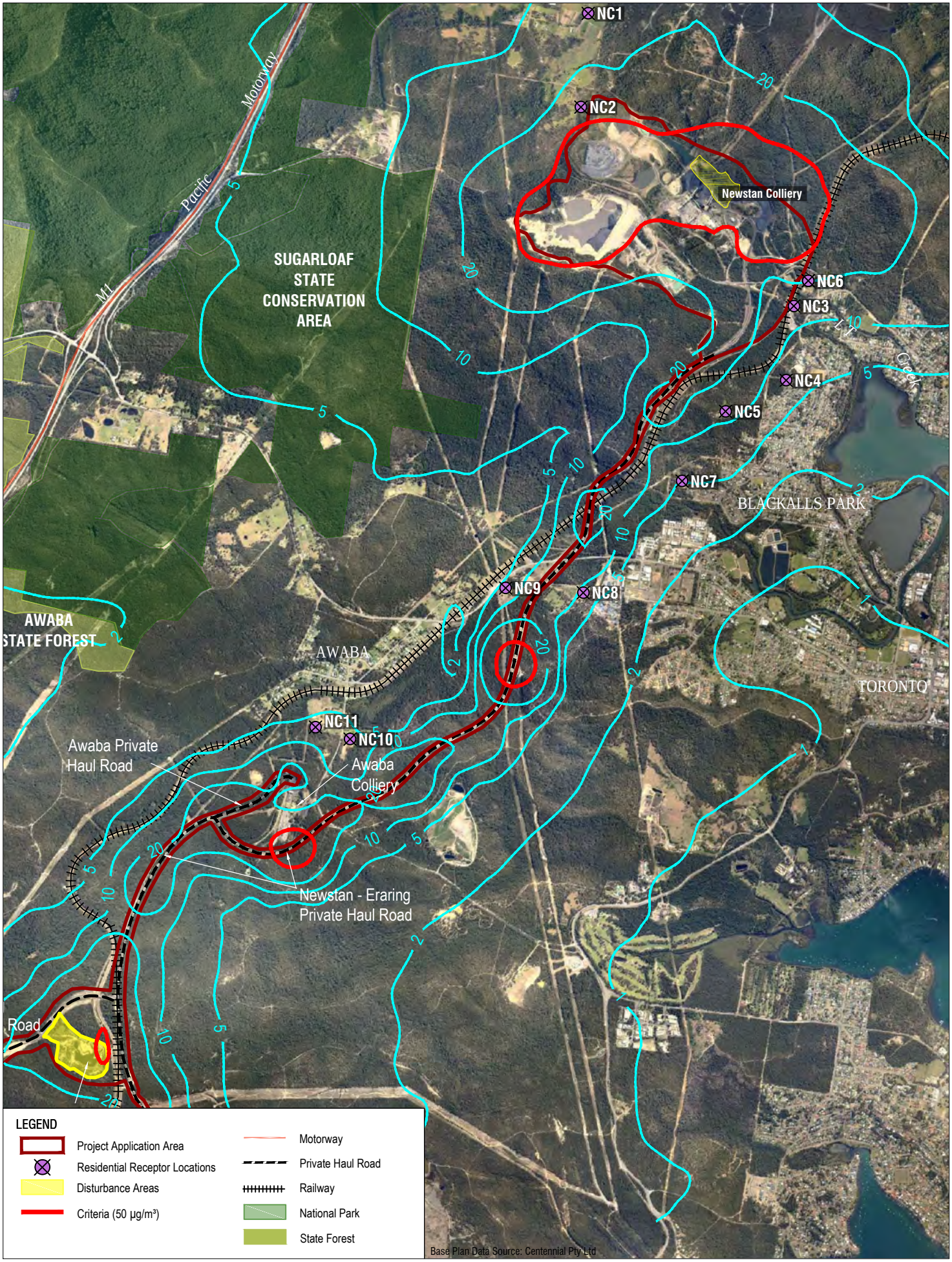
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 4
Increment Only

APPENDIX B



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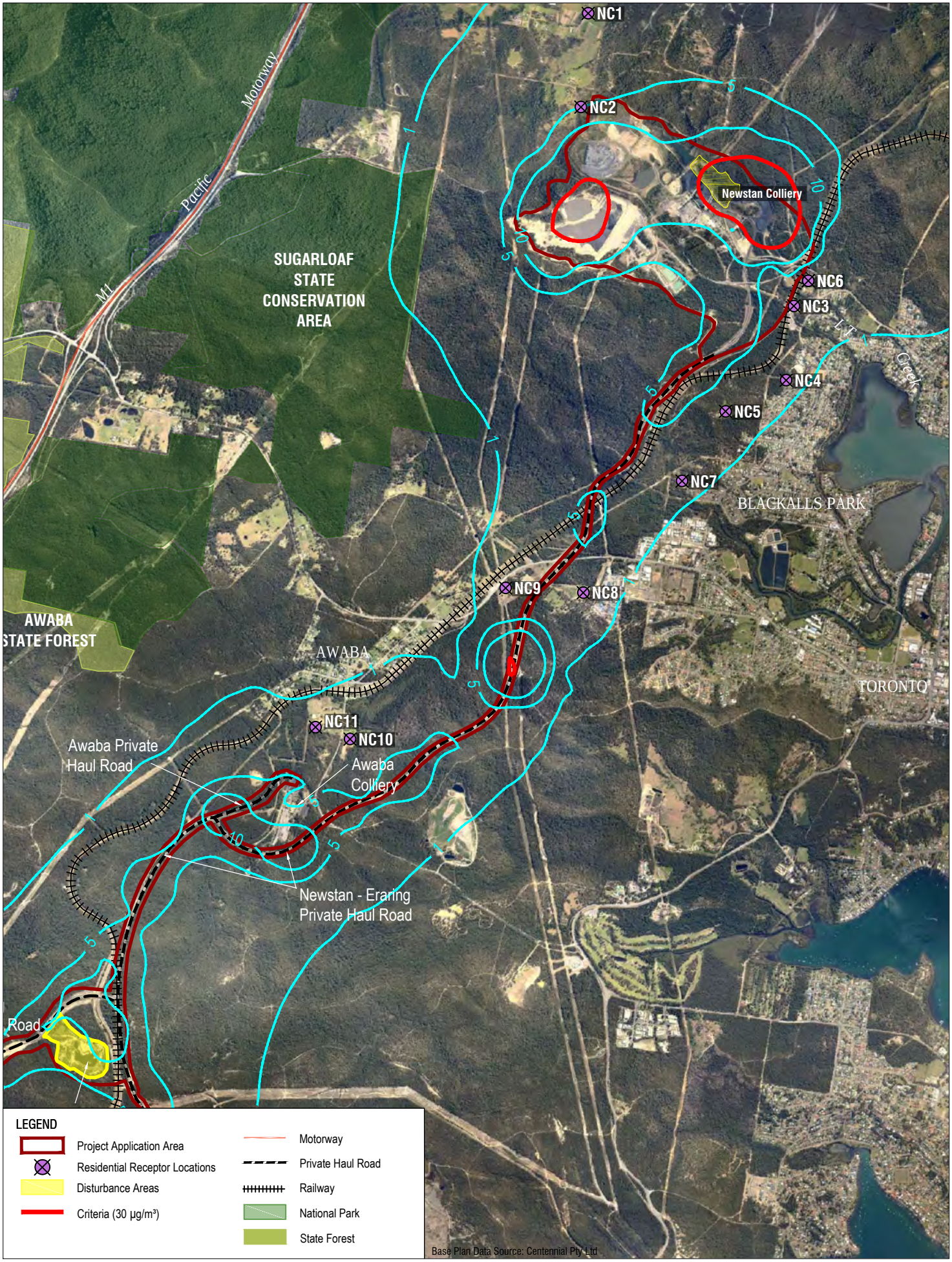
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 4
Increment Only

APPENDIX B



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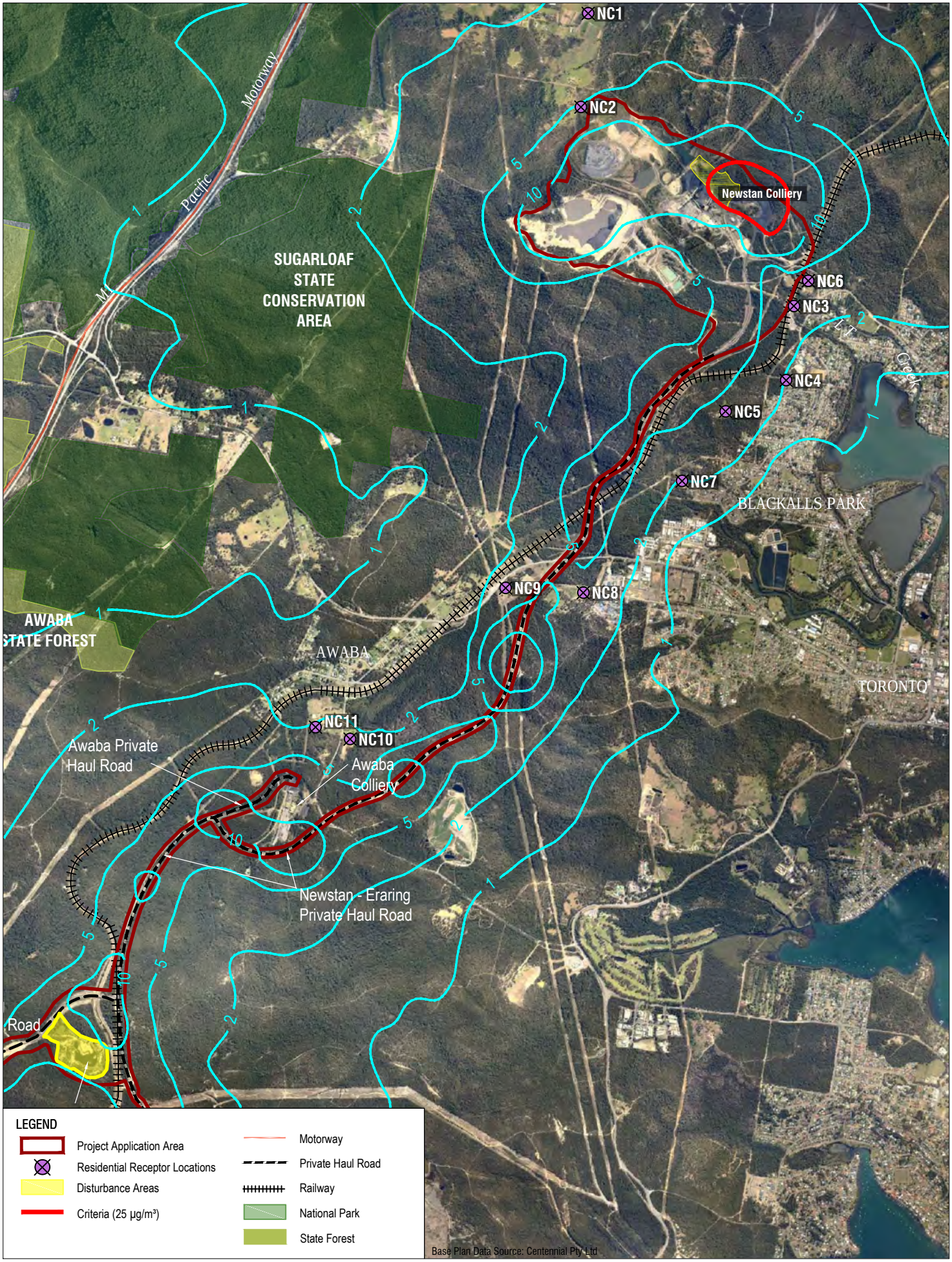
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 4
Increment Only

APPENDIX B



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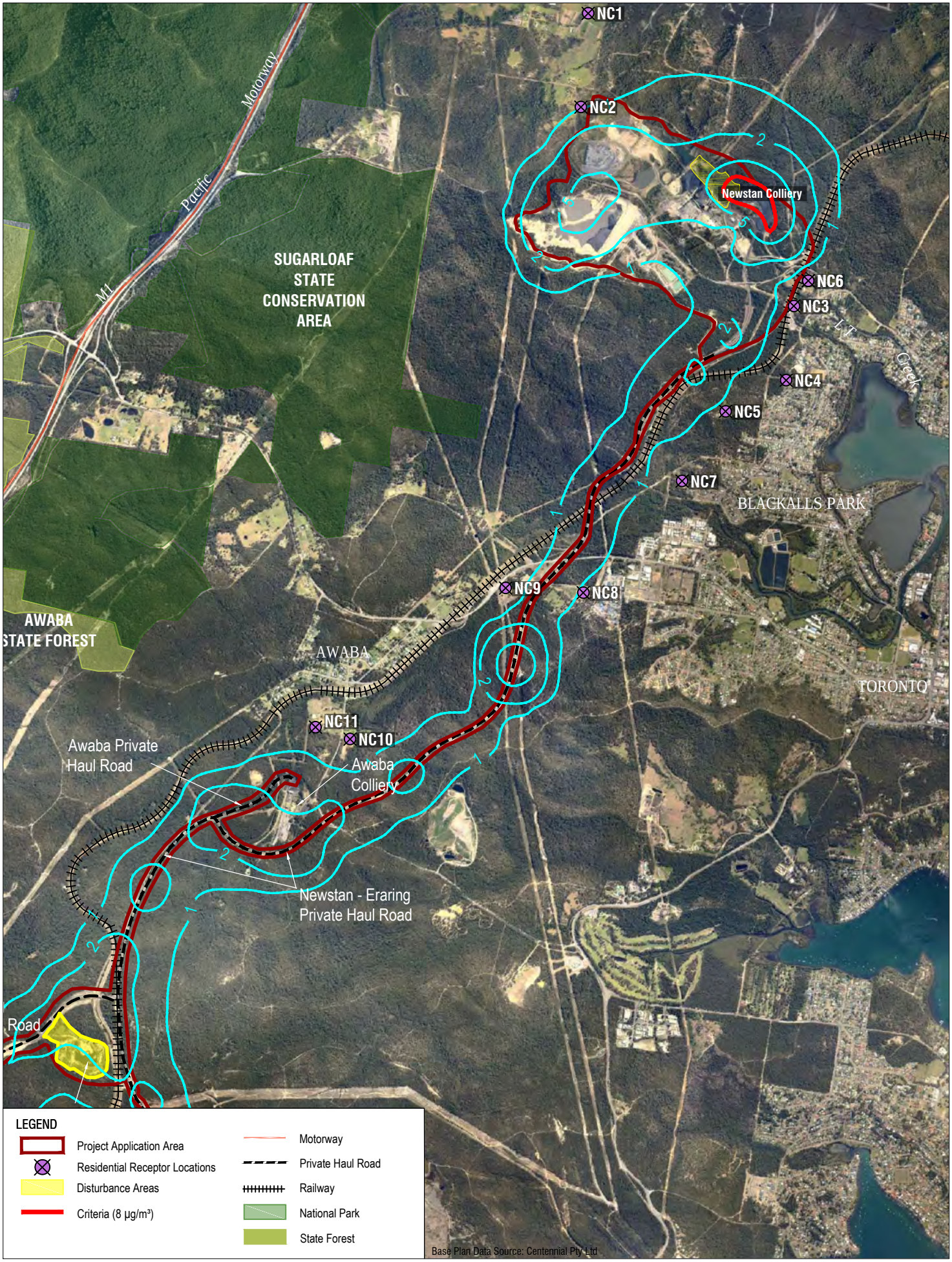
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 4
Increment Only

APPENDIX B



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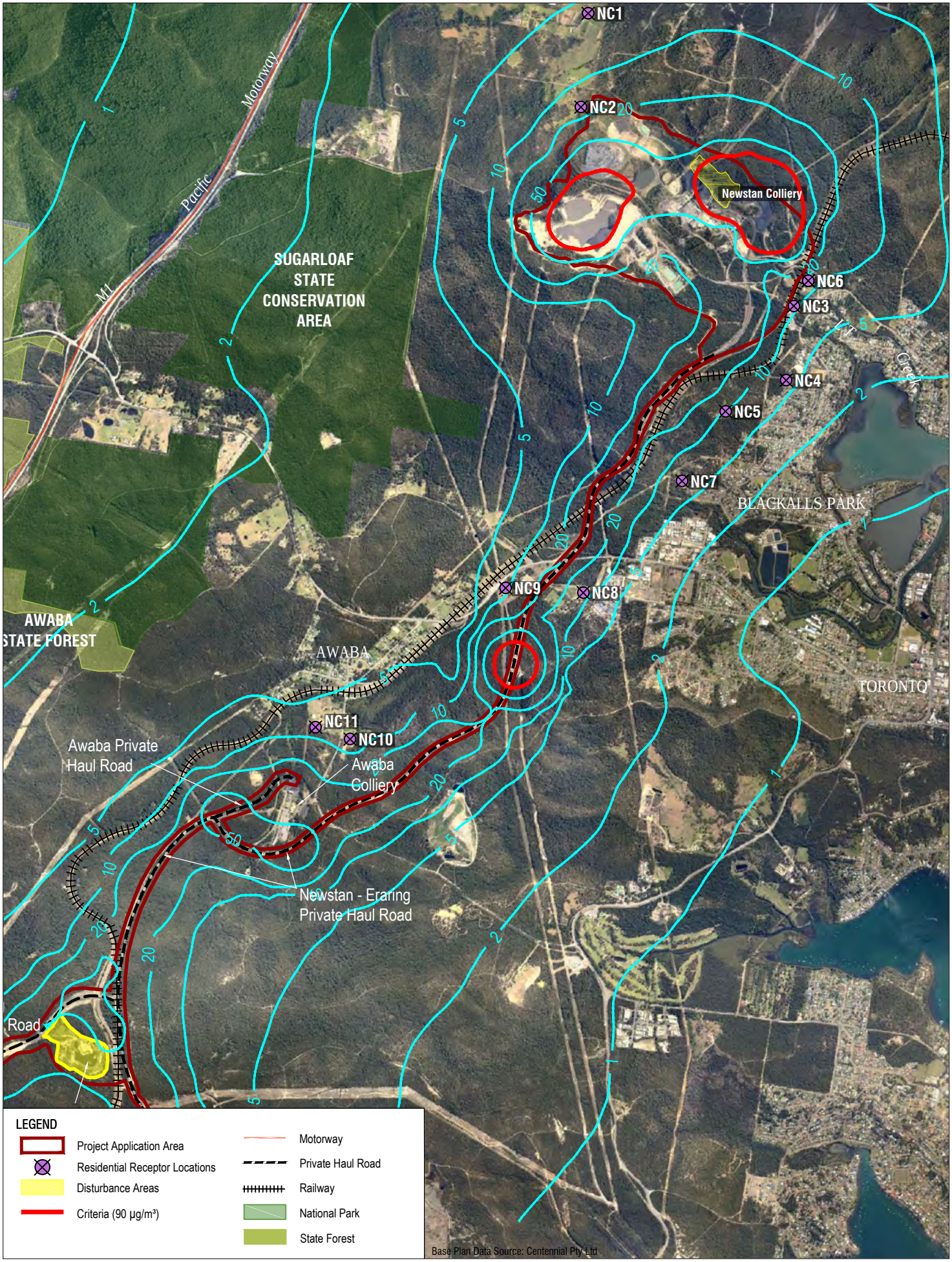
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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 4
Increment Only

APPENDIX B



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0.0 800 1600 m

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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 4
Increment Only

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N

0.0 240 480 m

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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 5a
Increment Only

APPENDIX B



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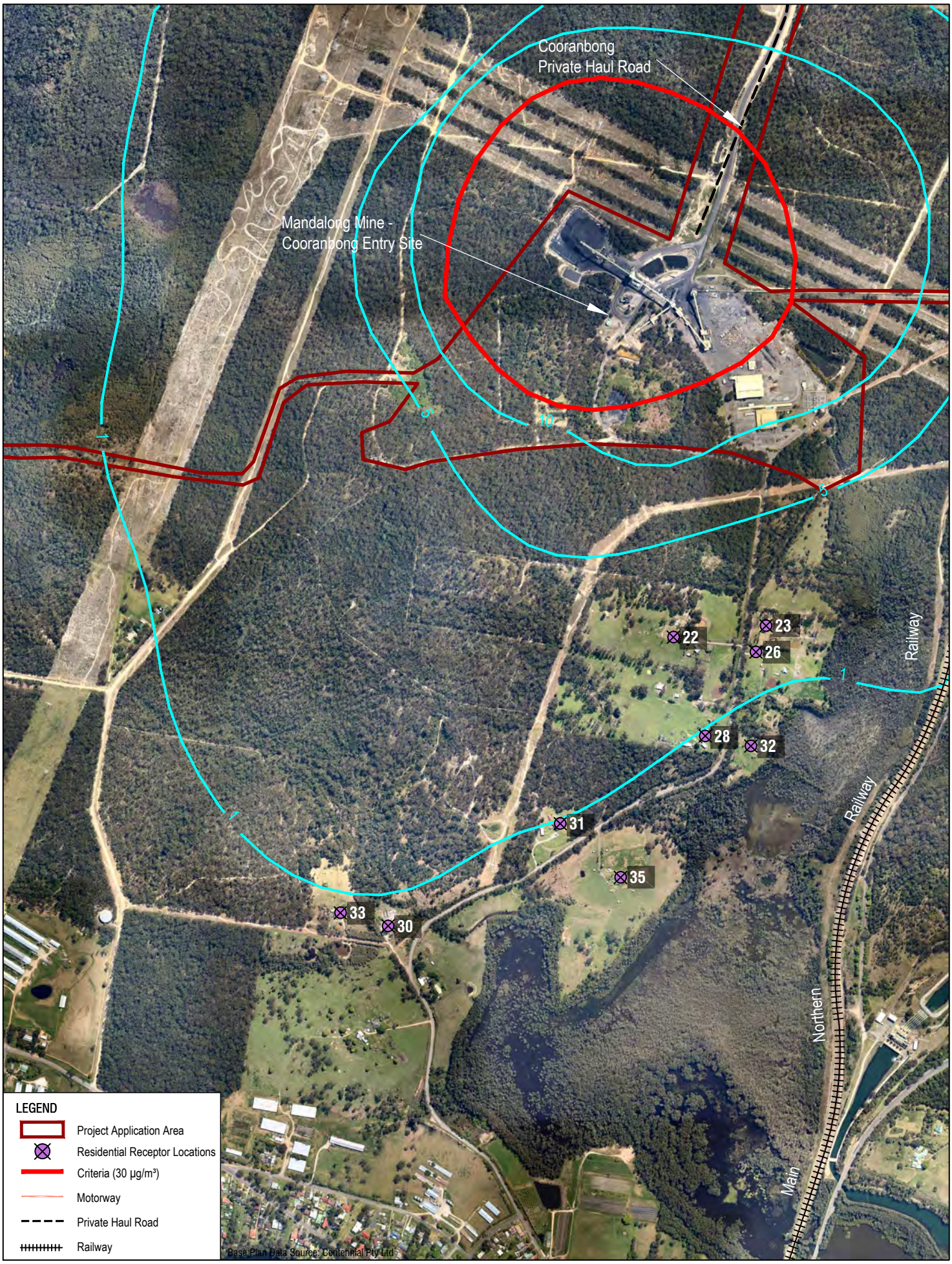
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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 5a
Increment Only

APPENDIX B



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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 5a
Increment Only

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0.0 240 480 m

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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - 24 Hour µg/m³
Scenario 5a
Increment Only

APPENDIX B



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0.0 240 480 m

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CENTENNIAL COAL LOGISTICS AIR

PM2.5 - Annual µg/m³
Scenario 5a
Increment Only

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CENTENNIAL COAL LOGISTICS AIR

TSP Annual µg/m³
Scenario 5a
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CENTENNIAL COAL LOGISTICS AIR

Dust Deposition Annual g/m²/month
Scenario 5b
Increment Only

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CENTENNIAL COAL LOGISTICS AIR

PM10 - 24 Hour µg/m³
Scenario 5b
Increment Only

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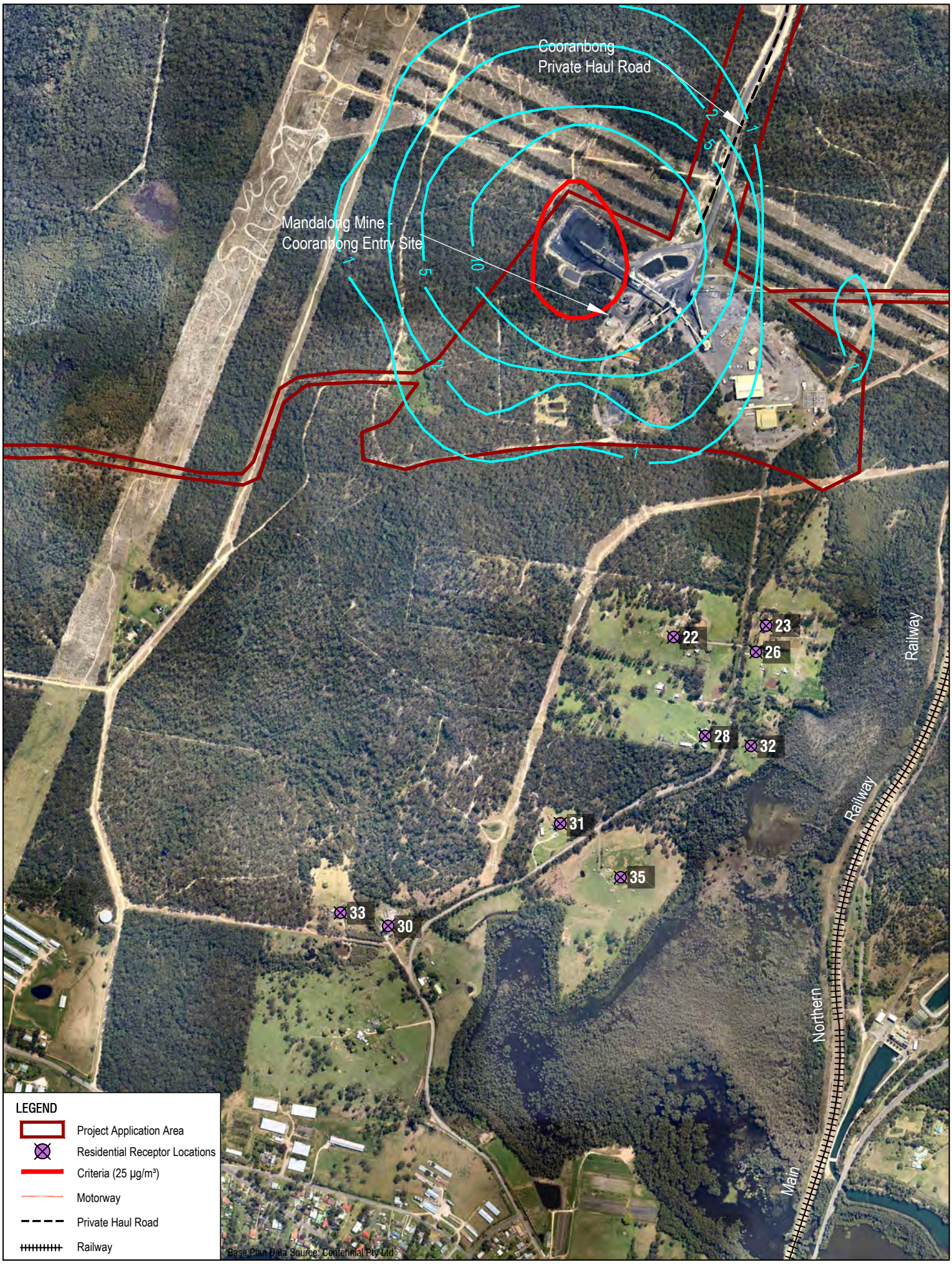
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CENTENNIAL COAL LOGISTICS AIR

PM10 - Annual µg/m³
Scenario 5b
Increment Only

APPENDIX B



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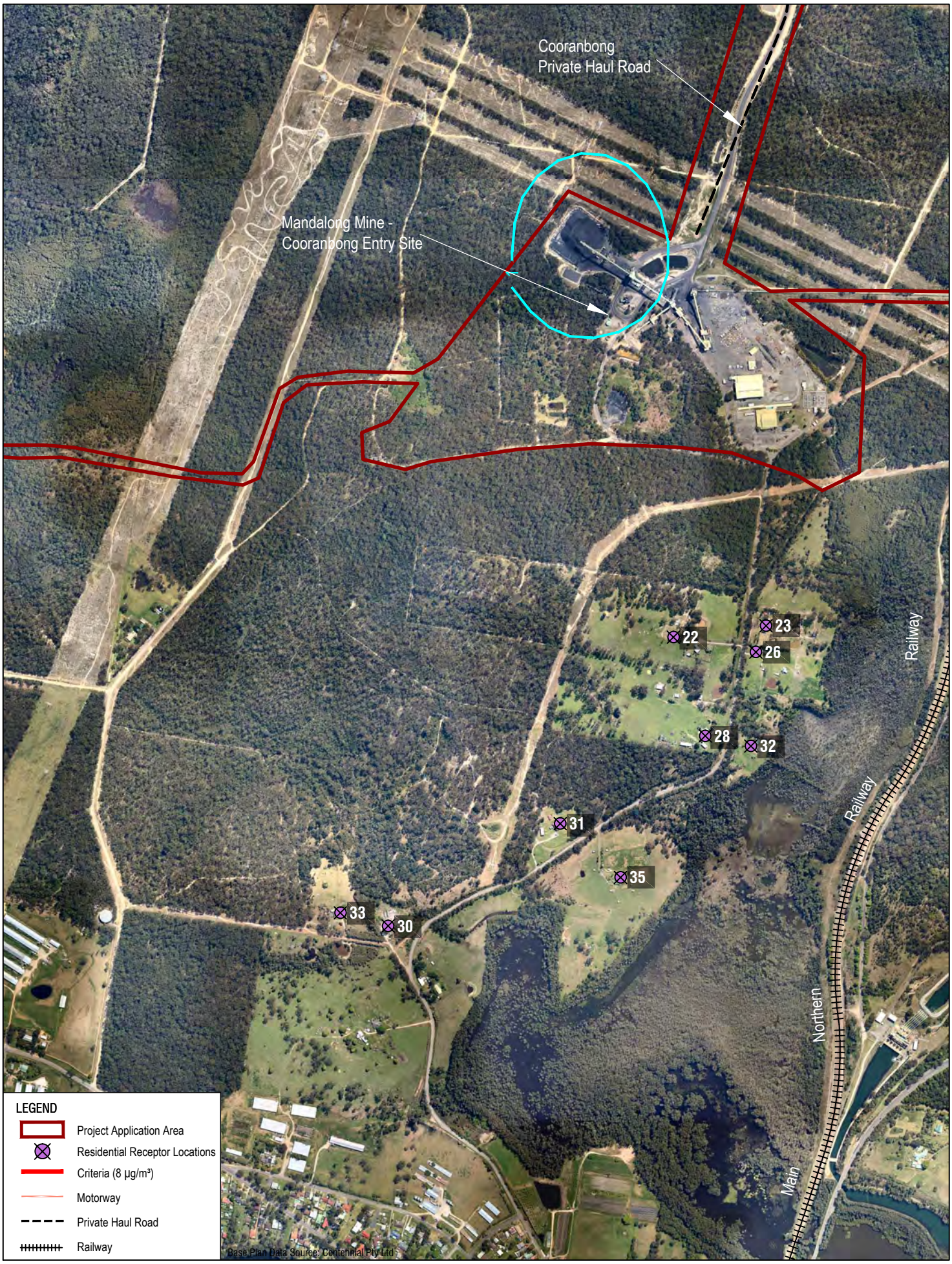
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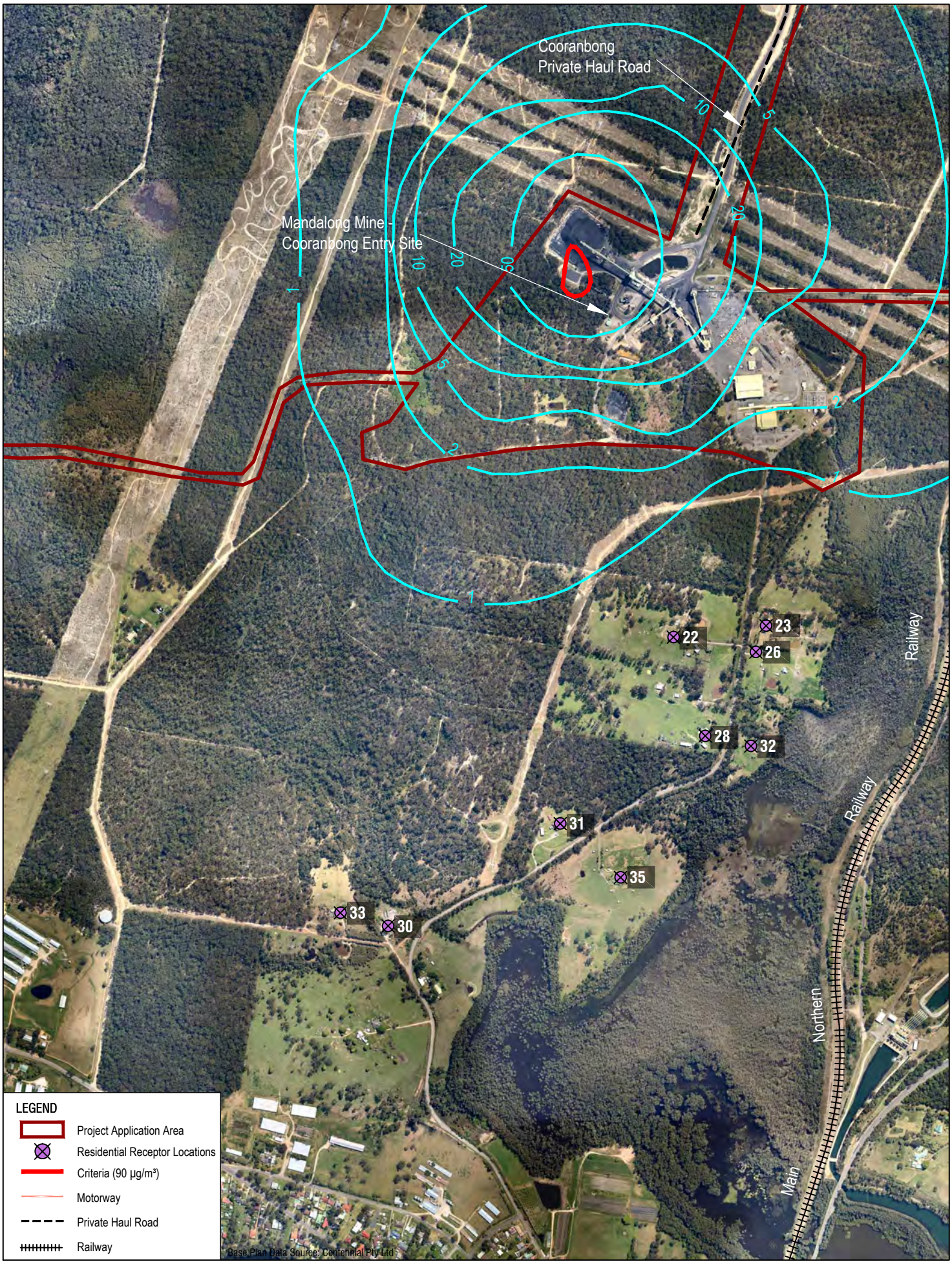
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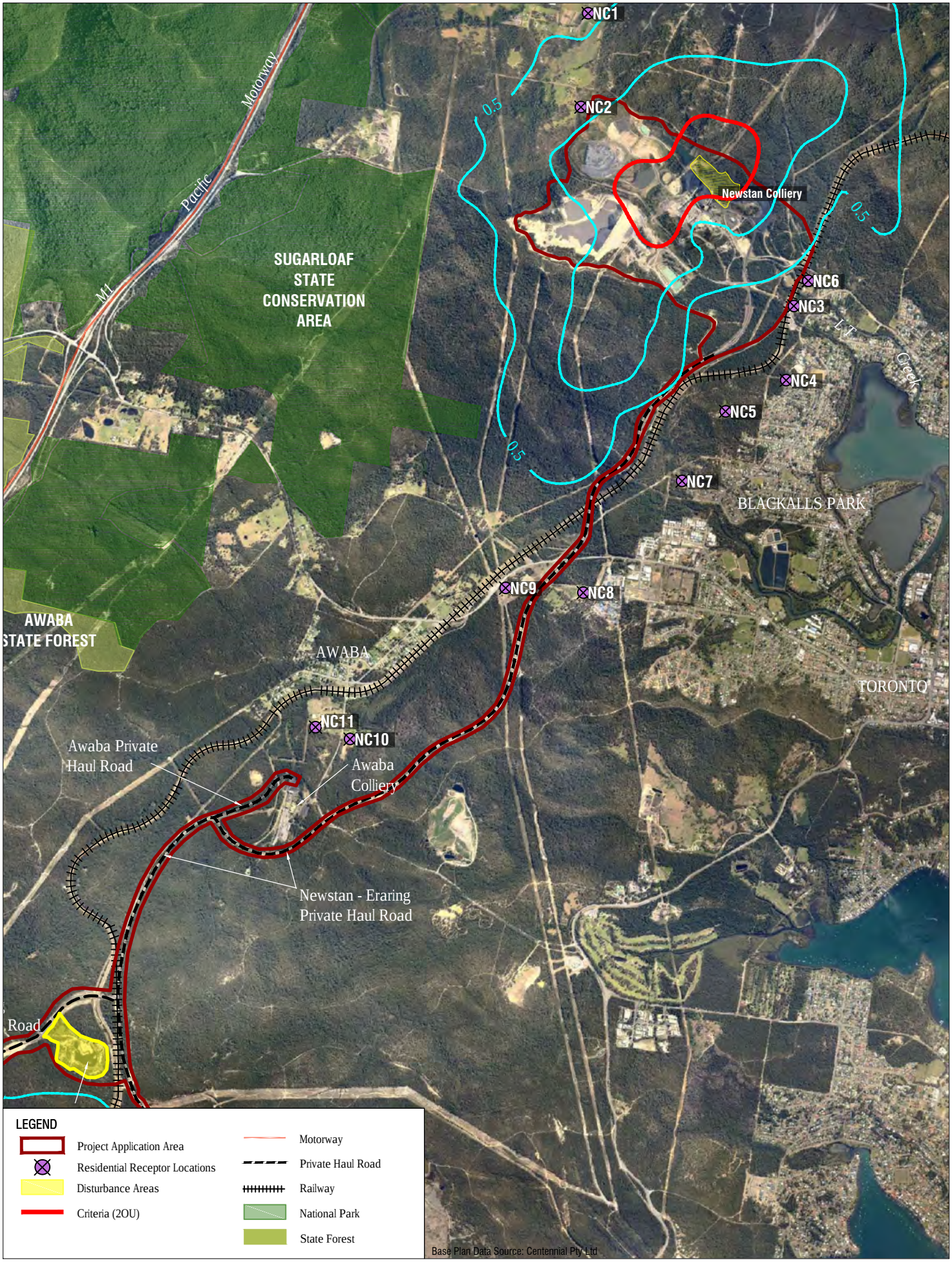
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TSP Annual µg/m³
Scenario 5b
Increment Only

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CENTENNIAL COAL LOGISTICS AIR

Odour (OU)
Increment Only

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Odour (OU)
Increment Only

APPENDIX B

Appendix 6 – DotE Feedback on the Flora and Fauna Impact Assessment

Preliminary Documentation Requirements	**Department's Comments on draft EIS (PD documentation)**
General comments	There is insuffient contextual information in the summary and introductory section of the EIS to explain how this EIS relates to the EPBC Act assessment by PD. • It must be clear that this document (or sections of) also constitutes the PD documentation required under the EPBC Act assessment. • The PD requirements need to be clearly identified and where the document addresses these requirements (e.g. as has been done for the DGRs in section 1.6). I note that there is a comment that "The *Flora and Fauna* Assessment (RPS 2014a) summarised in **Section 10.4** was prepared to satisfy the requirements of the additional information." however, this is well within the body of the EIS on page p200.
1. Details about the local population of the Black-eyed Susan (*Tetratheca juncea*), including an estimate of the number of individuals/clumps present in the vicinity of the project area derived from surveys in accordance with the methods recommended in the department's publication "Referral guidelines for the vulnerable black-eyed susan, *Tetratheca juncea*" (August 2011), available at: www.environment.gov.au/epbc/publications/black-eyed-susan.html.	adequate
2. Using the information gained from 1. above, an assessment of the residual impact to the Black-eyed Susan (*Tetratheca juncea*) including whether the proposed action will result in: • Indirect impacts, for example from dust, altered hydrology and/or edge effects. • Loss of greater than 25% of plant clumps within the affected area, or	Generally well covered. Further information is required on dust impacts – what levels of dust might the retained *Tetratheca juncea* be exposed to and what impact could this have.

• Fragmentation of a subpopulation by greater than 500 m within native vegetation, or 100 m within degraded or cleared vegetation.	
3. Details of proposed impact avoidance, mitigation and monitoring actions, including sediment and erosion control, weed and *Phytophthora cinnamomi* controls, and the proposed barrier to reduce noise and light impacts to bat species utilising the abandoned mine drift entrance.	Further information is required on what dust control measures might be implemented to protect *Tetratheca juncea* – cuurently it is only stated that "control measures will be implemented where necessary to protect adjacent vegetation communities "
4. Details of the proposed translocation trial for Black-eyed Susan (*Tetratheca juncea*) and *Grevillea parviflora* subsp. *parviflora*. Please note that the department does not support translocation as a mitigation measure. Translocation may be considered as part of an offset package, where its long-term success has been established using rigerous scientific methods.	Details are provided
5. Where impacts cannot be avoided or mitigated, an offset package to compensate for any predicted or potential residual significant impacts on matters of national environmental significance. Offsets should demonstrate consistency with the Commonwealth EPBC Act Environmental Offsets Policy (October 2012, or subsequent versions), available at www.environment.gov.au/epbc/publications/environmental-offsets-policy.html. Please find attached the department's information requirements in relation to EPBC Act offset proposals.	I note that it is concluded in the EIS that there will be no residually significant impact
6. Rehabilitation and decommissioning plans, including how these activities may impact threatened species.	Plans briefly outlined
7. Other information, as relevant to the controlling provision, listed threatened species and communities.	Adequate

Appendix 7 - Revised Flora and Fauna Impact Assessment

Northern Coal Logistics Project

Flora and Fauna Assessment

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Report Number: PR113119
Version / Date: Final / January 2015

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Draft C	Draft for Client Review	Arne Bishop	Paul Hillier	02.02.2014
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Final V.1	Final for Issue	Ziggy Andersons		19.03.2014
Final V.2	Final for Issue	Ziggy Andersons		17.04.2014
Final V.3	Final for issue	Arne Bishop		06.01.2015

Approval for Issue

Name	Signature	Date
Ziggy Andersons		17.04.2014

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Summary

Introduction

RPS Australia East Pty Ltd (RPS) was engaged by Northern Coal Services Pty Ltd (Northern Coal Services) to undertake a Flora and Fauna Assessment (FFA) as part of an Environmental Impact Statement for the Northern Coal Logistics Project (the Project). Northern Coal Services is seeking approval for the Project under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act 1979). The FFA is also designed to satisfy the additional Supplementary Information Requirements from the Commonwealth Department of the Environment (DoE) for approval of the Project under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). The aim of this FFA was to determine the likelihood of the Project having a significant impact on any threatened species, populations or ecological communities listed within the NSW *Threatened Species Conservation Act 1995* (TSC Act 1995) and / or Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) within the Project Application Area (PAA).

Based on the potential for significant impacts upon threatened species listed under the EPBC Act 1999, a referral was submitted (Ref: 2013/6906) to the Commonwealth Department of the Environment (DoE) (formerly the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC)). As a result of the referral process, the proposed action was deemed to be a Controlled Action and that the Project will need to be assessed through Preliminary Documentation. The controlled action decision letter and request for additional information is provided in **Appendix 1**. This report has been written to satisfy the requirements of the additional information request letter.

The Project comprises both a continuation of existing operations and an upgrade to the surface coal handling and preparation infrastructure at the Newstan Colliery Surface Site and the Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site), along with the existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Colliery Extension of Mining Project and Mandalong Southern Extension Project) for domestic and export markets.

The Project will allow for improved and flexible coal handling arrangements across both the Newstan Colliery and Mandalong Mine to deliver the range of coal products required to meet domestic and export market demands.

Two disturbance footprints are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site; and
- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

Flora

In total, the Project will result in approximately 21.4 ha of disturbance. Of that area 12.63 ha is already cleared / disturbed with the remaining area made up of 8.75 ha of remnant native vegetation in varying condition. The proposed disturbance footprints are made up of the following:

Site 1

- 3.50 ha of MU 15: Coastal Foothills Spotted Gum - Ironbark Forest;
- 1.22 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 2.78 ha of Cleared (roads, tracks and powerlines).

Site 2

- 2.00 ha of Regrowth Acacia decurrens;
- 1.93 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 0.10 ha of MU 6: Coastal Narrabeen Moist Forest; and
- 9.85 ha of Cleared (roads, tracks and waterbodies).

In total, two threatened flora species were detected within the proposed disturbance footprints. 376 *Tetratheca juncea* (Black-eyed Susan) were recorded within Site 1 and one *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) was recorded within Site 2. Both species are listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999.

Habitat

The habitat within Site 1 was found to be in good condition, with a mixture of mature trees and a juvenile understorey. Fallen timber and a dense groundcover provides suitable shelter for a wide range of terrestrial species, with hollow-bearing trees providing suitable breeding and nesting habitat for avifauna and arboreal species. In addition, the cave (old drift entrance) adjacent to Site 1, which is known as 'Bat Alley', provides potentially important roosting habitat for cave-dwelling bat species. Site 2 was found to be native vegetation that was mostly regrowth with large areas of cleared land and old quarry workings which have since filled with water.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints.

Fauna

In total, four threatened fauna species were recorded within the Project Application Area. The Little Lorikeet (*Glossopsitta pusilla*) was recorded within Site 1 and within close proximity to Site 2. The Grey-headed Flying-fox (*Pteropus poliocephalus*) was recorded within close proximity to Site 1. The Little Bentwing-Bat (*Miniopterus australis*) and Large-eared Pied Bat (*Chalinolobus dwyeri*) were both recorded within Site 1. Each of these species is listed as Vulnerable under the TSC Act 1995. In addition, the Grey-headed Flying-fox and Large-eared Pied Bat are listed as Vulnerable under the EPBC Act 1999.

Potential Impacts

As aforementioned, two threatened flora species were detected within the proposed disturbance footprints, namely *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) and *Tetratheca juncea* (Black-eyed Susan), which are both listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999. As a result of the Project, one individual of *G. parviflora* subsp. *parviflora* (within Site 2) and 376 clumps of *T. juncea* (within Site 1) will be removed.

As part of addressing the Controlled Action decision (**Appendix 1**), RPS conducted targeted seasonal surveys for *Tetratheca juncea* outside of the disturbance footprint area around Site 1. The purpose of

undertaking additional surveys outside of the disturbance footprint was to determine whether the proportion of the 'local population' (as defined in DSEWPAC 2011) within the disturbance footprint constitutes a loss of greater than 25% of the local population. A loss of greater than 25% of plant clumps is a considered a ' high risk of significant impacts on Black-eyed Susan' (DSEWPAC, 2011). The immediate surrounding vegetation type (MU30) is preferred habitat for *T. juncea* and following additional targeted surveys it has been established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west which number at least 1,958 clumps. This sub-population estimate is a conservative estimate and additional surveys within the region would most likely result in a much larger estimate of this subpopulation. Given the current information, the removal of 376 clumps equates to the removal of up to approximately 19.2% of the recorded sub-population of *T. juncea*.

Redesign of the disturbance footprint at Site 2 has led to the avoidance of 131 stems of *G. parviflora* subsp. *parviflora*. In addition, RPS has recorded several nearby occurrences of *G. parviflora* subsp. *parviflora* within the Newstan lease area. This includes the recording of 173 stems at three locations within habitat immediately adjacent to the proposed Site 2 disturbance footprints, as well as an additional 230 stems at 54 locations within vegetated habitats all located between 1 km and 4 km from the population recorded within Site 2. Therefore, large amounts of occupied and potential habitat exist for this species in the locality. Due to the avoidance measures enacted and the large amounts of available habitat, the impact assessments undertaken within this report have concluded that the removal of one individual stem of *G. parviflora* subsp. *parviflora* is unlikely to constitute a significant impact.

Three additional threatened flora species (*Syzygium paniculatum, Melaleuca biconvexa* and *Maundia triglochinoides*) occur or are likely to occur within the riparian zone downstream from the Hawkmount Quarry (Site 2 (refer to **Table 10**)). There is potential for impact upon these species as a result of water discharge from the sedimentation basin and associated LDP at this site. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon *S. paniculatum, M. biconvexa* and *M. triglochinoides*.

No threatened ecological communities or populations listed under the TSC Act 1995 or EPBC Act 1999 were detected within the disturbance footprints. However, four Endangered Ecological Communities (EECs) listed under the TSC Act 1995 occur downstream from proposed and existing LDPs. The Water Impact Assessment (GHD 2014) concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon these EECs.

The Project is likely to remove potential habitat for threatened fauna species, including Glossy Black-Cockatoo (*Calyptorhynchus lathami*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Scarlet Robin (*Petroica boodang*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*). Additionally, habitats within the disturbance footprints provide potential opportunities for threatened mammal species, including Spotted-tail Quoll (*Dasyurus maculatus maculatus*), Squirrel Glider (*Petaurus norfolcensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Little Bentwing-bat (*Miniopterus australis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Southern Myotis (*Myotis macropus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Previous surveys using harp traps placed at the entrance of Bat Alley (old drift entrance) near Site 1 detected the Little Bentwing Bat (*Miniopterus australis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), some of which appeared pregnant (Gunninah 1998b). On release, the bats flew directly into the

mine tunnel, suggesting that it is being used as a roosting and, possibly, nesting site. Due to safety concerns from rock fall, the drift entrance was not examined internally to verify if bats were utilising the mine for roosting purposes. However, the disused mine workings are most likely being utilised for roosting as bats were detected leaving the entrance at dusk.

The original area of the proposed Site 1 disturbance footprint has been redesigned to decrease potential impacts upon microbats utilising the shaft. A vegetation buffer has also been retained to ensure further protection of the microbats species, and additional mitigation measures have been proposed in this report. An annual ongoing monitoring program centred on Bat Alley has commenced.

With the exception of the Spotted-tail Quoll and Squirrel Glider the threatened fauna species which were considered to have potential to occur within the disturbance footprints are highly mobile and occupy large home ranges. Additionally, both of the disturbance footprints are adjacent to large areas of native vegetation providing additional habitat opportunities for those threatened fauna species. The relatively small area (8.75 ha) of native vegetation proposed to be disturbed is not expected to significantly impact upon the threatened fauna species considered, either by direct habitat loss or fragmentation. The potentially important bat roost area known as Bat Alley has been avoided and protected to ensure that no impact to potential breeding opportunities for the Little Bentwing Bat and Eastern Bentwing Bat occur.

The Project will result in an increase in truck movements within the existing private haul routes linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Hawkmount Quarry and Cooranbong Entry Site from the current maximum of 28 heavy vehicle movements per hour (14 two way trips per hour) to up to 32 heavy vehicle movements per hour (16 two way trips per hour). Due to the current design measures in place along the haul roads and the relatively small increase in truck movements proposed by the Project, it is anticipated that relatively low levels of incidents involving wildlife will be maintained.

Mine Water Discharges

In addition to the direct surface impacts within Site 1 and Site 2 (disturbance footprints), the Project proposes to increase water discharge through existing Licensed Discharge Points (LDPs) at Cooranbong Entry Site and Newstan Colliery Surface Site), and also establish a new LDP at the Newstan Colliery Surface Site and a new LDP at Hawkmount Quarry.

The Project proposes to increase the volume of surface water discharged via licensed discharge points (LDPs) at the various surface sites within the PAA. Specifically discharge through Newstan LDP001 at Newstan Colliery Surface Site into LT Creek is proposed to be increased from the current approved 11 ML per day to up to 14.5 ML per day. The Project will increase the likelihood of discharges from Newstan LDP003, which is predicted to potentially result in a decrease in maximum discharge from 60 ML/day to 39 ML/day. The discharge through Cooranbong LDP001 at the Cooranbong Entry Site into an unnamed tributary of Muddy Lake is proposed to be increased from the current approved 5 ML per day to up to 8 ML per day.

The proposed Hawkmount Quarry LDP will not be a constant discharge arrangement. During ‘construction’ phase for the quarry, existing water management storages on site will be dewatered down to manageable levels, where they will be maintained during operations. The estimates of potential maximum discharges as a result of the initial dewatering is expected to be a maximum 142 ML/yr within the first year with approximately the first six months of the construction period requiring an increased pump rate (3 ML/day). This increased pump rate is required to draw down the existing filled storage down to appropriate management levels. The average volume per year of water to be discharged from Hawkmount Quarry LDP during operations is predicted to be 40 ML/yr (0.11 ML/day). This volume is based on the rainfall predicted to fall within the Site 2 catchment and is based on 113 years of re-sampled rainfall data.

The potential impacts from increased mine water discharge include increases in flow and changes to water quality, particularly increases in salinity. Changes to hydrology and water chemistry have potential to impact upon terrestrial flora and fauna that inhabit the affected riparian environments.

Water Quality

GHD (2014) have utilised data collected from a variety of monitoring sites, and water quality values recommended by the ANZECC and ARMCANZ (2000) guidelines to establish site-specific trigger values (SSTVs) for discharges.

The ANZECC and ARMCANZ (2000) guidelines define trigger values as: *'the concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of impact if exceeded and should 'trigger' some action, either further ecosystem specific investigations or implementation of management/remedial actions'.*

The water which is to be discharged will be diluted or treated within a water management system. SSTVs have been set for all potential toxicants and have been derived from naturally occurring levels upstream of the site or within tolerance levels for flora and fauna set out by ANZECC and ARMCANZ (2000). Therefore, the discharges are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

Water Quantity

The expected increase in flows has been assessed for its potential to affect bank stability through erosion. GHD (2014).There is no evidence from the model predictions that the likelihood of the bank instability will be increased as a result of the Project. This has been based on the evaluation of the current and known permissible velocities for different channel conditions and or channel linings. Therefore, potentially occurring flora and fauna downstream are not considered likely to be impacted upon by sedimentation and erosion as a result of the Project.

The LDPs, which are to receive modified discharge rates as a result of the Project, are discussed further in **Section 6.2.**

Impact Mitigation

The surface disturbance footprints for the Project have been designed through the detailed planning processes to avoid impacts to threatened flora species and significant fauna habitat as far as practical. Additionally, a range of measures have been incorporated into the Project (such as light and sound barriers) to further minimise potential impacts to threatened flora and fauna. Further mitigation measures will be adopted by Northern Coal Services during the construction and operational phases of the Project to ensure potential impacts to flora and fauna species are further reduced. In addition, the population of T. juncea within Site 1 will be translocated and monitored in accordance with a research program to be developed by Northern Coal Services. The proposed translocation research programme will be designed to build on the existing knowledge gained from previous translocation trials undertaken by Centennial Coal.

A variety of indirect offset measures are proposed to offset the potential impacts of this Project. Compensatory measures will include translocation trials, installation of nest boxes and research programmes. It is proposed as part of the compensation measures to:

- Develop and implement a *Tetratheca juncea* translocation research programme to build on the current knowledge regarding translocation of this species. The 376 clumps of *Tetratheca juncea* from within Site 1 will be translocated and monitored in accordance with the proposed research programme;
- Install nest boxes at a ratio of 1:1 (i.e. one nest box for every habitat hollow removed). The design and

installation of nest boxes will draw on the information obtained from the 5 year research programme undertaken by Centennial Mandalong into the utilisation of different nest box designs and aspects; and

- Fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of Tetratheca juncea from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of *Tetratheca juncea*.

The proposed research programme has been developed with a focus on addressing the priority actions identified by the Office of Environment and Heritage and the Commonwealth DoE for *Tetratheca juncea* as part of this species Recovery Plan.

Conclusion

The seven-part tests conducted for threatened flora and fauna species and EECs recorded or considered likely to occur within the two proposed disturbance footprints and surface water discharge locations concluded that the Project is unlikely to have a significant impact (**Appendix 2**). The EPBC Act Assessment of Significant concluded that no Matters of National Environmental Significance which were detected or considered likely to occur within the Project Application Area will be significantly impacted by the Project (**Appendix 3**).

Terms & Abbreviations

Abbreviation	Meaning
API	Aerial Photograph Interpretation
DECCW	Former NSW Department of Environment, Climate Change and Water (now Office of Environment and Heritage)
DoE	Commonwealth Department of the Environment
DPC	NSW Department of Premier and Cabinet
EEC	Endangered Ecological Community
EPA	NSW Environment Protection Authority
EP&A Act 1979	NSW *Environmental Planning and Assessment Act 1979*
EPBC Act 1999	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPL	Environment Protection Licence
GIS	Geographic Information System
GPS	Global Positioning System
HBOC	Hunter Bird Observers Club
KTP	Key Threatening Processes
LDP	Licensed Discharge Point
LGA	Local Government Area
LHCCREMS	Lower Hunter and Central Coast Regional Environment Management Strategy
MNES	Matter of National Environmental Significance
Mtpa	Million tonnes per annum
NPW Act	NSW National Parks and Wildlife Act 1974
OEH	NSW Office of Environment and Heritage
PAA	Project Application Area
PFC	Percentage Foliage Cover
ROTAP	Rare or Threatened Australian Plants
RPS	RPS Australia East Pty Ltd
SEPP	State Environmental Planning Policy
DSEWPAC	Former Commonwealth Department of Sustainability, Environment, Water, Population and Communities (now Commonwealth Department of the Environment)
TSC Act 1995	NSW *Threatened Species Conservation Act 1995*

1.0 Introduction

RPS Australia East Pty Ltd (RPS) was engaged by Northern Coal Services Pty Ltd (Northern Coal Services) to undertake a Flora and Fauna Assessment (FFA) as part of the Environmental Impact Statement (EIS) for the Northern Coal Logistics Project (the Project). Northern Coal Services is seeking approval for the Project under Part 4 of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act 1979). Pursuant to Section 89C of the EP&A Act 1979, and in accordance with the *State Environmental Planning Policy (State and Regional Development) 2011* (SRD SEPP), the Project is comprises State significant development (SSD).

The aim of this FFA is to determine the likelihood of the Project having a significant impact upon any threatened species, populations or ecological communities listed within the NSW Threatened Species Conservation Act 1995 (TSC Act 1995) and/or Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999). It also aims to satisfy the Director General's Requirements (DGR's) issued for the Project on 20 March 2012 and re-issued on 7 August 2013 (see **Section 1.4**).

Based on the potential for significant impacts upon threatened species listed under the EPBC Act 1999, a referral was submitted (Ref: 2013/6906) to the Commonwealth Department of the Environment (DoE) (formerly the Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC)). As a result of the referral process, the proposed action was deemed to be a Controlled Action and the Project will need to be assessed through Preliminary Documentation. The controlled action decision letter and request for additional information is provided in **Appendix 1**. In addition to the aims mentioned above, this report has been written to satisfy the requirements of the additional information request letter (see **Section 1.4**).

1.1 Description of the Project

The Project comprises both a continuation of existing operations and an upgrade to the surface coal handling and preparation infrastructure at the Newstan Colliery Surface Site and the Mandalong Mine - Cooranbong Entry Site (Cooranbong Entry Site), along with the existing private haul roads and rail loading infrastructure. These facilities are integral to the on-going handling, processing and transport of coal from the underground workings of Newstan Colliery and Mandalong Mine (including the proposed Newstan Colliery Extension of Mining Project and Mandalong Southern Extension Project) into domestic and export markets.

The Project will allow for improved and flexible coal handling arrangements across Newstan Colliery and Mandalong Mine to deliver the range of coal products required to meet domestic and export market demands.

The primary components of the Project are:

- Re-develop and upgrade the existing coal preparation and handling infrastructure at the Newstan Colliery Surface Site to enable continued utilisation for the receipt, handling and processing of up to 8 million tonnes per annum (Mtpa) of run-of-mine (ROM) coal from the Newstan Colliery (up to 4.5 Mtpa), Awaba Colliery (up to 0.88 Mtpa) and Mandalong Mine (up to 6 Mtpa);
- Continue to utilise the existing coal handling infrastructure at the Cooranbong Entry Site to enable the receipt, handling and processing of up to 6 Mtpa of ROM coal from Mandalong Mine;
- Increase the volume of coal transported from the Cooranbong Entry Site to Newstan Colliery Surface Site, via trucks using existing private haul roads, from 4 to 6 Mtpa;
- Increase the volume of coal transported from the Cooranbong Entry Site to Eraring Power Station, using an existing dedicated overland conveyor, from 4 to 6 Mtpa;

- Increase the volume of coal transported from the Newstan Colliery Surface Site to Eraring Power Station, via trucks using existing private haul roads, from 2 to 4.5 Mtpa;
- Increase the volume of coal transported from the Newstan Colliery Surface Site rail loading facilities by train to the Port of Newcastle and/or Port Kembla (for export) and/or Vales Point Power Station from 3 to 8 Mtpa;
- Continue to transport up to 0.5 Mtpa of middlings by truck via private haul roads from Newstan Colliery Surface Site to Cooranbong Entry Site for subsequent supply to the Eraring Power Station via a dedicated overland conveyor.
- Continue to transport up to 0.88 Mtpa of material (including coal and stone from construction activities undertaken as part of the Newstan Colliery Extension of Mining Project) by truck via private haul roads from the Awaba Colliery Surface Site to the reject emplacement areas at the Newstan Colliery Surface Site;
- Transport reject material from the Newstan Colliery Surface Site to the Newstan Colliery Northern Reject Emplacement Area (NREA), Newstan Colliery Southern Reject Emplacement Area (SREA) and/or Hawkmount Quarry via existing private haul roads;
- Increase the volume of water discharged via licensed discharge points at the Newstan Colliery Surface Site and Cooranbong Entry Site;
- Provide employment for up to 120 full-time personnel;
- Provide a life of operation of 30 years from the granting of development consent; and
- Operate 24 hours per day, seven days per week.

While the majority of land within the Project Application Area (PAA) is already highly disturbed and developed, the Project does comprise two areas of proposed surface disturbance:

  - Site 1 - Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-development and upgrade of the coal handling and processing infrastructure at this site; and
  - Site 2 – An area of approximately 13.9 ha within Hawkmount Quarry (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

The Project proposes to increase the volume of surface water discharged via licensed discharge points (LDPs) at the various surface sites within the PAA. Specifically discharge through Newstan LDP001 at Newstan Colliery Surface Site into LT Creek is proposed to be increased from the current approved 11 ML per day to up to 14.5 ML per day. The project will increase the likelihood of discharges from Newstan LDP003, with a predicted decrease in maximum discharge from 60 ML/day to 39 ML/day. The discharge through Cooranbong LDP001 at the Cooranbong Entry Site into an unnamed tributary of Muddy Lake is proposed to be increased from the current approved 5 ML per day to up to 8 ML per day.

The proposed Hawkmount Quarry LDP will not be a constant discharge arrangement. During the initial 'construction' phase, existing water management storages on site will be dewatered down to manageable levels, to be maintained during the operation phase. The estimate of potential maximum discharges as a result of the initial dewatering is expected to be a maximum of 142 ML/yr. This increased pump rate is required to draw down the existing filled storage down to appropriate management levels. The average volume per year of water to be discharged from Hawkmount Quarry LDP during operations is predicted to be 40 ML/yr (0.11 ML/day). This volume is based on the rainfall predicted to fall within the Site 2 catchment and is based on 113 years of re-sampled rainfall data.

A reach of the North Arm of LT Creek just downstream from Newstan LDP001 is proposed to be enclosed into a pipeline in order to mitigate any potential contamination from the increase in coal stockpile. The pipe will enclose LT Creek from the downstream side of the By-Wash Dam in the upper catchment to the south of

the rail loading facility. This pipe will be built to withstand the predicted increase in discharge. An Aquatic Ecology Impact Assessment prepared by Cardno (2013) to assess the impacts associated with the pipeline proposal (refer to **Appendix 8**).

The haulage of coal and reject material along private haul roads is expected to result in an increase in truck movements from 28 movements per hour (14 two way trips per hour) to up to 32 movements per hour (16 two way trips per hour).

1.2 Site Particulars

Locality The Project Application Area (PAA) is located between Fassifern and Dora Creek, on the western side of Lake Macquarie approximately 25 km south-west of Newcastle, NSW.

LGA Lake Macquarie

Area The PAA encompasses 503 ha. The proposed disturbance footprints include Site 1, with a proposed disturbance footprint of approximately 7.5 ha, and Site 2, with a proposed disturbance footprint of 13.9 ha... For the purposes of this ecological assessment Site 1 and Site 2 will referred to separately when depicting the localities of specific impacts. However, Site 1 and Site 2 will be referred to collectively as the 'disturbance footprints' within the impact assessment.

Boundaries Site 1 is located within the Newstan Colliery Surface Site and is adjacent to an area of native vegetation. Site 2 is located within the Hawkmount Quarry area adjacent to the Cooranbong Private Haul Road, with native vegetation to the north and south.

Current Land Use The Newstan Colliery Surface Site is currently owned and operated by Centennial Newstan Pty Limited and comprises coal handling and processing infrastructure, reject emplacement areas, water management infrastructure, rail loading infrastructure and mine support infrastructure. The site is accessed from Miller Road, which traverses through the site, and the Main Northern Railway Line traverses immediately to the east.

Site 1 comprises undeveloped land that predominantly consists of native vegetation, with a powerline easement dissecting the northwest corner.

The Cooranbong Entry Site is currently owned and operated by Centennial Mandalong Pty Limited and comprises coal handling and processing infrastructure, water management infrastructure and mine support infrastructure The site is accessed from Gradwells Road (from Dora Creek) and is connected to Newstan Colliery Surface Site via private haul roads.

Hawkmount Quarry is located on Crown land under a permissive occupancy held by Lake Macquarie City Council (LMCC). It comprises a disused quarry located adjacent to the Cooranbong Private Haul Road. The quarry has not been used for extraction purposes for several years, and there is no evidence of any closure or rehabilitation activities.

Site 2 comprises mostly cleared/disturbed land, with some native vegetation.

The private haul roads that link the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Cooranbong Entry Site, Hawkmount Quarry and Eraring Power Station are:

- Newstan-Eraring Private Haul Road - owned by Eraring Energy and links the Newstan Colliery Surface Site to the Eraring Power Station.
- Cooranbong Private Haul Road – owned by Centennial Mandalong Pty Limited and links the Cooranbong Entry Site to the Newstan Colliery Surface Site via the Newstan-Eraring Private Haul Road.
- Awaba Private Haul Road – owned by Centennial Newstan Pty Limited and links the Awaba Colliery Surface Site to the Newstan-Eraring Private Haul Road.

Topography The PAA is located in gently undulating terrain. Numerous drainage lines are present throughout the PAA, which ultimately drain eastwards into Lake Macquarie.

1.3 Scope of the Study

The scope of this FFA is to:

- undertake a desktop assessment of relevant ecological assessments within and adjacent to the PAA;
- undertake relevant database searches of threatened flora and fauna species, populations and ecological communities within a 10 km radius of the PAA;
- identify threatened flora and fauna species, populations and ecological communities known or likely to occur within the proposed disturbance footprints;
- identify vascular plant species found within the proposed disturbance footprints;
- identify and map existing vegetation communities;
- consider the direct and indirect impacts associated with the proposed increase in surface water discharge via licensed discharge points;
- undertake seven part tests under the TSC Act to assess the potential of the Project to have a significant impact on any threatened species, populations or ecological communities (listed under the TSC Act) known or likely to occur within the proposed disturbance footprints (including the areas which have the potential to be impacted upon as a result of surface water discharges) and/or their immediate vicinity;
- assess the potential of the Project to have a significant impact on any Matters of National Environmental Significance (listed under the EPBC Act) known or likely to occur within the proposed disturbance footprints and/or their immediate vicinity; and
- provide all relevant information as required by government agencies and stakeholders, specifically Department of Planning and Infrastructure (DP&I) (Director General's Requirements), DoE, NSW Environment Protection Authority (EPA), NSW Office of Environment and Heritage (OEH) and Forests NSW.

1.4 Environmental Assessment Requirements

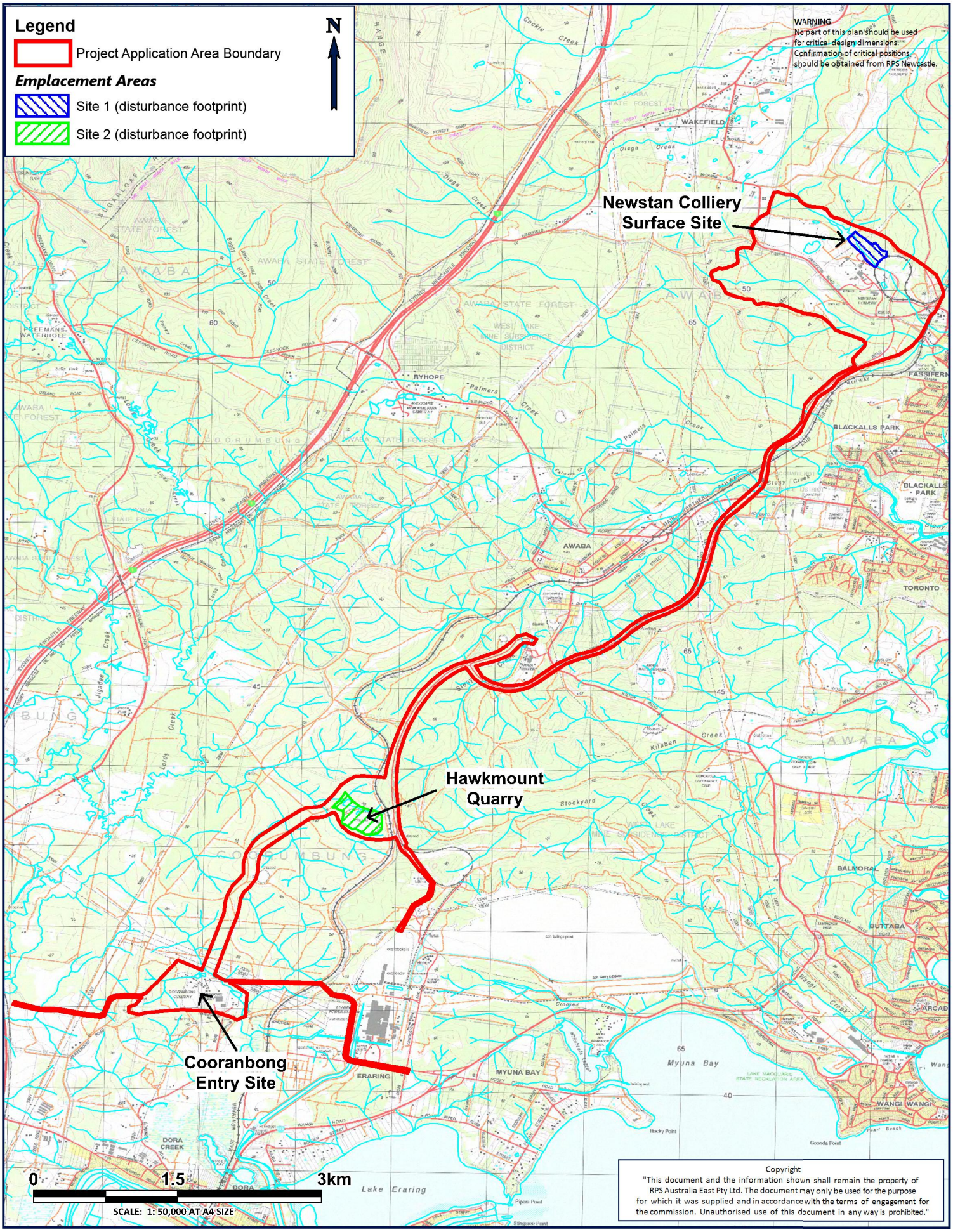
Environmental Assessment Requirements were issued for the Project by the Director General for the Department of Planning and Infrastructure on 20 March 2012 and re-issued on 7 August 2013. This report addresses the Director General's Requirements (DGRs), along with additional information requirements in response to the controlled action decision for EPBC reference 2013/6906 made by DoE (refer to **Appendix 1**). **Table 1** below lists the DGRs (including the EPA's requirements) and DoE's requirements relevant to this assessment and where they have been addressed in this report.

Table 1 Environmental Assessment Requirements

Requirement	Report section addressing requirement
Director General Requirements	
Measures taken to avoid, reduce or mitigate impacts on biodiversity	**Section 7**
Accurate estimates of proposed vegetation clearing	**Table 8**
A detailed assessment of potential impacts of the development on any:	-
1. Terrestrial or aquatic threatened species or populations and their habitats and endangered ecological communities;	**Section 6**
2. Groundwater dependant ecosystems; and	**Section 6.1.5**
3. Regionally significant remnant vegetation or vegetation corridors	**Section 4.6.2**
A comprehensive offset strategy to ensure the development maintains or improves the terrestrial and aquatic biodiversity values of the region in the medium to long term	**Section 7.3**
NSW Environment Protection Authority (Scenario 2 – Where a proposal is assessed outside the BioBanking Assessment Methodology)	
1. The EIS should include a detailed biodiversity assessment, including assessment of impacts on threatened biodiversity, native vegetation and habitat. This assessment should address the matters included in the following sections.	**Section 6**
2. A field survey of the site should be conducted and documented in accordance with relevant guidelines, including:	-
▪ the Threatened Species Survey and Assessment Guidelines: Field Survey Methods for Fauna − Amphibians (DECC, 2009)	**Section 3**
▪ Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities − Working Draft (DEC, 2004), and	**Section 3**
▪ Threatened species survey and assessment guideline information on www.environment.nsw.qov.aulthreatenedspecies/surveyassessmentqdlns.htm.	**Section 3**
If a proposed survey methodology is likely to vary significantly from the above methods, the proponent should discuss the proposed methodology with the Environment Protection Authority (EPA) prior to undertaking the EIS, to determine whether the EPA considers that it is appropriate.	-
Recent (less than five years old) surveys and assessments may be used. However, previous surveys should not be used if they have:	-
▪ been undertaken in seasons, weather conditions or following extensive disturbance events when the subject species are unlikely to be detected or present, or	**Section 3.2**
▪ utilised methodologies, survey sampling intensities, timeframes or baits that are not the most appropriate for detecting the target subject species.	**Section 3.2**
Unless these differences can be clearly demonstrated to have had an insignificant impact upon the outcomes of the surveys. If a previous survey is used, any additional species listed under the TSC Act since the previous survey took place, must be surveyed for.	-
Determining the list of potential threatened species for the site must be done in accordance with:	-
▪ Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities − Working Draft (DEC, 2004); and	**Section 3.1**
▪ Guidelines for Threatened Species Assessment (Department of Planning, July 2005).	**Section 3.1**
The EPA Threatened Species website http://www.environment.nsw.qov.au/threatenedspecies/ and the Atlas of NSW Wildlife database must be the primary information sources for the list of threatened species present. The BioBanking Threatened Species Database, the Vegetation Types databases (available on EPA website at: http://www.environment.nsw.qov.aulbiobanking/biobankin.qtspd...htm; and http://www.environment.nsw.qov.au/biobankin.q/veqtypedatabase.htm. respectively.	**Section 3.1**

Requirement	Report section addressing requirement
Other data sources (e.g. PlantNET, Online Zoological Collections of Australian Museums (http−.//www.ozcam.orql). previous or nearby surveys etc.) may also be used to compile the list.	-
3. The EIS should contain the following information as a minimum:	-
a. The requirements set out in the Guidelines for Threatened Species Assessment (Department of Planning, July 2005)	**Appendix 2**
b. Description and geo−referenced mapping of the PAA (and spatial data files), e.g. overlays on topographic maps, satellite images and /or aerial photos, including details of map datum, projection and zone, all survey locations, vegetation communities (including classification and methodology used to classify), key habitat features and reported locations of threatened species, populations and ecological communities present in the subject site and PAA.	**Figures 1-7**
c. Description of survey methodologies used, including timing, location and weather conditions.	**Section 3**
d. Details, including qualifications and experience of all staff undertaking the surveys, mapping and assessment of impacts as part of the EIS.	**Appendix 7**
e. Identification of national and state listed threatened biota known or likely to occur in the PAA and their conservation status.	**Table 10**
f. Description of the likely impacts of the proposal on biodiversity and wildlife corridors, including direct and indirect and construction and operation impacts. Wherever possible, quantify these impacts such as the amount of each vegetation community or species habitat to be cleared or impacted, or any fragmentation of a wildlife corridor.	**Section 6**
g. Identification of the avoidance, mitigation and management measures that will be put in place as part of the proposal to avoid or minimise impacts, including details about alternative options considered and how long term management arrangements will be guaranteed.	**Section 7**
h. Description of the residual impacts of the proposal. If the proposal cannot adequately avoid or mitigate impacts on biodiversity, then a biodiversity offset package is expected (see the requirements for this at point 6 below).	**Section 7.3**
i. Provision of specific Statement of Commitments relating to biodiversity.	**Section 8**
4. An assessment of the significance of direct and indirect impacts of the proposal must be undertaken for threatened biodiversity known or considered likely to occur in the PAA based on the presence of suitable habitat. This FFA must take into account: a. the factors identified in s.5A of the EP&A Act, and b. the guidance provided by The Threatened Species Assessment Guideline − The Assessment of Significance (DECC, 2007) which is available at: http ://www.environment.nsw.qov.au/resources/threatenedspecies/tsaq uide07393.pdf	**Table 10** **Appendix 2**
5. Where an offsets package is proposed by a proponent for impacts to biodiversity (and a BioBanking Statement has not been sought) this package should:	-
- meet the EPA's Principles for the use of biodiversity offsets in NSW, which are available at: www.environment.nsw.gov.au/biocertification/offsets.htm.;	**Section 7.3**
- identify the conservation mechanisms to be used to ensure the long term protection and management of the offset sites;	-
- include an appropriate Management Plan (such as vegetation or habitat) that has been developed as a key amelioration measure to ensure any proposed compensatory offsets, retained habitat; and	-
- enhancement features within the disturbance footprints and/or impact mitigation measures (including proposed rehabilitation and/or monitoring programs) are appropriately managed and funded.	

Requirement	Report section addressing requirement
6. Where appropriate, likely impacts (both direct and indirect) on any adjoining and/or nearby NSW estate reserved under the National Parks and Wildlife Act 1974 or any marine and estuarine protected areas under the Fisheries Management Act 1994 or the Marine Parks Act 1997 should be considered. Refer to the Guidelines for developments adjoining land and water managed by the Office of Environment and Heritage 2010.	**Section 6**
7. With regard to the Commonwealth Environment Protection and Biodiversity Conservation Act 1999, the assessment should identify any relevant Matters of National Environmental Significance and whether the proposal has been referred to the Commonwealth or has already been determined to be a controlled action.	-
Department of the Environment – EPBC Act (Extract from Appendix 6)	
1. Details about the local population of the Black-eyed Susan *(Tetratheca juncea),* including an estimate of the number of individuals/clumps present in the vicinity of the project area derived from surveys in accordance with the methods recommended in the departments publication "Referral guidelines for the vulnerable Black-eyed Susan, *Tetratheca juncea*" (August 2011), available at: www.environment.gov.au/epbc/pulications/black-eyed-susan.html.	**Section 4.4.2.2**
2. Using the information gained from 1. above, an assessment of the residual impact to the Black-eyed Susan *(Tetratheca juncea)* including whether the proposed action will result in: - indirect impacts, for example from dust, altered hydrology and/or edge effects; - loss of greater than 25% of plant clumps within the affected area; or - fragmentation of a subpopulation by greater than 500m within native vegetation, or 100m within degraded or cleared vegetation.	**Section 6.5**
3. Details of the proposed impact avoidance, mitigation and monitoring actions, including sediment and erosion control, weed and *Phytophthora cinnamomi* controls, and the proposed barrier to reduce noise and light impacts to bat species utilising the abandoned mine drift entrance.	**Section 7**
4. Details of the proposed translocation trial for Black-eyed Susan *(Tetratheca juncea)* and *Grevillea parviflora* subsp. *Parviflora.* Please note that the department (DoE) does not support translocation as a mitigation measure. Translocation may be considered as part of an offset package, where its long-term success has been established using rigorous scientific methods.	**Section 7.3.1**
5. Where impacts cannot be avoided or mitigated, an offset package to compensate for any predicted or potential residual significant impacts on matters of national environmental significance. Offsets should demonstrate consistency with the Commonwealth EPBC Act Environmental Offsets Policy (October 2012, or subsequent versions), available at www.environment.gov.au/epbc/publications/environmental-offsets -policy.html Please find attached the department's information requirements in relation to EPBC Act offset proposals.	**Section 7**
6. Rehabilitation and decommissioning plans, including how these activities may impact threatened species.	**Section 7.3.2**
7. Other information, as relevant to the controlling provision, listed threatened species and communities.	-



TITLE: FIGURE 1: PROJECT LOCALITY

LOCATION: COAL LOGISTICS PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 20/12/2012
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): D A4 (JS-NW)

CLIENT: CENTENNIAL COAL
JOB REF: 113119-1

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2.0 Qualifications and Licensing

2.1 Qualifications

This report was written by Paul Hillier BEnvSc, Andrew Smith PhD BSc, Lauren Vanderwyk (BSc) , Ziggy Andersons (BSc) and Arne Bishop (BEnvSc) of RPS.

The academic qualifications and professional experience of all RPS consultants involved in the Project are documented in **Appendix 7**.

2.2 Licensing

Research was conducted under the following licences:

- NSW National Parks and Wildlife Service Scientific Investigation Licence S100536 (Valid 31 December 2014);
- Animal Research Authority (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2014);
- Animal Care and Ethics Committee Certificate of Approval (Trim File No: 01/1142) issued by NSW Agriculture (Valid 12 March 2016); and
- Certificate of Accreditation of a Corporation as an Animal Research Establishment (Trim File No: 01/1522 & Ref No: AW2001/014) issued by NSW Agriculture (Valid 22 May 2014).

2.3 Certification

As the principal author, I, Ziggy Andersons, make the following certification:

- The results presented in the report are, in the opinion of the principal author and certifier, a true and accurate account of the species recorded, or considered likely to occur within the PAA;
- Commonwealth, state and local government policies and guidelines formed the basis of project surveying methodology, or where the survey work has been undertaken with specified departures from industry standard guidelines, details of which are discussed and justified in Section 3.6; and
- All research workers have complied with relevant laws and codes relating to the conduct of flora and fauna research, including the Animal Research Act 1995, National Parks and Wildlife Act 1974 and the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

Signature of Principal Author and Certifier:



Ziggy Andersons

Ecology Manager
March 2014

3.0 Methodology

Database searches, literature reviews and a variety of field survey techniques were employed by RPS for this FFA in order to describe the ecological attributes and detect any threatened fauna or flora species across the PAA and particularly within the disturbance footprints. Field surveys were undertaken on:

- 13 April 2012 (preliminary survey);
- 14–18 May 2012 (targeted threatened flora surveys, vegetation mapping and fauna surveys);
- 17–19 September 2012 (targeted threatened flora searches);
- 3–4 October 2012 (targeted frog searches);
- 11 October 2012 (targeted threatened flora surveys);
- 10–11 January 2013 (targeted threatened flora searches)
- 26 August 2013 (targeted threatened flora searches)
- 6 September 2013 (targeted threatened flora searches);
- 9-11 September 2013 (targeted threatened flora searches); and
- 16-20 September 2013 (fauna surveys).

Surveys methods included vegetation community verification and various fauna survey methods including Elliott trapping, harp trapping, hair tubes, bat echolocation, spotlighting, call playback, diurnal bird and herpetological surveys, habitat assessments and opportunistic surveys. Targeted searches for threatened flora and fauna species were also undertaken. The flora and fauna surveys are described in further detail in the below sections.

3.1 Desktop Assessment

Database searches were undertaken to identify State and Commonwealth records of threatened entities and Commonwealth matters of national environmental significance (NES). Databases interrogated for this purpose were:

- The NSW Wildlife Atlas which is managed by the OEH. A coordinate search using the boundary of the PAA was undertaken to determine threatened species records listed under the TSC Act to within 10 kilometres of the PAA (accessed January 2014).
- The Protected Matters Search Tool which is managed by the DoE. A coordinate search using the boundary of the PAA was undertaken to determine threatened species records listed under the EPBC Act to within 10 kilometres of the PAA (accessed January 2014).

In addition to the above a review of the following was undertaken:

- aerial photograph interpretation (API) and literature reviews to determine the broad categorisation of vegetation within the PAA;
- review of the Lower Hunter and Central Coast Regional Environment Management Strategy Vegetation Survey, Classification and Mapping (LHCCREMS) (NPWS 2000);
- review of Bell, S. and Driscoll, C. (2012). Vegetation Mapping of Lake Macquarie LGA: Stage 3 (report to Lake Macquarie City Council);
- a review of Geographic Information System (GIS) data including (but not limited to) aerial photography, topographic maps, wetland mapping under the State Environmental Planning Policy No. 14 – Coastal Wetlands (SEPP 14) and soil landscapes; and

- collective knowledge gained from extensive work in the area.

3.1.1 Literature Review

A literature review was undertaken to assist in identifying distributions, suitable habitats and known records of threatened species, populations and community's within the PAA to help guide the field survey program. Information sources included:

- Cumberland Ecology (2007). Newstan Colliery, modification to development consent, SEE, Ecological Impact Assessment;
- Cumberland Ecology (2008). Newstan Colliery, Longwall Panel 25, REF, Ecological Impact Assessment;
- Eco Biological (2005). Awaba Outbye SMP;
- Gunninah (1998). Proposed waste emplacements and coal handling facilities upgrade. Flora and fauna assessment. Newstan Colliery. October 1998;
- HLA (2006). Flora and Fauna Impact Assessment Upgrade to Existing Ash Dam Eraring Power Station. Flora and Fauna Report. Appendix E. February 2006;
- Hunter Eco (2008a). Awaba East Exploratory Drilling Program REF Stage 1 – Ecology. A Report for Centennial Coal;
- Hunter Eco (2008b). Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation;
- Hunter Eco (2009). Awaba East Exploratory Drilling Program REF Stage 2 – Ecology. A Report for Centennial Coal;
- Umwelt / Gunninah (1998). Life Extension Project 1998 Flora and Fauna Assessment and SIS;
- Umwelt (2004). Centennial Newstan Longwall 22–23 Flora and Fauna Assessment; and
- Umwelt (2005). Summer targeted rare plants survey works for the Awaba open cut mine development environmental impact statement. Letter report to Centennial Coal. April 2005.

3.2 Flora Survey

3.2.1 Vegetation Mapping

Seven flora quadrats were completed within the proposed disturbance sites (three in Site 1 and four in Site 2) on the 29-30 April 2013. Flora quadrats were undertaken with reference to current NSW mapping standards whereby floristic data was collected using a six point Braun-Blanquet cover abundance scale. The applied Braun-Blanquet cover abundance scale assigns each species to one of these six cover abundance classes, which are considered indicative of the dominance of these species within the quadrat. Additionally, structural features of the vegetation within the quadrat and other relevant habitat features (e.g. soil type; presence of rock; slope) were also recorded. All quadrats were 20 metres by 20 metres (400 square metres in area).

In addition to the quadrats, seven Rapid Data Points (RDP) were undertaken to verify LHCCREMS (NPWS 2000) and Vegetation Mapping of Lake Macquarie LGA: Stage 3 (Bell and Driscoll 2012) (Vegetation Mapping of Lake Macquarie LGA: Stage 3 covers Site 2 only). The RDP methodology involves the recording of vegetation community structure and dominant species within each strata. Three RDPs in Site 1 and three in Site 2 were undertaken on 14-18 May 2012.

Further vegetation identification was undertaken while in transit across the proposed disturbance footprints and in the course of targeted threatened flora surveys.

3.2.2 Significant Flora Survey

Targeted threatened flora searches were undertaken within the two proposed disturbance footprints on 13 April 2012, 14–18 May 2012, 17–19 September 2012, 11 October 2012,10–11 January 2013, 26 August 2013, 6 September 2013 and 9-11 September 2013. **Table 2** provides a list of those flora species that have been identified during desktop assessments, as well as several additional species that are known to occur within the Lake Macquarie local area and along the Central Coast of NSW.

As part of addressing the controlled action decision (**Appendix 1**), RPS conducted targeted seasonal surveys for *Tetratheca juncea* (*T. juncea*) outside of the Site 1 disturbance footprint area. The purpose of undertaking additional surveys outside of the disturbance footprint was to determine whether the proportion of the 'local population' (as defined in DSEWPAC (2011)) within the disturbance footprint constitutes a loss of greater than 25% of the local population. A loss of greater than 25% of plant clumps is a considered a ' high risk of significant impacts on Black-eyed Susan' (DSEWPAC, 2011).

T. juncea surveys were conducted in line with methods recommended by the DoE (DSEWPAC, 2011). This methodology is based on a methodology developed by Payne *et al* (2002). These standardised best practice recording and counting methodologies for *T. juncea* clumps were utilised. These methodologies include the basic definitions and what constitutes a single clump (individual clumps are separated by more than 30 cm (Payne *et al.* 2002)) and how to delineate an important local population (groups of individual clumps separated by no more than 500 m in intact native vegetation and 100 m in disturbed vegetation (DSEWPAC 2011)).

Table 2 Threatened Flora Species likely to occur within the PAA, flowering periods and recommended survey timing (seasonality)

Threatened Flora Species	Recommended Survey Time	January	February	March	April	May	June	July	August	September	October	November	December
Acacia bynoeana	Survey Anytime	X								X	X		
Angophora inopina	Survey Anytime	X											
Caladenia tessellata	Survey Only During Flowering									X	X		
Callistemon linearifolius	Survey Anytime	X								X	X		
Corybas dowlingii	Survey Only During Flowering								X				
Corunastylis sp. *Charmhaven*	Survey Only During Flowering	X											
Cryptostylis hunteriana	Survey Only During Flowering	X											
Cynanchum elegans	Survey Anytime								X	X	X		
Diuris praecox	Survey Only During Flowering								X				
Eucalyptus camfieldii	Survey Anytime												
Eucalyptus parramattensis subsp. *parramattensis*	Survey Anytime	X											
Grevillea parviflora subsp. *parviflora*	Survey Anytime								X	X			
Maundia triglochinoides	Survey Only During Flowering	X											

Threatened Flora Species	Recommended Survey Time	January	February	March	April	May	June	July	August	September	October	November	December
Melaleuca biconvexa	Survey Anytime										X		
Pelargonium sp. *Striatellum (G.W.Carr 10345)*	Survey Only During Flowering										X		
Prasophyllum sp. *Wybong (C.Phelps ORG 5269)*	Survey Only During Flowering										X		
Pterostylis gibbosa	Survey Only During Flowering								X	X	X		
Rhizanthella slaterii	Survey Only During Flowering										X		
Rutidosis heterogama	Survey Best During Flowering	X									X		
Senecio spathulatus	Flowers sporadically at other times												
Senna acclinis	Survey Only During Flowering	X								X			
Syzygium paniculatum	Survey Anytime												
Streblus pendulinus	Survey Anytime	X											
Tetratheca glandulosa	Survey Anytime								X	X			
Tetratheca juncea	Survey Only During Flowering									X			
Thelymitra sp. *'Adorata'*	Survey Only During Flowering									X			

3.3 Fauna Survey

Fauna surveys were undertaken within the two proposed disturbance footprints. Trapping transects included, terrestrial fauna and microchiropteran bats (microbats) trapping, microbat echolocation call recording, avifauna surveys, herpetofauna surveys, spotlighting, secondary indications (e.g. scats, scratches and diggings) and incidental observations.

The location and effort of each survey methodology was determined based on the diversity and quality of fauna habitat located within the proposed disturbance footprints.

3.3.1 Arboreal Trapping

Arboreal trapping was undertaken within the two proposed disturbance footprints using Elliott B size traps. Traps were mounted on brackets set at approximately 2 m height on trees with a Diameter at Breast Height (DBH) greater than 30 cm. Traps were baited with a rolled oats, peanut butter and honey mixture and the tree trunks were sprayed liberally with a brown sugar and water mixture each day in the late afternoon. Traps were checked early each morning. The location of each trap line is shown on **Figure 2** and **Figure 3**.

Arboreal traps targeted arboreal mammals such as the threatened Squirrel Glider (*Petaurus norfolkensis*) which has been detected previously from the surrounding area. A total of 80 arboreal trap nights were undertaken in May 2012 across two trapping transects.

3.3.2 Terrestrial Trapping

Terrestrial trapping was undertaken using Elliott A, Elliott B traps and cage traps. Traps were baited with rolled oats, peanut butter and honey. Cage traps were baited with chicken necks or chicken thighs. Traps were checked early each morning, with any captures identified and released at point of capture. Traps were re-baited where necessary. The location of each trap line is shown on **Figure 2** and **Figure 3**.

Terrestrial traps targeted small terrestrial mammals such as dasyurids (e.g. antechinus) and rodents (e.g. rats and mice). A total of 202 trap nights of Elliott A traps, 200 trap nights of Elliott B traps and 48 trap nights of cage traps were undertaken in May 2012 and September 2013 across two trapping transects.

3.3.3 Hair Funnels

Surveys within the two proposed disturbance footprints were undertaken using Faunatech hair tubes over four nights at each site. These were baited with rolled oats, peanut butter and honey.

Hair tubes targeted small-medium mammals such as dasyurids (e.g. Antechinus), rodents (e.g. rats and mice), gliders and bandicoots. A total of 80 arboreal trap nights and 80 terrestrial trap nights were undertaken in September 2013 across two trapping transects.

Any hair samples retrieved during the survey were sent to Barbara Triggs at ‘Dead Finish’ for analysis.

3.3.4 Bat Trapping – Harp Traps

An active bat roost cave, in the form of a disused mine shaft (Bat Alley), is known to occur within close proximity to Site 1. Two harp traps were placed in front of the main cave roost entrance (drift entrance) along a track to the north of Site 1 over four consecutive nights by RPS. Traps were checked early each morning, with any captured bats identified and released at point of capture. The location of each trap line is shown on **Figure 2**.

A total of eight harp trap nights were undertaken within Site 1 during surveys.

Additionally, a monitoring program was undertaken at Bat Alley by Fly By Night Bat Surveys Pty Ltd accompanied by an RPS Ecologist to monitor microbat species presence and to assess any likely impacts as a result of the Project. Anabats and harp traps were typically placed at the entrance of Northumberland Number 1 mine, with a second detector placed at the nearby shaft to the workings. On a single occasion (August 2012), the anabats were accompanied by the use of an infrared camera to assess microbat activity and enable an individual count.

Four surveys were undertaken during the monitoring period of Bat Alley including 30 and 31 August 2012, 5 and 6 December 2012, 18 January 2013 and 11 and 13 March 2013.

3.3.5 Microbat Echolocation Call Recording

Microbat echolocation calls were recorded using two Anabat II Detector and CF ZCAIM units set to remotely record for the entire night (6pm to 6am). Two Anabats were placed within close proximity to Bat Alley to the north of Site 1 over four nights in May 2012, resulting in eight nights of bat call recording.

Site 1 had four consecutive nights of sampling, with emphasis placed on those areas deemed likely to provide potential foraging and flyway sites for microbats. The location of the microbat call survey is shown on **Figure 2**. Bat call analysis was undertaken by Anna McConville who is experienced in the analysis of bat echolocation calls.

3.3.6 Avifauna Survey

The presence of avifauna within the two proposed disturbance footprints was determined via targeted diurnal and nocturnal surveys as well as opportunistic observations during fieldwork. These surveys were scheduled for peak activity periods i.e. dawn and dusk, and were undertaken in areas that displayed high bird activity or had favourable habitat features such as flowering trees. Birds were identified by either direct observation or by recognition of calls. Other distinctive identification features included nests, feathers and owl regurgitation pellets. The potential for threatened avifauna to use the proposed disturbance footprints was also assessed by identification of habitat attributes and their capacity to support threatened species that are known to occur in the wider locality. Nocturnal surveys (refer to **Section 3.4.8** and **Section 3.4.9**) were undertaken to detect nocturnal bird species.

3.3.7 Herpetofauna Survey

Opportunistic herpetofauna searches were conducted during fauna surveys and when moving throughout the proposed disturbance footprints with a focus on suitable habitat areas. Known occurrences of threatened herpetofauna species from the region were taken into account during assessment of onsite habitat, to determine the potential for the proposed disturbance footprints to support such species.

Targeted diurnal and spotlighting surveys for threatened species were also undertaken.

3.3.8 Spotlighting

Spotlighting was undertaken via the use of 35-Watt hand-held spotlights and head torches during walking and vehicular transects. A total of eight person hours of spotlighting was carried out across the proposed disturbance footprints as shown in **Figure 2** and **Figure 3**. The call playback methodology was also undertaken during spotlighting.

3.3.9 Call Playback

Call-playback surveys were undertaken for aural recognition of threatened owl and mammal species with the potential to occur within the PAA and particularly within the proposed disturbance footprints. Pre-recorded calls were broadcast in an effort to elicit vocal responses or to attract an owl or mammal to the playback site. The calls were broadcast through an amplification system (a hand held megaphone) designed to project the sound for at least one kilometre under still night conditions.

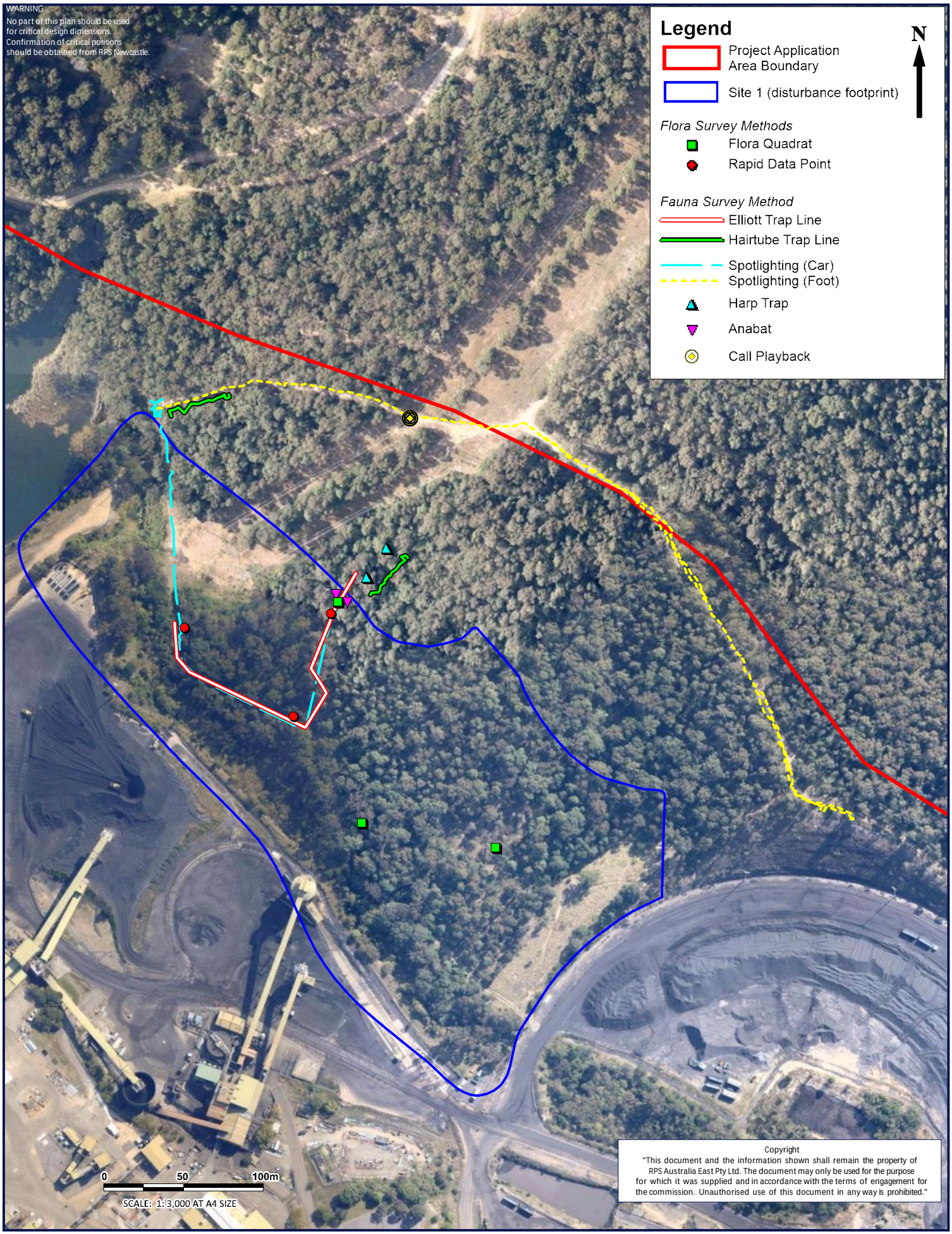
As described by Kavanagh and Peake (1993) and Debus (1995), the call of each species was broadcast for at least five minutes, followed by five minutes of listening, and stationary spotlighting. Following the final broadcast and listening, the area was spotlighted on foot. Species broadcasted included Powerful Owl (*Ninox strenua)*, Barking Owl (*Ninox connivens)*, Sooty Owl (*Tyto tenebricosa)*, Masked Owl (*Tyto novaehollandiae)*, Koala (*Phascolarctos cinereus*), Squirrel Glider (*Petaurus norfolcensis)* and Yellow-bellied Glider *(Petaurus australis).* The locations of the call playback sites are shown in **Figure 2** and **Figure 3**.

3.3.10 Secondary Indications and Incidental Observations

Opportunistic sightings of secondary indications of resident fauna were noted. Such indicators included:

- Distinctive scats and scents left by mammals;
- Collection of predator scats for analysis;
- Nests made by various guilds of birds;
- Whitewash, regurgitation pellets and prey remains from owls;
- Skeletal material of vertebrate fauna;

- Calls of fauna;
- Footprints left by mammals;
- Chewed she-oak (*Allocasuarina* spp.) cones indicative of feeding by Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Chewed fruit remains indicative of past feeding by frugivorous birds such as fruit-doves; and
- Any other obvious signs of fauna occupation.



TITLE: FIGURE 2: SITE 1 FLORA AND FAUNA SURVEY EFFORT

LOCATION: COAL LOGISTICS PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

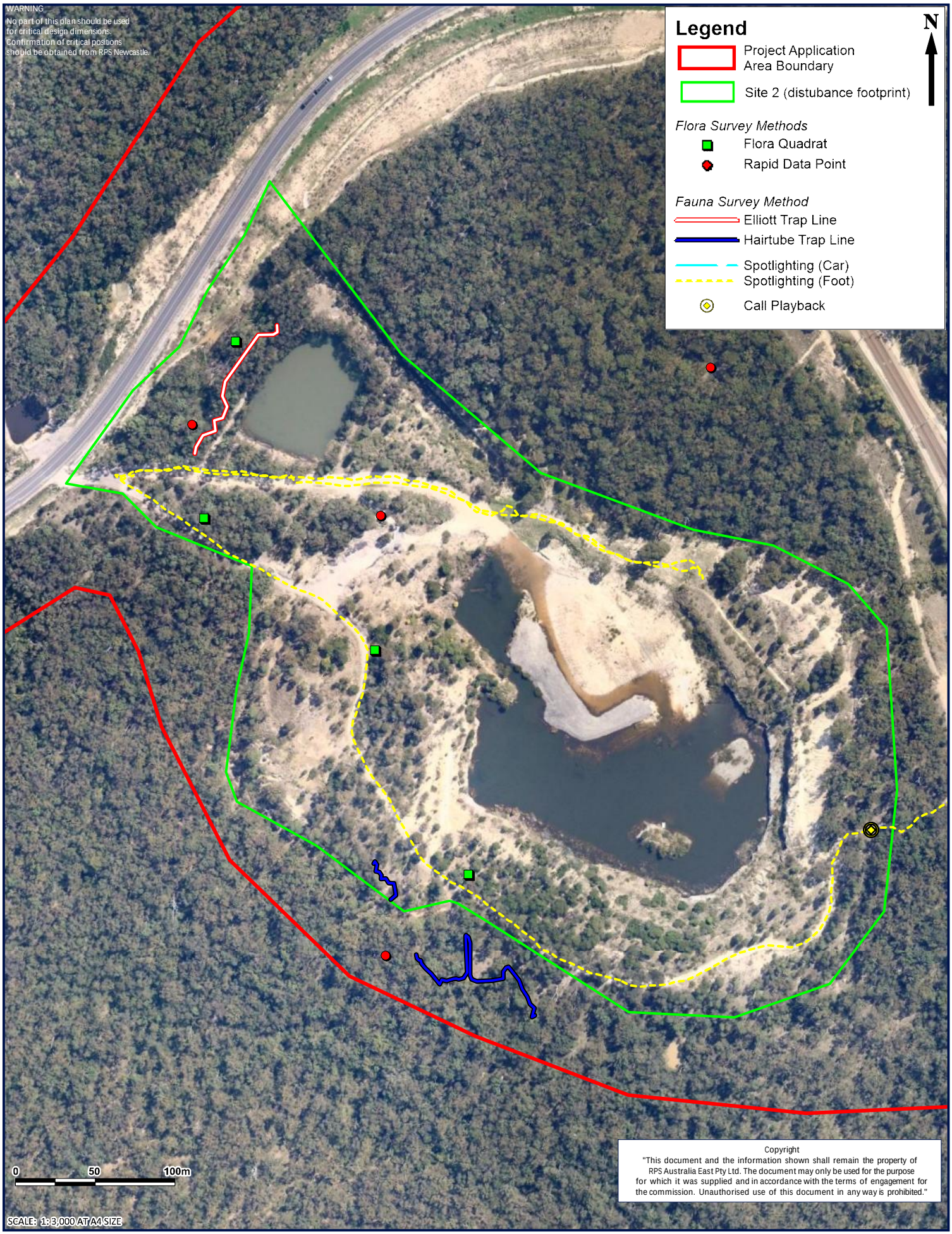
DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): F A4 (PH-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-2

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TITLE: FIGURE 3: SITE 2 FLORA AND FAUNA SURVEY EFFORT

LOCATION: COAL LOGISTICS PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): E A4 (PH-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-2

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3.4 Habitat Survey

An assessment of the relative habitat value present within the two proposed disturbance footprints was undertaken. This FFA focused primarily on the identification of specific habitat types and resources within the proposed disturbance footprints favoured by known threatened species from the region. The assessment also considered the potential value of the proposed disturbance footprints (and surrounds) for all major guilds of native flora and fauna.

Habitat assessment was based on the specific habitat requirements of each threatened fauna species in regards to home range, feeding, roosting, breeding, movement patterns and corridor requirements. Consideration was given to contributing factors including topography, soil, light and hydrology for threatened flora and assemblages.

3.5 State Environmental Planning Policy No. 44 (Koala Habitat Protection)

Assessment of potential koala habitat under SEPP 44 requires the following steps be undertaken:

The first consideration – Is the land 'Potential Koala Habitat'?

If the total tree cover contains 15% or more of the koala food tree species listed in Schedule 2 of SEPP 44 then it is deemed to be 'Potential Koala Habitat'. Identification of 'Potential Koala Habitat' requires the determination of the presence of 'Core Koala Habitat'.

The second consideration – Is the land 'Core Koala Habitat'?

'Core Koala Habitat' is defined as an area of land with a resident population of Koalas, evidenced by attributes such as breeding females (females with young), recent sightings and historical records of a Koala population. Under SEPP 44, identification of "Core Koala habitat" requires that a plan of management accompanies the Development Application (DA).

3.6 Survey Effort

The level of survey effort is in accordance line with the Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities (DEC 2004). These guidelines use a concept of 'stratification units' in order to recommend the amount of flora and fauna survey effort to be undertaken over a given area. It is recommended that the survey area be initially stratified on biophysical attributes (eg. landform, geology, elevation, slope, soil type, aspect), followed by vegetation structure (eg. forest, woodland, shrubland), and then floristics (eg. species or specific vegetation communities).

Both Site 1 and Site 2 contain similar vegetation types dominated by dry sclerophyll woodlands and forests, with a small area of moist forest (refer to **Section 4.4**). Within the combined area of Sites 1 and 2 totalling 21.38 ha, approximately 8.75 ha of native vegetation occurs within the two sites. The vegetation types provide similar habitats for those threatened fauna that have potential to occur. Due to the similarities in vegetation and associated habitat availability, considering all native vegetation within the proposed disturbance footprints as one stratification unit is warranted. Hence, the survey effort undertaken is in accordance with DEC (2004) for target threatened fauna species and fauna species in general.

In order to appropriately identify each vegetation community within the disturbance footprints, flora survey effort was undertaken in accordance with DEC (2004), with each individual vegetation community representing a separate stratification unit. In addition, seasonal targeted surveys occurred throughout the disturbance footprints on several occasions. Targeted flora surveys were significantly in excess of recommended survey effort.

3.7 Survey Limitations

The limitations associated with this survey and report is presented herewith. In instances where surveys were not able to reliably detect a particular species or guild, a precautionary approach has been adopted; as such 'assumed presence' of known and expected threatened species, populations and ecological communities has been made where relevant and scientifically justified to ensure a holistic assessment.

3.7.1 Flora Species

The cryptic nature of a number of flora species means that surveys may not have been able to detect species, despite being present. There is a range of common albeit cryptic plant species that have a brief flowering period and hence small 'window' of effective 'detectability'. In addition, the seasonality of surveys also places limits on the number of flora species identified. Therefore, some threatened species not detected cannot be discounted off-hand due to seasonality and other factors, and are therefore, addressed in terms of their potential for occurrence based on ecological factors and previous records.

Survey effort and timing sought to reduce this limitation by undertaking targeted surveys within the flowering periods of all threatened flora known from the locality.

3.7.2 Fauna Species

The presence of fauna species within a particular area is not static over time and may be seasonal or in response to the availability of a particular resource. The flowering and fruiting plant species that attract some nomadic or migratory threatened species, often fruit or flower in cycles spanning a number of years. Furthermore, these resources might only be accessed in some areas during years when resources more accessible to threatened species fail. As a consequence threatened species may be absent from some areas where potential habitat exists for extended periods.

3.7.3 Data Availability and Accuracy

The collated threatened flora and fauna species records provided by the Atlas of NSW Wildlife for the region are known to vary in accuracy and reliability. This is often due to the reliability of information provided to OEH for collation and/or the need to protect specific threatened species locations. During the review of threatened species records sourced from Atlas of NSW Wildlife, consideration has been given to the date and accuracy of each threatened species record in addition to an assessment of habitat suitability within the PAA and particularly the disturbance footprints.

Similarly, EPBC Protected Matters Searches provide a list of threatened species and communities that have been recorded within 10 km or which are predicted to have suitable habitat within the wider area. Records from the EPBC Protected Matters Search are therefore, subject to the same inherent inaccuracy issues as State derived databases.

In order to address these limitations in respect to data accuracy, threatened species records have been used to provide a guide only to the types of species which occur within the locality of the PAA. Consequently, habitat assessments and the results of surveys conducted within the disturbance footprints have been used to assess the likelihood of occurrence of threatened species, populations and ecological communities to occur.

4.0 Results

4.1 Database Search

4.1.1 Potentially Occurring Threatened Flora

Based on suitable habitat available in the area, a search of the NSW Wildlife Atlas database and a Protected Matters Search was undertaken in January 2014 to identify potentially occurring threatened flora species within the locality (10 km radius of the PAA) (**Table 3**). This list included threatened flora species and flora populations listed under the TSC Act 1995 and/or EPBC Act 1999. A total of 24 threatened flora species and one threatened flora population were identified as having potential to exist within the locality (**Table 3**).

Table 3 Threatened flora species occurring and potentially occurring within a 10 km site radius of the PAA

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Plants				
Acacia bynoeana	Bynoe's Wattle	E	V	67
Angophora inopina	Charmhaven Apple	V	V	949
Asterolasia elegans	-	E	E	0
Callistemon linearifolius	Netted Bottle Brush	V	-	41
Corybas dowlingii	Red Helmet Orchid	E	-	1
Cryptostylis hunteriana	Leafless-tongue Orchid	V	V	9
Cynanchum elegans	White-flowered Wax Plant	E	E	2
Diuris praecox	Rough Doubletail	V	V	0
Eucalyptus camfieldii	Camfield's Stringybark	V	V	0*
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	145
Maundia triglochinoides	-	V	-	7
Melaleuca biconvexa	Biconvex Paperbark	V	V	151
Pelargonium sp. Stiatellum (G.W,Carr 10345)	Omeo Stork's-bill	-	E	0
Persicaria elatior	Tall Knotweed	V	V	1
Prasophyllum sp. Wybong (C.Phelps ORG 5269)	a leek-orchid	-	CE	0
Pterostylis gibbosa	Illawarra Greenhood	E	E	0
Rhizanthella slateri	Eastern Underground Orchid	V	E	0
Rutidosis heterogama	Heath Wrinklewort	V	V	2
Senecio spathulatus	Coast Groundsel	E	-	1
Streblus pendulinus	Sia's Backbone	-	E	0
Syzygium paniculatum	Magenta Lilly Pilly	E	V	8

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Tetratheca glandulosa	Glandular Pink-bell	V	V	0
Tetratheca juncea	Black-eyed Susan	V	V	1585
Zannichellia palustris	-	E	-	1
Population				
Eucalyptus parramattensis subsp. *parramattensis* population in the Wyong and Lake Macquarie Local Government Areas.		E Pop	-	4

Status (TSC Act 1995):

CE – Endangered Species

E – Endangered Species

E (pop) – Endangered Population

V – Vulnerable Species

Status (EPBC Act 1999):

CE – Endangered Population

E – Endangered Species

V – Vulnerable Species

4.1.2 Potentially Occurring Threatened Fauna Species

Based on suitable habitat available in the locality, a search of the NSW Wildlife Atlas database and a Protected Matters Search were undertaken in January 2014 to identify potentially occurring threatened fauna species within the locality (10 km radius of the PAA) (**Table 4**). This list included threatened fauna species and populations listed under the TSC Act 1995 and/or EPBC Act 1999. A total of 69 threatened fauna species were identified as having potential to exist within the locality (**Table 4**).

Table 4 Potential Threatened Fauna Species

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Birds				
Anthochaera phrygia	Regent Honeyeater	CE	E	15
Botaurus poiciloptilus	Australasian Bittern	E	E	0
Burhinus grallarius	Bush Stone-curlew	E	-	1
Calidris ferruginea	Curlew Sandpiper	E	C, J, K	5
Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	9
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	67
Charadrius mongolus	Lesser Sand-plover	V	C, J, K	1
Chthonicola sagittata	Speckled Warbler	V	-	2
Circus assimilis	Spotted Harrier	V	-	1
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	7
Daphoenositta chrysoptera	Varied Sittella	V	-	22
Dasyornis brachypterus	Eastern Bristlebird	E	E	0
Ephippiorhynchus asiaticus	Black-necked Stork	E	-	11
Epthianura albifrons	White-fronted Chat	V	-	4
Erythrotriorchis radiatus	Red Goshawk	CE	V	1
Falco subniger	Black Falcon	V	-	0
Glossopsitta pusilla	Little Lorikeet	V	-	46

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Haematopus fuliginosus	Sooty Oystercatcher	V	-	1
Haematopus longirostris	Pied Oystercatcher	E	-	3
Hieraaetus morphnoides	Little Eagle	V	-	5
Irediparra gallinacea	Comb-crested Jacana	V	-	3
Ixobrychus flavicollis	Black Bittern	V	-	9
Lathamus discolor	Swift Parrot	E	E	19
Lophoictinia isura	Square-tailed Kit	V	-	1
Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	1
Neophema pulchella	Turquoise Parrot	V	-	4
Ninox connivens	Barking Owl	V	-	4
Ninox strenua	Powerful Owl	V	-	80
Oxyura australis	Blue-billed Duck	V	-	1
Pandion cristatus	Eastern Osprey	V	-	23
Petroica boodang	Scarlet Robin	V	-	6
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	1
Ptilinopus regina	Rose-crowned Fruit-Dove	V	-	2
Ptilinopus superbus	Superb Fruit-Dove	V	-	2
Rostratula australis	Australian Painted Snipe	E	V	2
Stagonopleura guttata	Diamond Firetail	V	-	1
Sternula nereis nereis	Fairy Tern	-	V	0
Stictonetta naevosa	Freckled Duck	V	-	1
Tyto novaehollandiae	Masked Owl	V	-	56
Tyto tenebricosa	Sooty Owl	V	-	21
Mammals				
Cercartetus nanus	Eastern Pygmy-possum	V	-	1
Dasyurus maculatus maculatus	Spotted-tailed Quoll	V	E	19
Petaurus australis	Yellow-bellied Glider	V	-	39
Petaurus norfolcensis	Squirrel Glider	V	-	158
Petrogale penicillata	Brush-tail Rock-wallaby	E	V	0
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	2
Phascolarctos cinereus	Koala	V	V	30
Potorous tridactylus tridactylus	Long-nosed Potoroo (SE mainland)	V	V	3
Pseudomys novaehollandiae	New Holland Mouse	-	V	0
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	73
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	4
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	49
Phoniscus papuensis (*Syn Kerivoula papuensis*)	Golden-tipped Bat	V	-	9
Miniopterus australis	Little Bentwing-bat	V	-	94
Miniopterus schreibersii oceanensis	Eastern Bentwing-bat	V	-	89
Myotis macropus	Southern Myotis	V	-	19

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Records within 10 km
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	41
Vespadelus troughtoni	Eastern Cave Bat	V	-	8
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	11
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	8
Frogs				
Crinia tinnula	Wallum Froglet	V	-	4
Heleioporus australiacus	Giant Burrowing Frog	V	V	3
Litoria aurea	Green and Golden Bell Frog	E	V	0
Litoria brevipalmata	Green-thighed Frog	V	-	2
Litoria littlejohni	Littlejohn's Tree Frog	V	V	0
Mixophyes balbus	Stuttering Frog	E	V	37
Mixophyes iteratus	Giant Barred Frog	E	E	0
Pseudophryne australis	Red-crowned Toadlet	V	-	2
Reptiles				
Hoplocephalus bungaroides	Broad-headed Snake	E	V	0
Hoplocephalus stephensii	Stephens' Banded Snake	V	-	3

Status (TSC Act 1995):

CE – Endangered Species

E – Endangered Species

E (pop) – Endangered Population

V – Vulnerable Species

Status (EPBC Act 1999):

CE – Critically Endangered Species

E – Endangered Species

V – Vulnerable Species

C – CAMBA

J – JAMBA

K – ROKAMBA

4.1.3 Literature Review

4.1.3.1 Significant Flora

A total of five threatened flora species listed under TSC Act 1995 and/or the EPBC Act 1999 have been recorded in the areas surrounding the PAA by previous ecological surveys (**Table 5**).

Table 5 Flora of Conservation Significance Previously Recorded in the wider area

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Source
Acacia bynoeana	Bynoe's Wattle	E	V	Umwelt 2005, Cumberland Ecology 2007, 2008 HunterEco 2008a, 2008b, 2009a
Angophora inopina	Charmhaven Apple	V	V	Cumberland Ecology 2007, 2008 HunterEco 2008a, 2009a
Callistemon linearifolius	Netted Bottlebrush	V	-	Umwelt 2004
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	Umwelt 2005 Eco Biological 2005 Cumberland Ecology 2007, 2008 Hunter Eco 2008a, 2008b

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Source
Tetratheca juncea	Black-eyed Susan	V	V	Umwelt 1998, 2004, 2005 Eco Biological 2005; HLA 2006 Cumberland Ecology 2007, 2008 Hunter Eco 2008a, 2008b

4.1.3.2 Significant Fauna

Ten threatened fauna species listed under TSC Act 1995 and/or the EPBC Act 1999 have been recorded in the area surrounding the PAA by previous ecological surveys (**Table 6**).

Table 6 Fauna of Conservation Significance Recorded in the Area

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Source
Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Gunninah 1998; HLA 2006
Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	HLA 2006
Miniopterus australis	Little Bentwing-bat	V	-	Gunninah 1998; HLA 2006 Cumberland Ecology 2007
Miniopterus schreibersii oceanensis	Eastern Bent-wing Bat	V	-	Gunninah 1998; HLA 2006
Mormopterus norfolkensis	Eastern Freetail-bat	V	-	Cumberland Ecology 2007; HLA 2006
Petaurus norfolcensis	Squirrel Glider	V	-	Gunninah 1998
Pteropus poliocephalus	Grey-headed Flying –fox	V	V	Cumberland Ecology 2007; HLA 2006
Saccolaimus flaviventris	Yellow-bellied Sheathtail Bat	V	-	Cumberland Ecology 2007
Tyto novaehollandiae	Masked Owl	V	-	Cumberland Ecology 2007
Tyto tenebricosa	Sooty Owl	V	-	Cumberland Ecology 2007

4.2 Weather Conditions

The prevailing weather conditions during the fauna survey period are presented in **Table 7**.

Table 7 Prevailing Weather Conditions

Parameters	14 May 2012	15 May 2012	16 May 2012	17 May 2012	16 September 2013	17 September 2013	18 September 2013	19 September 2013
Temperature ^{o}C	10–17	8–19	10–19	9–19	9-18	14-22	12-25	6-24
Rain (24hrs to 9:00am) mm	0.0	0.0	0.0	0.0	0.0	14.6	1.6	0.0
Sun Rise	06:37	06:37	06:38	06:39	05:52	05:50	05:49	05:47
Sun Set	17:04	17:03	17:02	17:02	17:46	17:47	17:47	17:48
Moon Rise	00:18	01:14	02:10	03:04	14:23	15:29	16:34	17:38
Moon Set	13:05	13:36	14:06	14:37	03:09	03:53	04:33	05:12

4.3 Flora Survey

4.3.1 Vegetation Community Mapping

4.3.1.1 Project Application Area

A review of previous vegetation mapping undertaken over the proposed disturbance footprints revealed that LHCCREMS (NPWS 2000) mapped the entire area of Site 1 as Coastal Plains Smooth-barked Apple Woodland. Site 2 was mapped by NPWS (2000) as predominately cleared land, with Coastal Plains Smooth-barked Apple Woodland, Riparian Melaleuca Swamp Woodland and Coastal Plains Scribbly Gum Woodland around the edges of this site. The Vegetation Mapping of Lake Macquarie LGA: Stage 3 (Bell and Driscoll 2012) also mapped Site 2 as predominately cleared, with Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland on the edges.

Surveys and ground-truthing recorded five vegetation communities and/or discernible areas within the proposed disturbance footprints, namely:

- Coastal Narrabeen Moist Forest;
- Coastal Foothills Spotted Gum - Ironbark Forest;
- Coastal Plains Smooth-barked Apple Woodland;
- Regrowth Acacia decurrens; and
- Cleared, roads, tracks and waterbodies

Table 8 provides the areas of these communities / areas within each site. **Figure 4** and **Figure 5** provide the final vegetation maps of the proposed disturbance footprints incorporating results of RPS flora ground-truthing surveys.

Table 8 Vegetation Communities or Delineated Areas Confirmed within the PAA

Vegetation Community / Delineated Area	Analogous to LHCCREMS MU	Corresponds to TSC Act 1995 EEC	Area (ha)		Total Area (ha)
			Site 1	Site 2	
Coastal Narrabeen Moist Forest	MU 6	-	-	0.10	**0.10**
Coastal Foothills Spotted Gum - Ironbark Forest	MU 15	-	3.50	-	**3.50**
Coastal Plains Smooth-barked Apple Woodland	MU 30	-	1.22	1.93	**3.15**
Regrowth *Acacia decurrens*	None	-	-	2.00	**2.00**
Cleared, roads, tracks and waterbodies	None	-	2.78	9.85	**12.63**
Total Area (ha)			**7.5**	**13.9**	**21.38**

The following section provides a brief outline of the dominant floral characteristics of each identified vegetation community based on RPS field surveys. The below vegetation community descriptions are derived from flora surveys undertaken within the proposed disturbance footprints.

Coastal Narrabeen Moist Forest (LHCCREMS MU 6)



Plate 1 Coastal Narrabeen Moist Forest

Description: A small patch of this vegetation community occurs within the west of Site 2. Coastal Narrabeen Moist Forest is a tall moist open vegetation community found in sheltered aspects and gullies.

Canopy Layer: 15 to 20 m – 20% Percentage Foliage Cover (PFC). Dominant species were *Eucalyptus acmenoides* (White Mahogany) and *Callicoma serratifolia* (Black Wattle).

Shrub Layer: 1 – 3 m - 70% PFC. Dominated by *Melaleuca linariifolia* (Flax-leaved Paperbark), *Backhousia myrtifolia* (Grey Myrtle), *Glochidion ferdinandi* (Cheese Tree), *Acacia longifolia* (Sydney Golden Wattle), *Dodonaea triquetra* (Large-leaf Hop-bush), *Breynia oblongifolia* (Coffee Bush) and *Leptospermum polygalifolium* subsp. *polygalifolium*.

Ground Layer: To 1 m – 40-60% PFC. Dominant species included *Oplismenus aemulus* (Australian Basket Grass), *Gahnia clarkei* (Tall Saw-sedge), *Adiantum aethiopicum* (Common Maidenhair), *Imperata cylindrica* (Blady Grass), *Entolasia marginata* (Bordered Panic) and *Echinopogon ovatus* (Forest Hedgehog Grass).

Classification: This community is not commensurate with any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.

Total Area Approximately 0.10 ha (Site 2)

Coastal Foothills Spotted Gum – Ironbark Forest (LHCCREMS MU 15)



Plate 2 Coastal Foothills Spotted Gum – Ironbark Forest

Description: This vegetation community occurred over the majority of Site 1. Coastal Foothills Spotted Gum - Ironbark Forest is typically a moderately tall open forest dominated by ironbark species.

Canopy Layer: 20 m – 40% PFC. The dominant canopy species were *Corymbia maculata* (Spotted-gum) with, *Angophora costata* (Smooth-barked Apple), *Eucalyptus crebra* (Narrow-leaved Ironbark), *Eucalyptus umbra* (Broad-leaved White Mahogany) and *Eucalyptus acmenoides* (White Mahogany).

Shrub Layer: 1-2 m – 20-30% PFC. Dominant shrub species included *Dodonaea triquetra* (Large-leaf Hop-bush), *Persoonia linearis* (Narrow-leaved Geebung), *Podolobium ilicifolium* (Native Holly), *Acacia longifolia (*Sydney Golden Wattle) and *Lissanthe strigosa* (Peach Heath)

Ground Layer: 0m to 0.5 m – 50-60% PFC. Dominant species included *Lomandra multiflora* (Many-flowered Mat-rush), *Lomandra filiformis* (Wattle Mat-rush), *Pratia purpurascens* (Whiteroot), *Entolasia stricta* (Wiry Panic) and *Microlaena stipoides* (Weeping Grass).

Classification: This community is not commensurate with any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.

Total Area: Approximately 3.50 ha (Site 1)

Coastal Plains Smooth-barked Apple Woodland (LHCCREMS MU 30)



Plate 3 Coastal Plains Smooth-barked Apple Woodland

Description: This vegetation community occurred within the east of Site 1 and within the south and east of Site 2. This community is a dry and shrubby forest with an open mid layer.

Canopy Layer: 20 to 25 m – 40-60% PFC. Dominant species included *Angophora costata* (Smooth-barked Apple), *Corymbia gummifera* (Red Bloodwood), *Eucalyptus umbra* (Broad-leaved White Mahogany) and *Eucalyptus capitellata* (Brown Stringybark),

Shrub Layer: 1.5 to 3 m – 10-30% PFC. Dominant shrub species included; *Allocasuarina littoralis* (Black She-oak), *Persoonia linearis* (Narrow-leaved Geebung), *Dodonaea triquetra* (Large-leaf Hop-bush) and *Acacia longifolia (*Sydney Golden Wattle).

Ground Layer: 0 to 0.5 m – 70% PFC. Dominant species included *Entolasia stricta* (Wiry Panic), *Imperata cylindrica* (Blady Grass), *Pteridium esculentum* (Bracken), *Microlaena stipoides* (Weeping Grass), *Dianella caerulea* (Blue Flax Lily) and *Lomandra obliqua*.

Classification: This community is not commensurate with any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.

Total Area Approximately 1.22 ha (Site 1) and 1.93 ha (Site 2)

Regrowth Acacia decurrens (No LHCCREMS equivalent)



Plate 4 Regrowth *Acacia decurrens*

Description:	Two areas classified as *Acacia decurrens* regrowth occurred within the south/centre of Site 2. This vegetation type is moderately disturbed with scattered trees and a sparse ground cover.
Canopy Layer:	To 10 m – 30% PFC. Dominant species included *Corymbia maculata* (Spotted Gum) and *Eucalyptus punctata* (Grey Gum).
Shrub Layer:	1.5 to 3 m – 40% PFC. Dominant shrub species included; *Acacia decurrens* (Black Wattle), *Allocasuarina littoralis* (Black She-oak) and *Hakea sericea* (Needlebush).
Ground Layer:	0 to 0.5 m – 50% PFC. Dominant species included *Entolasia stricta* (Wiry Panic), *Rytidosperma racemosum*, *Cynodon dactylon* (Couch), *Juncus usitatus*, *Microlaena stipoides* (Weeping Grass) and *Dianella caerulea* (Blue Flax Lily).
Classification:	This community is not commensurate with any MU or any threatened ecological community listed under the TSC Act 1995 or EPBC Act 1999.
Total Area	Approximately 2.00 ha (Site 2)

Cleared / Disturbed Lands (No MU)

All areas classified as Cleared/Disturbed Lands are areas where the native tree and shrub cover has been mostly removed. These areas retain less than three percent canopy cover i.e. widely spaced isolated trees. Areas of Cleared/Disturbed Lands do not include areas of regrowth native vegetation.

Examples of areas classified as Cleared/Disturbed Lands within the two proposed disturbance footprints include:

- Cleared lands;
- Waterbodies;
- Roads, tracks and associated verges; and
- Infrastructure.

Total area: 2.78 ha (Site 1) and 9.85 ha (Site 2).

4.3.1.2 Riparian Vegetation Below Licensed Discharge Points

A review of LHCCREMS (NPWS 2000) and *Vegetation Mapping of Lake Macquarie LGA: Stage 3* (Bell and Driscoll 2012) has been undertaken for the riparian habitats associated with the licensed discharge points: Newstan LDP001, LDP002 and LDP003 at Newstan Colliery Surface Site; Cooranbong LDP001 and LDP002 at the Cooranbong Entry Site; and a proposed LDP at Hawkmount Quarry.

Vegetation downstream of Newstan LDP001, LDP002 and LDP003 transitions from woodland on the hills and slopes through to floodplain and estuarine communities where LT Creek discharges into Lake Macquarie. Newstan LDP001 and LDP002 vegetation consists of MU30 – Coastal Plains Smooth-barked Apple Woodland in the upper reaches through to MU15 – Coastal Foothills Spotted Gum-Ironbark Forest (LDP003 also contains; MU 11 – Coastal Sheltered Apple-Peppermint Forest and MU 111a – Lake Macquarie Snappy Gum Forest, at this point) as the terrain begins to flatten. From the upper tidal extent of LT Creek to where it discharges into Lake Macquarie vegetation is comprised of pockets of floodplain and estuarine communities (MU38 – Redgum Rough Barked Apple Forest (EEC) and MU42 – Riparian Melaleuca Swamp Woodland (EEC)) amongst residential development.

Vegetation mapping along the unnamed tributary, which receives water from Cooranbong LDP001 and LDP002, consists of MU37 – Swamp Mahogany – Paperbark Forest (EEC). This unnamed tributary enters into Muddy Lake, where vegetation transitions into cleared land, with pockets of MU43 – Estuarine Paperbark Scrub Forest and MU40 – Swamp Oak – Rushland Forest (EEC). The vegetation where Muddy Lake discharges into Lake Macquarie is fringed by MU47 – Mangrove - Estuarine Complex and Saltmarsh (EEC).

The vegetation downstream of the proposed sedimentation basin and associated LDP at Hawkmount Quarry transitions from woodland on the hills and slopes through to floodplain and estuarine communities where it discharges into Lake Macquarie. The name of the creek that this LDP will discharge in to changes name as it flows towards Lake Macquarie; it is known as Lords Creek in the upper reaches near the quarry; it becomes Jigadee Creek as the terrain flattens; and as it widens out and becomes tidal it is named Dora Creek. The vegetation consists of MU30 – Coastal Plains Smooth-barked Apple Woodland and MU 11 – Coastal Sheltered Apple-Peppermint Forest in the upper reaches (Lords Creek) and MU37 – Swamp Mahogany – Paperbark Forest (EEC), MU 5 – Alluvial Tall Moist Forest, MU42 – Riparian Melaleuca Swamp Woodland (EEC), MU 31 – Coastal Plains Scribbly Gum Woodland as the terrain begins to flatten (Jigadee Creek). From the upper tidal extent of Dora Creek to where it discharges into Lake Macquarie vegetation is comprised of pockets of floodplain communities (MU38 – Redgum Rough Barked Apple Forest (EEC), MU42

– Riparian Melaleuca Swamp Woodland (EEC), MU 123 - Cooranbong Blackbutt Tall Forest and MU40 – Swamp Oak – Rushland Forest (EEC)) amongst cleared farm land and residential development.

4.3.2 Threatened Flora

Two threatened flora species were recorded within the proposed disturbance footprints (Site 1 and Site 2) during targeted threatened species searches or in the course of other vegetation mapping activities (**Table 9, Figure 4** and **Figure 5**). These species have also been previously recorded within the wider area. The Project will remove habitat and individuals of two threatened flora species, namely *Tetratheca juncea* and *Grevillea parviflora* subsp. *parviflora*.

Table 9 Threatened Flora Recorded within Site 1 and site 2

Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	V	V	-	1
Tetratheca juncea	Black-eyed Susan	V	V	376	

Figures 4 and 5 shows the locations of all threatened flora detected within the proposed disturbance footprints.

4.3.2.2 Grevillea parviflora subsp. parviflora

A total of 132 stems of *G. parviflora* subsp. *parviflora* were recorded within the original layout of Site 2. However, the boundary of Site 2 was re-designed to avoid impacts upon 131 of the 132 stems of *G. parviflora* subsp. *parviflora,* therefore; only one individual stem is proposed to be removed by the Project.

4.3.2.3 Tetratheca juncea

A total of 376 *T. juncea* clumps are located and proposed to be removed within Site 1. The original layout of Site 1 contained an additional 425 clumps of *T. juncea* to the immediate north of Site 1 (refer to **Figure 4**). However, a redesign of Site 1 has avoided impacts to the additional 425 clumps. The immediate surrounding vegetation type (MU30) at Site 1 is preferred habitat for *T. juncea* and following additional targeted surveys it has been established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west and number at least 1,958 clumps (refer to **Figure 6**). Due to the noted availability of potential habitat surrounding Site 1, which wasn't surveyed, additional surveys within the region would most likely result in a much larger estimate of the local population. Given the current information, the removal of 376 clumps within Site 1 equates to the removal of up to 19.2% of the recorded subpopulation of *T. juncea*, however the actual percentage is likely to be substantially less.

The original layout of Site 2 also contained 219 *T. juncea* clumps. However, following the re-design of the site layout, all 219 recorded clumps of *T. juncea* within Site 2 will be avoided.

4.4 Fauna Survey

A total of 48 fauna species were detected within the proposed disturbance footprints during surveys, including six terrestrial mammal species, two arboreal mammal species, one species of megachiropteran bat, four species of microchiropteran bats, 30 bird species, one reptile species and four amphibian species. Four threatened fauna species listed under the EPBC Act 1999 and/or TSC Act 1995 were recorded during RPS surveys:

- Little Lorikeet (*Glossopsitta pusilla*) (listed as Vulnerable under the TSC Act 1995);
- Grey-headed Flying-fox (*Pteropus poliocephalus*) (listed as Vulnerable under the TSC Act 1995 and

EPBC Act 1999);

- Large-eared Pied bat (*Chalinolobus dwyeri*) (listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999); and
- Little bentwing-bat (*Miniopterus australis*) (listed as Vulnerable under the TSC Act 1995).

In addition, to the threatened fauna species recorded by RPS, six other fauna species listed under TSC Act 1995 and/or the EPBC Act 1999 have been recorded in the surrounding area by previous ecological surveys (**Table 6**).

The results for each group are discussed further below. **Appendix 4** lists all fauna species recorded within each site. Refer to **Figure 4** and **Figure 5** for threatened fauna locations.

4.4.1 Terrestrial Mammals

A total of five Bush Rats (*Rattus fuscipes)*, four Black Rats (*Rattus rattus*), seven Brown Antechinus (*Antechinus stuartii*), one Dusky Antechinus (*Antechinus swainsonii*) and one short-beaked Echidna (*Tachyglossus aculeatus)* were captured during terrestrial/arboreal trapping across the proposed disturbance footprints. Hair tubes had a single specimen from a *Rattus* species, most likely one of the two species captured during trapping. Two Swamp Wallabies (*Wallabia bicolor*) were observed during spotlighting.

4.4.2 Arboreal Mammals

Two arboreal mammal species were recorded within the proposed disturbance footprints. Common Ringtail Possums (*Pseudocheirus peregrinus*) were observed within both Site 1 and Site 2 during spotlighting. Sugar Gliders (*Petaurus breviceps*) were trapped in arboreal Elliott traps at Site 1 and Site 2. No threatened arboreal mammal species listed under the TSC Act 1995 or EPBC Act 1999 were detected.

4.4.3 Bats

Several Grey-headed Flying-foxes, which are listed as Vulnerable under both the TSC Act 1995 and EPBC Act 1999, were recorded during spotlighting. Both Eastern Horseshoe Bat (*Rhinolophus philippinensis*) and Little Forest Bat (*Vespadelus vulturnus*) were captured within the harp traps in Site 1. A total of four species of microchiropteran bats were identified from Anabat echo-location call recording surveys of Site 1, namely:

- Eastern Horseshoe Bat (*Rhinolophus megaphyllus*);
- White-striped Freetail Bat (*Tadarida australis*);
- Large-eared Pied Bat (*Chalinolobus dwyeri*) (listed as Vulnerable under both the TSC Act 1995 and EPBC Act 1999); and
- Little Bentwing-bat (*Miniopterus australis*) (listed as Vulnerable under the TSC Act 1995).

The results of the bat call analysis provided in **Appendix 6**.

4.4.3.1 Bat Alley

An old drift entrance and vent shaft is located adjacent to the northern boundary of Site 1 known locally as ‘Bat Alley’. Previous surveys using harp traps placed at the entrance of the drift have detected the Little Bentwing Bat (*Miniopterus australis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*), some of which appeared pregnant (Gunninah 1998b). On release, the bats flew directly into the mine tunnel, suggesting that it is being used as a roosting and, possibly, a nesting site. Due to safety concerns from rock fall, the drift entrance was not examined internally to verify if bats were utilising the mine for roosting purposes. However, the mine is most likely being utilised for roosting as bats were detected leaving the entrance at dusk.

The original footprint of the proposed Site 1 disturbance footprint was redesigned to decrease potential impacts upon microbats utilising this shaft. A vegetation buffer has also been retained to ensure further protection of the microbats species from the project. An annual ongoing monitoring program centred on the shaft has commenced.



Plate 5 Harp traps deployed at 'Bat Alley'

Monitoring results of Bat Alley by Fly By Night Bat Surveys Pty Ltd (Hoye 2012a, 2012b, 2013a and 2013b) recorded numerous microbat species through echolocation and direct capture. Hoye (2012b:1) states "the low number of bats recorded at adit and shaft may indicate that the workings are not being used for breeding". Although Gunninah (1998b) made observations of potentially pregnant females, pregnancies were not confirmed (nor detailed as to how they were considered pregnant) and the larger context of the situation established through periodic monitoring by a bat specialist indicates that the adit and shaft are likely to only be utilised for roosting and not breeding purposes.

4.4.4 Avifauna Survey

A total of 30 bird species were recorded within the proposed disturbance footprints during the survey period. The most commonly recorded species were Yellow-faced Honeyeater (*Lichenostomus chrysops*), Grey Fantail (*Rhipidura fuliginosa*), Superb Fairy-wren (*Malurus cyaneus*), Lewin's Honeyeater (*Meliphaga lewinii*), Eastern Spinebill (*Acanthorhynchus tenuirostris*) and Mistletoebird (*Dicaeum hirundinaceum*).

The threatened Little Lorikeet (*Glossopsitta pusilla*), which is listed as Vulnerable under the TSC Act 1995, was observed flying over both sites.

4.4.5 Herpetofauna

Targeted and opportunistic surveys were conducted for amphibians and reptiles within the proposed disturbance footprints. Two common amphibian species were recorded during spotlighting and included Whirring Treefrog (*Litoria revelata*) and Common Eastern Froglet (*Crinia signifera*). Three additional amphibian species were recorded during surveys of LT Creek namely; Eastern Dwarf Tree Frog (*Litoria fallax*), Broad Palmed Frog (*Litoria latopalmata*) and Peron's Tree Frog (*Litoria peronii*). A red-bellied black snake (*Pseudechis porphyriacus*) was captured in an Elliott B trap. No threatened herpetofauna species listed under the TSC Act 1995 or EPBC Act 1999 were detected.

4.5 Habitat Survey

4.5.1 Terrestrial Habitats

Habitats within the proposed disturbance footprints were assessed for their potential to support native fauna species including threatened fauna recorded from the wider locality. Broad habitat types recorded within the proposed disturbance footprints included; open forest/woodland areas, riparian areas, and cleared/disturbed areas.

Open forest communities provide moderately suitable habitat for a number of terrestrial mammal species. They also provide abundant foraging resources such as foliage, pollen, nectar and invertebrates for possums, gliders and flying-foxes. Common Ringtail Possums (*Pseudocheirus peregrinus*) were detected during spotlighting and Sugar Gliders (*Petaurus breviceps*) were captured during trapping, which confirms that gliders are present as was expected. No Koalas or signs of their presence were detected during the surveys.

The supply of nectar attracts insect populations, which provide foraging opportunities for a range of microbat species that occur within the locality. In addition, the hollow-bearing trees within the proposed disturbance footprints provide roosting and nesting habitat for a number of microbat species. Bat Alley (drift entrance) adjacent to Site 1 provides roosting opportunities for cave dwelling species such as the Large-eared Pied Bat (*Chalinobus dwyeri*), which is listed as Vulnerable under both the TSC Act 1995 and EPBC Act 1999.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows were recorded including; seven small hollows (2–10 cm) of a size suitable for microbats and small gliders and three medium (11-25 cm) sized hollows suitable for medium sized mammals, such as Brush-tailed Possums. The medium hollows may also be sufficient to provide sub-optimal breeding/nesting habitat for owl and large parrot species. However, no large hollows (>25 cm) which provide important breeding/roosting habitat for these species were identified within the proposed disturbance footprints.The forested areas also provide suitable foraging resources, nesting and roosting opportunities for a variety of sedentary and breeding-migrant bird species. There are also fallen logs, dead stags, and ground debris providing sheltering opportunities for a wide range of terrestrial mammals, reptiles and amphibian species.

Stands of *A. littoralis* and *A. torulosa* are favoured food sources of the Glossy Black-Cockatoo (*Calyptorhynchus lathami*) and were found in Site 2, suggesting this species may utilise the area. Terrestrial mammal species, such as Bush Rats (*Rattus fuscipes*) and Brown Antechinus (*Antechinus stuartii*), were found to be reasonably abundant within the disturbance footprints and are likely to provide hunting opportunities for the Masked Owl (*Tyto novaehollandiae*). Furthermore, Common Ringtail Possums were detected in Site 1 and are a known food source for Powerful Owls (*Ninox strenua*).

4.5.2 Corridors and Habitat Linkages

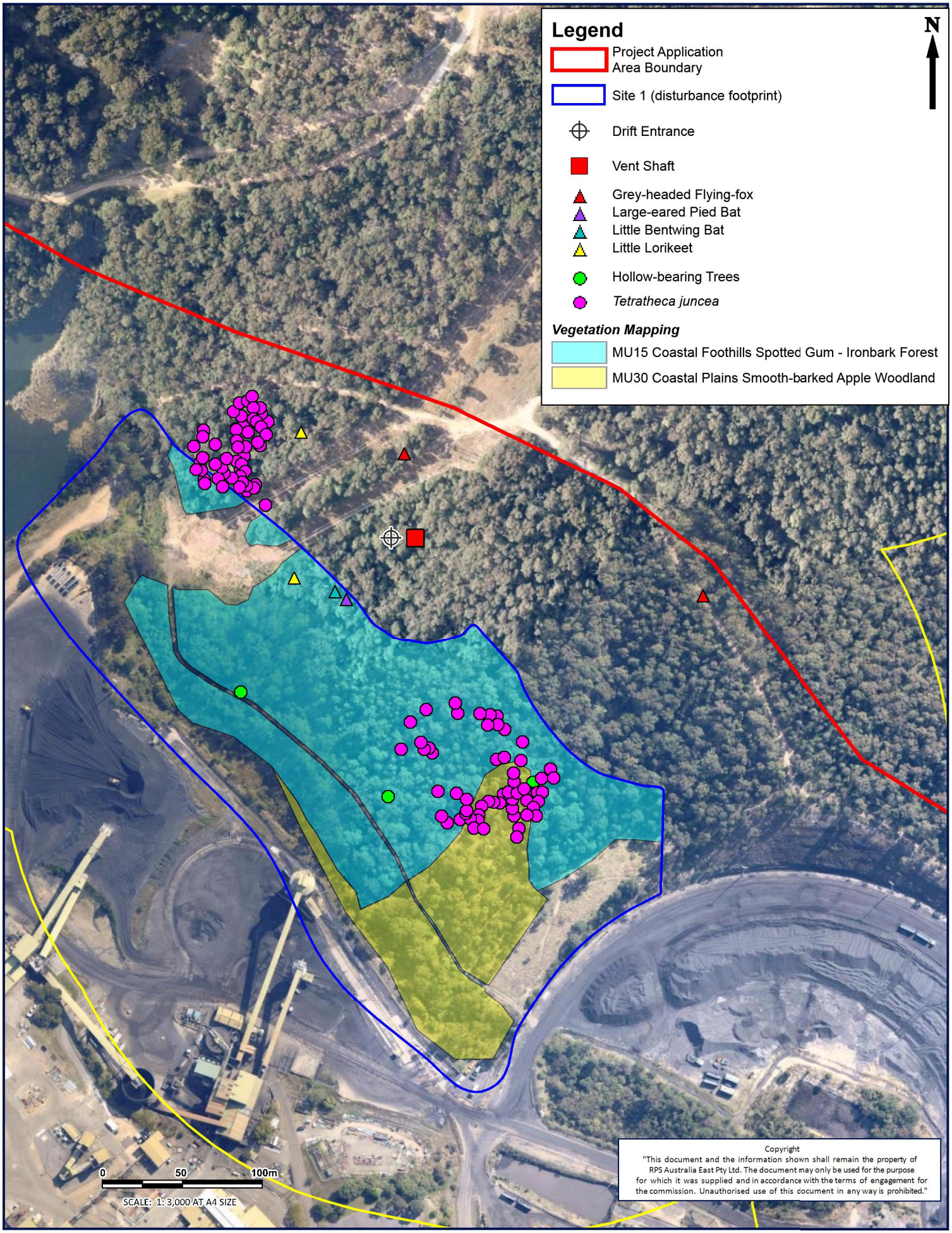
The Lake Macquarie Native Vegetation and Corridors Map (Lake Macquarie City Council 2011) detail a mixture of ‘Corridor of Remnant Native Vegetation’, ‘Corridor of Partially Cleared Remnant Native Vegetation’, and ‘Partially Cleared Remnant Vegetation’ at both Sites 1 and 2. Both sites were adjacent to ‘Widely Interfaced Crossing Point’. Site 1 had limited value as a corridor and habitat linkage as it is bordered on its southern and eastern side by a coal stockpile and other coal handling infrastructure. Site 2 consists of mostly cleared lands and regrowth vegetation and is surrounded by remnant vegetation. Therefore, the corridor and habitat linkage value of Site 2 is also limited.

4.6 State Environmental Planning Policy No. 44 (Koala Habitat Protection)

Lake Macquarie LGA is listed in Schedule 1 of SEPP 44 and therefore the Project is subject to SEPP 44 assessment. One of the species recorded within the disturbance footprints is listed under Schedule 2 of

SEPP 44 as a primary feed tree. This feed tree species was detected within Site 1, namely Eucalyptus punctata (Grey Gum). However, this tree species was recorded at densities below the 15% composition threshold. Therefore, Site 1 does not constitute 'Potential Koala Habitat' and consequently it does not constitute 'Core Koala Habitat' either. Furthermore, no other signs of Koalas were detected within Site 1. No feed trees were found within Site 2 and no signs of Koalas were detected. Therefore, despite the presence of primary Koala feed trees in the disturbance footprints, they do not occur in the density required for any part of the disturbance footprints to be defined as "Potential" or "Core" Koala habitat. Targeted searches for Koala scat in association with feed trees did not identify the presence of Koalas.

Under SEPP 44, identification of "Core Koala habitat" requires that a plan of management accompanies the Development Application (DA). However, no activities that may disturb areas containing "Potential" or "Core" koala habitat are proposed. Therefore, a plan of management is not considered necessary in this instance.



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TITLE: FIGURE 4: SITE 1 VEGETATION COMMUNITIES, THREATENED FLORA & FAUNA & HOLLOW-BEARING TREES

LOCATION: COAL LOGISTICS PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

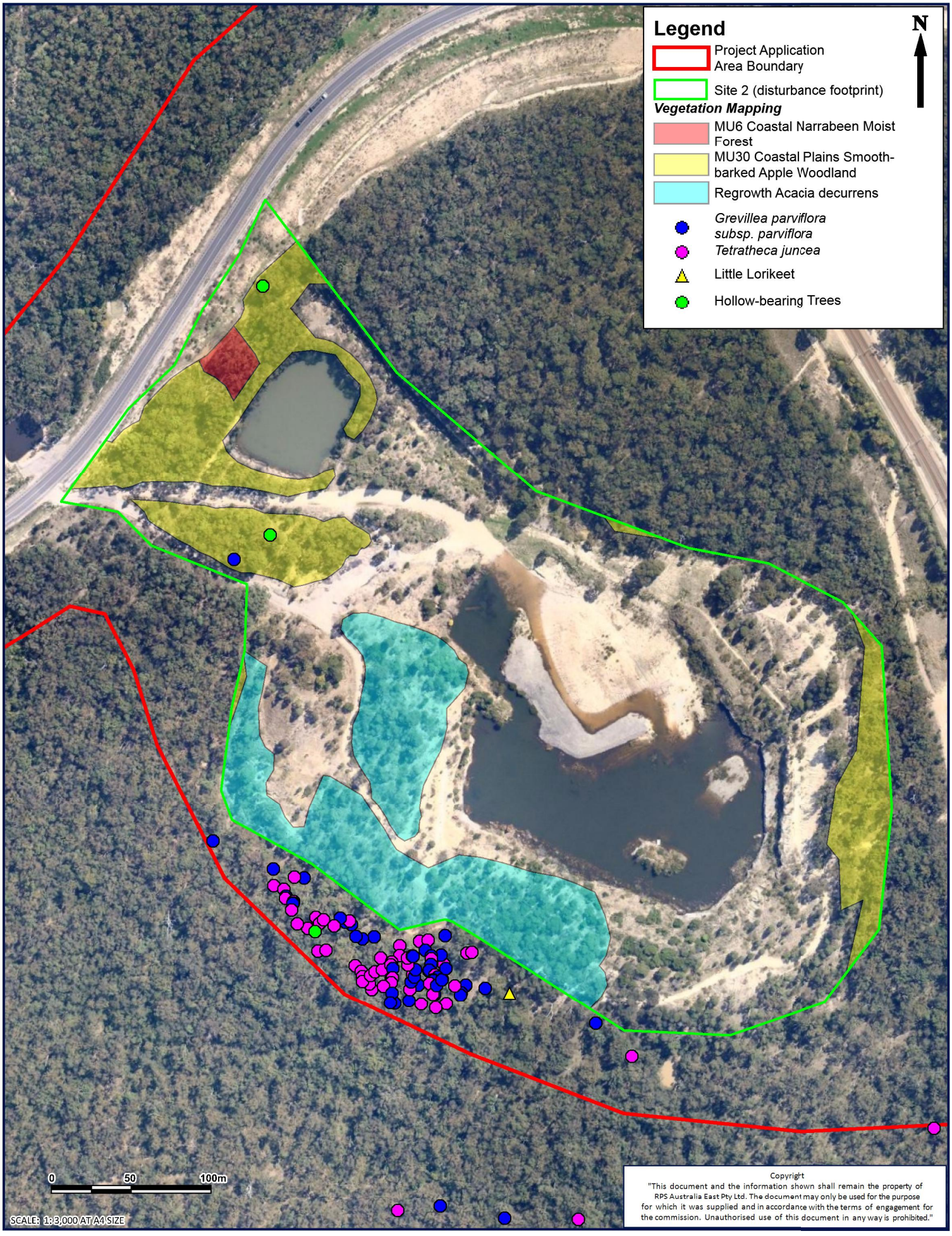
DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): C A4 (AS-NW-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-1

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TITLE: FIGURE 5: SITE 2 VEGETATION COMMUNITIES, THREATENED FLORA & FAUNA & HOLLOW-BEARING TREES

LOCATION: COAL LOGISTICS PROJECT

DATUM: (GDA 94)
PROJECTION: MGA ZONE 56

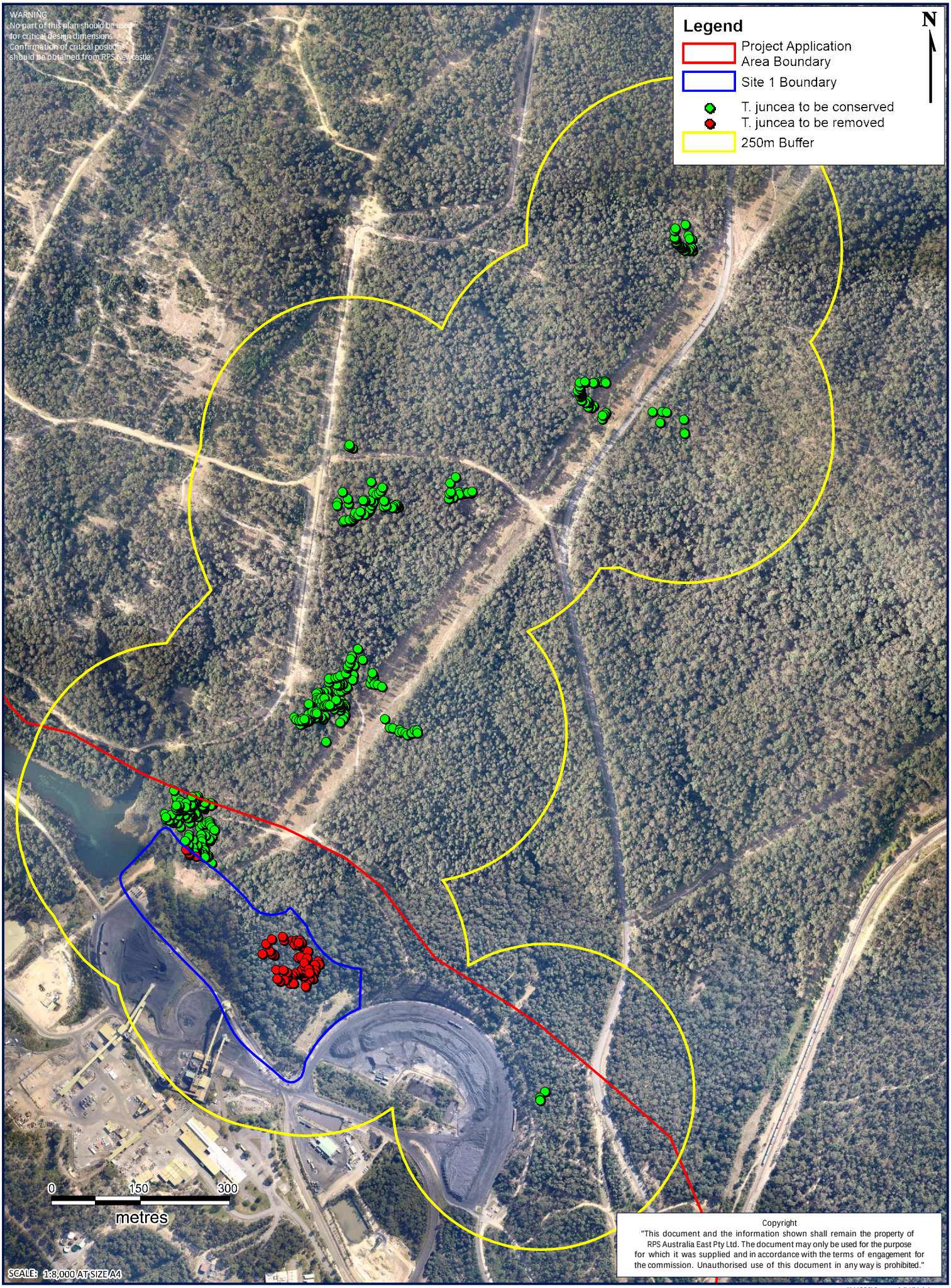
DATE: 23/01/2014
PURPOSE: ECOLOGY

LAYOUT REF: J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces\Eco Report Figures
VERSION (PLAN BY): D A4 (PH-AB)

CLIENT: CENTENNIAL
JOB REF: 113119-1

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TITLE: FIGURE 6: TETRATHECA JUNCEA MAPPING
LOCATION: COAL LOGISTICS PROJECT
DATUM: (GDA 94)
PROJECTION: MGA ZONE 56
DATE: 19/09/2013
PURPOSE: ECOLOGY
LAYOUT REF: "J:\JOBS\Centennial\All Jobs\113119 Coal Logistics\10 - Drafting\Workspaces"
VERSION (PLAN BY): JS (B A4)

CLIENT: CENTENNIAL
JOB REF: 113119-1

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5.0 Threatened Species and Communities Assessment

5.1 Identification of Subject Species and Communities

Threatened flora and fauna species (listed under the TSC Act 1995 and/or the EPBC Act 1999) that have been recorded within a 10 km radius of the PAA (the locality) have been considered within this assessment. Threatened flora and fauna species and EECs known from the broader area have also been addressed where considered applicable. Each species / community was considered for its potential to occur within the proposed disturbance footprints (Site 1 and Site 2). In addition, some EECs have been considered for their potential to occur within the areas which are proposed to be subjected to an increase in surface water discharge (refer to GHD 2014).

This assessment deals with the following heads of consideration in tabulated form (refer to **Table 10** overleaf):

'**Species / Community / Population**' – Lists each threatened species / EEC known or considered likely to occur within the locality. The status of each threatened species under the TSC Act 1995 and the EPBC Act 1999 are also provided.

'**Habitat Description**' – Provides a brief account of the species / community / population and the preferred habitat attributes required for the existence / survival of each species / community.

'**Likelihood of Occurrence on Site**' – Assesses the likelihood of each species / community to occur within the disturbance footprints in terms of the aforementioned habitat description and taking into account local habitat preferences, results of current field investigations, data gained from various sources (such as OEH Atlas of NSW Wildlife and DoE Protected Matters Search Tool) and previously gained knowledge via fieldwork undertaken within RPS and other ecological assessments in the locality and the adjacent areas.

'**Potential for Impact**' – Assesses the potential of each species/community/population to be impacted upon within the disturbance footprints. In addition, some endangered ecological communities have been considered for their potential to be impacted upon within the areas which are proposed to be subjected to an increase in mine water discharge (refer to GHD 2014).

Table 10 Assessment of Likelihood of Occurrence of Threatened Species and Communities

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Plants			
Acacia bynoeana Bynoe's Wattle (E, V*)	Small, prostrate shrub found in low heath, open woodland, dry sclerophyll, generally on loamy clays and sand. Occurs from the Lower Hunter south to the Southern Highlands.	This species was not detected during extensive field work across the disturbance footprint; however, it has been recorded in the surrounding area previously by Umwelt (2005), Cumberland Ecology (2007, 2008) and Hunter Eco (2008a, 2008b). A review of these studies has found that this species has been recorded locally predominately within Coastal Plains Scribbly Gum Woodland, but also within Coastal Plains Smooth Barked Apple Forest. This species has potential to be missed, even during its flowering period. This species has **potential** to occur within the disturbance footprints.	Due to this species being recorded in several surveys of the surrounding area and within 10 km of the PAA, there is potential for impact on this species habitat within the disturbance footprints. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2** as well as an AoS (EPBC Act) in **Appendix 3.**
Angophora inopina Charmhaven Apple (V, V*)	Small to medium tree found in shallow sandy soils in open woodland, swamp woodland and wet heath. The main occurrences of this species are in the Wyong and Lake Macquarie LGA's (from Charmhaven to Wyee and Morisset, and north to near Toronto), with disjunct populations also in Port Stephens LGA (south of Karuah).	This conspicuous species was not detected during extensive field work across the disturbance footprints. This species is **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints, thus, it is unlikely to be affected by the proposed activities. Therefore, an AoS is not required for this species.
Asterolasia elegans (E, E*)	Occurs on Hawkesbury sandstone. Found in sheltered forests on mid- to lower slopes and valleys, e.g. in or adjacent to gullies which support sheltered forest. The canopy at known sites includes Turpentine (*S. glomulifera* subsp. *glomulifera*), Smooth-barked Apple (*A.costata*), Sydney Peppermint (*E. piperita*), Forest Oak (*A. torulosa*) and Christmas Bush (*C. gummiferum*).	Poor habitat for this species occurs throughout the disturbance footprints and it has not been recorded during previous studies of the surrounding area. The known distribution of this species is restricted to the Hawkesbury/Nepean Catchment Management Authority boundary. This species is **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Caladenia tessellata Tessellated Spider Orchid (E, V*)	Small terrestrial herb found in grassy dry sclerophyll woodland on clay loam or sandy soils. Small (6cm x 5mm), single leaf regrow's every year. Flowers between Sept-Nov. Species have been found in *Corymbia maculata* (Spotted Gum) - *Eucalyptus fibrosa* (Ironbark) grassy open forests in the Lower Hunter Valley. Locally, this species has been recorded from Munmorah State Conservation Area.	The nearest known population of this species is Munmorah State Conservation Area, approximately 17km to the south west of the PAA. The absence of records closer to the PAA indicates that this species is **unlikely** to occur.	This species is to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Callistemon linearifolius Netted Bottle Brush (V)	Shrub that grows in dry sclerophyll forest on the coast and adjacent ranges. Re-sprouting / juvenile specimens difficult to distinguish from other *Callistemon* species such as *C. rigidus* (Stiff Bottlebrush) or *C. linearis* (Narrow-leaved Bottlebrush) without the aid of flowering parts. Significant populations recently found within the HEZ and Werakata National Park.	This conspicuous species was not detected during extensive field work across the disturbance footprints. This species is **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints, thus, is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Cryptostylis hunteriana Leafless-tongue Orchid (V, V*)	A very rare leafless, saprophytic orchid, which has a symbiotic relationship with a mycorrhizal fungi which provides the plant with all its nutrient requirements. This orchid remains underground for the majority of its lifecycle, flowering periodically when conditions are optimal to reproduce. This species is extremely cryptic as it does not flower every year. Known to occur within a range of habitats including woodlands to swamp heaths. Within the Hunter region larger populations have been typically found in woodland dominated by *E. racemosa* (Scribbly Gum) and it prefers areas with an open grassy understorey. The species typically prefers moist sandy soils in sparse to dense heath and sedgeland, or moist to dry clay loams in coastal forests.	The disturbance footprints contain vegetation that is suitable habitat for this species. Preferred habitat tends to be Scribbly Gum Woodland (Hunter Eco 2008a; RPS, 2010; Umwelt, 2004) (which occurs extensively in wider area). This species was not recorded by RPS or previous surveys. However, due to the cryptic nature of the species and the wide range of habitats where it has been recorded, it cannot be entirely discounted from occurring within the disturbance footprints. Therefore, there is **potential** for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**, as well as an AoS (EPBC Act 1999) in **Appendix 3**.
Cynanchum elegans White-flowered Wax Plant (E, E*)	The White-flowered Wax Plant usually occurs on the edge of dry rainforest vegetation. Other associated vegetation types include littoral rainforest; *Leptospermum laevigatum* (Coastal Tea-tree) Coastal Banksia *Banksia integrifolia* subsp. *integrifolia* coastal scrub; Forest Red Gum *Eucalyptus tereticornis* aligned open forest and woodland; Spotted Gum *Corymbia maculata* aligned open forest and woodland; and Bracelet Honeymyrtle *Melaleuca armillaris* scrub to open scrub.	This species was not detected during extensive field work across the disturbance footprints. The disturbance footprints do not contain suitable dry rainforest vegetation that this species prefers. This species is **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Corybas dowlingii Red Helmet Orchid (E)	*Corybas dowlingii* is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It is known from the local government areas of Cessnock, Great Lakes, Lake Macquarie and Port Stephens. It occurs in sheltered areas such as gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10-200 m	This species was not detected during extensive field work across the disturbance footprints. It is not known to commonly occur in the area. However, as potential habitat does occur within the disturbance footprints, it cannot be entirely discounted from occurring within the disturbance footprints. Therefore, there is **potential** for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Corunastylis sp. Charmhaven (CE)	*Corunastylis* sp. Charmhaven (NSW896673) is currently only known from the Wyong Shire of NSW where it is restricted to a single location in the Gorokan / Charmhaven area. It occurs within low woodland to heathland with a shrubby understorey and ground layer. Dominants include *Allocasuarina littoralis, Leptospermum juniperinum*, *Melaleuca nodosa, Callistemon linearis* and *Schoenus brevifolius.*	Whilst little other information has been released, the available information suggests that this species could occur in Map Unit (MU) 23: Narrabeen Impeded Wet Heath or MU 31: Narrabeen Doyalson Coastal Woodland as mapped by *The natural vegetation of the Wyong Local Government Area, Central Coast, New South Wales* (Bell, 2002). The literature, therefore, indicates that this species is restricted to a low woodland or heathland with a more coastal influence than what exists within the disturbance footprints. This species is **unlikely** to occur.	Due to the lack of suitable habitat for this species occurring within the disturbance footprints, it is unlikely to be affected by the Project; therefore, an AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Diuris praecox Rough Doubletail (V, V*)	A small, terrestrial herb, which grows on hills and slopes of near-coastal districts in open forests, which have a grassy to fairly dense understorey. Exists as subterranean tubers most of the year and produces leaves and flowers in winter. In the Hunter Valley, this species has been recorded in *Corymbia maculata* (Spotted Gum) - *Eucalyptus fibrosa* (Ironbark) open forest, *Eucalyptus pilularis* (Blackbutt) open forest, *Eucalyptus haemastoma* (Scribbly Gum) woodland, *Eucalyptus piperita* (Sydney Peppermint) - *Angophora costata* (Smooth-barked Apple) forest as well as *Eucalyptus tereticornis* (Forest Red Gum), *Melaleuca* and *Casuarina glauca* dominated riparian or swamp areas.	This species was not detected during field surveys and no records exist within 10 km of the disturbance footprints. The preferred hill top habitats of this species do not exist within the disturbance footprints. This species is **unlikely** to occur.	Due to the lack of suitable habitat for this species occurring within the disturbance footprints, it is unlikely to be affected by the Project; therefore, an AoS for this species is not required.
Eucalyptus camfieldii Camfield's Stringybark (V, V*)	A small/medium sized tree with a scattered distribution from Waterfall in the south to Raymond Terrace in the north. Occurs in exposed coastal environments on shallow sandy soils derived from Hawkesbury Sandstone. Often found growing with Scribbly Gum, Brown Stringybark and Narrow Leaf Stringybark.	Although some suitable habitat occurs within the disturbance footprints, this conspicuous species was not detected during extensive field surveys. The closest known population occurs in Norah Head, 40km south of the disturbance footprints (TSSC, 2008). Therefore, this species is **unlikely** to occur within the disturbance footprints.	The disturbance footprints are out of the main range for this species and based on low occurrences it is considered unlikely to be affected by the proposed activities; therefore, an AoS is not required for this species.
Grevillea parviflora subsp. *parviflora* Small-flower Grevillea (V, V*)	Occurs in light, clayey soils in woodlands. Most plants appear capable of suckering from a rootstock. Relatively widespread within the Cessnock LGA. Occurs within Werakata National Park. Much confusion surrounds the taxonomy of this species and other similar *Grevillea* taxa and a NPWS-funded study of the species is currently in progress.	This species was **detected** during surveys in the Site 2 and has been recorded within the surrounding area by Umwelt (2005), Eco biological (2005), Cumberland Ecology (2007;2008), Hunter Eco (2008a;2008b) and RPS (2011; April 2012).	Due to this species being recorded within Site 2, there is potential for impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2** as well as an AoS (EPBC Act 1999) in **Appendix 3.**
Maundia triglochinoides (V)	Grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30 - 60 cm deep on heavy clay, low nutrients. Associated with wetland species e.g. *Triglochin procerum*.	This species was not detected during extensive field work across the disturbance footprints. However, this species has been recorded within close proximity (~120 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is **potential** for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Melaleuca biconvexa Biconvex Paperbark (V, V*)	A shrub to small tree, which grows in poorly drained areas on the Central Coast with outlying populations at Jervis Bay and Port Macquarie. Records in the Hunter Region are confined to western Lake Macquarie (Atlas of NSW Wildlife data). It may occur in dense stands adjacent to watercourses, in association with other *Melaleuca* species or as an understorey species in wet forest.	This species was not detected during extensive field work across the disturbance footprints. However, this species has been recorded within close proximity (~15 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is **potential** for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2** as well as an AoS (EPBC Act 1999) in **Appendix 3.**
Pelargonium sp. *Striatellum* (G.W.Carr 10345) Omeo Stork's-bill (E*)	A tufted perennial herb known to occur within the South Eastern Highlands, South East Corner IBRA Bioregions and the Hawkesbury-Nepean, Murrumbidgee, Southern Rivers and North East Natural Resource Management Regions. This species grows in exposed lake beds or just above the high water mark of intermittently inundated or ephemeral lakes.	No suitable habitat exists within the disturbance footprints for this species and it has not been recorded during field surveys within the surrounding area or in the 10 km search. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints for this species, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required.
Prasophyllum sp. Wybong (C.Phelps ORG 5269) (CE*)	*Prasophyllum* sp. Wybong is a terrestrial orchid with a single flower spike with several fragrant flowers. Seven known populations of this species occurs within the Brigalow Belt South, Sydney Basin, New England Tablelands, NSW South Western Slopes IBRA Bioregions, Border Rivers-Gwydir, Namoi, Hunter-Central Rivers and Central West Natural Resource Management Regions. It mainly grows in open eucalypt woodland and grassland. The area of occupancy of this species has been estimated to 1.5 km2.	The disturbance footprints are located outside of the distribution range of this species and it was not recorded during field surveys of the disturbance footprints or within the surrounding region. Due to the very restricted geographic distribution of this species, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Pterostylis gibbosa Illawarra Greenhood (E, E*)	Ground-dwelling orchid which grows in open forest or woodland on flat or gently sloping land with poor drainage. It is a deciduous orchid that is only visible above the ground between late summer and spring, only when soil moisture levels can sustain its growth. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark (*E. crebra*), Forest Red Gum (*E. tereticornis*) and Black Cypress Pine (*C. endlicheri*).	This species has not been recorded within 10 km of the disturbance footprints and was not detected by RPS or previous surveys. The disturbance footprints are not situated within this species known distribution. It is therefore, considered **unlikely** to occur.	This species was not recorded within the disturbance footprints or within 10 km of the disturbance footprints, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Rhizanthella slateri Eastern Underground Orchid (V, E*)	*Rhizanthella slateri* is an underground orchid with a whitish, fleshy underground stem to 15 cm long and 15 mm diameter. In NSW, it is currently only known from fewer than 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. At each location, only a few individuals are known. However, *R. slateri* is difficult to detect, it is usually located when the soil is disturbed, and there may well be more locations of the species within its known range. The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available.	This species was not detected during extensive field work across the disturbance footprints. It is not known or predicted to occur in wider the area (DoE 2014). Therefore, it is considered **unlikely** to occur.	This species was considered unlikely to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Rutidosis heterogama Heath Wrinklewort (V, V*)	This rare species grows mostly in heath, often along disturbed roadsides. It grows in heath on sandy soils and moist areas in open forest, and has been recorded along disturbed roadsides. It is chiefly found in coastal districts from Maclean to the Hunter Valley, and inland to Torrington. Populations have been found on the Central Coast and Lake Macquarie regions in recent years.	This species was not detected within the disturbance footprints during RPS field surveys; however, 2 records exist within a 10 km radius of the disturbance footprints (OEH 2014). A small amount of disturbed suboptimal moist forest habitats occur within the disturbance footprints. However, the preferred heath habitat does not occur within the disturbance footprints. Therefore, it is **unlikely** to occur.	This species was considered unlikely to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Senecio spathulatus Coast Groundsel (E)	Coast Groundsel occurs in Nadgee Nature Reserve (Cape Howe) and between Kurnell in Sydney and Myall Lakes National Park. It occurs in coast Groundsel grows on frontal dunes.	This species was not detected during extensive field work across the disturbance footprints. Its preferred habitat of frontal dunes does not occur within the disturbance footprints. Therefore, it is considered **unlikely** to occur.	This species was considered unlikely to occur and therefore, unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Streblus pendulinus Siah's Backbone (E*)	*Streblus pendulinus* is a large shrub or tree with red fleshy fruits (5-8 mm long). The Australian distribution of this species ranges from Cape York Peninsula to Milton, south-east NSW and Norfolk Island. On the mainland it grows in rainforest or gallery forest.	This conspicuous species was not detected during extensive field work across the disturbance footprints. Its preferred habitat of rainforest or gully forest does not occur within the disturbance footprints. Therefore, it is considered **unlikely** to occur.	This species was not recorded during field surveys and no suitable habitat exists within the disturbance footprints. Thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Syzygium paniculatum Magenta Lilly Pilly (E, V*)	A shrub to small tree found in sub-tropical and littoral rainforest on sandy soils or sheltered gullies mostly near water courses. Distributed between Bulahdelah and Jervis Bay. Hunter Region records are confined to the Lake Macquarie hinterland (Atlas of NSW Wildlife data).	There is no suitable habitat (littoral rainforest) present within the disturbance footprints for this species. However, this species has been recorded within close proximity (~20 metres) to Dora Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is **potential** for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2** as well as an AoS (EPBC Act 1999) in **Appendix 3.**
Tetratheca glandulosa Glandular Pink-bell (V, V*)	A low growing, spreading shrub (20 - 50 cm high) with pale pink to light lilac pink coloured flowers. This species occurs within the Hawkesbury–Nepean, Hunter–Central Rivers and Sydney Metro Natural Resource Management Regions where it grows in sandy or rocky heath, dry and open woodlands. Associated species include *C. gummifera*, *A. bakeri* and *E. capitellata*.	The disturbance footprints are located outside of the distribution range of this species and it was not recorded during field surveys or by previous surveys. It is therefore, considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints or within the surrounding region, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Tetratheca juncea Black-eyed Susan (V, V*)	Occurs in a variety of forested and heathy habitats. Locally found in Open Forests and Woodlands with dense, undisturbed understorey, often in association with *A. costata* / *C. gummifera* on slopes with south-easterly aspects.	This species was **detected** in both Site 1 and Site 2 during targeted flora surveys. This species has been recorded in previous surveys throughout the wider area within several vegetation communities (Gunninah 1998; Umwelt 2004, 2005; Eco biological 2005; Cumberland Ecology 2007, 2008; Hunter Eco 2008a, 2008b; RPS 2011).	Due to this species being recorded within the disturbance footprints, there is potential for impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2** as well as an AoS (EPBC Act 1999) in **Appendix 3.**
Zannichellia palustris (E)	In NSW, known only from the lower Hunter. Grows in fresh or slightly saline stationary or slowly flowing water.	Suboptimal habitat for this species occurs along the creekline within Site 1. However, no individuals were recorded by RPS or previous surveys. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints or in previous studies, thus is considered unlikely to be affected by the proposed activities; therefore, AoS is not required for this species.
Endangered Populations			
Eucalyptus parramattensis subsp. *parramattensis* Camfield's Eucalypt (E-pop)	This species usually occurs from the Goulburn Valley on the Central West slopes to Hill Top on the Central Coast. The endangered population in the Lake Macquarie and Wyong local government areas is at the north-eastern limit of the species range and is quite separate from other known populations. The majority of the population occurs within Wyong in the Porter's Creek and the Wallarah Creek catchments. This species is associated with low moist areas alongside drainage lines and adjacent to wetlands. It is often found in woodland on sandy soils. The endangered population occurs on sandy alluvium within a floodplain community which also supports *Eucalyptus robusta* (Swamp mahogany), *E. tereticornis* (Forest Red Gum), *E. gummifera* (Sydney Bloodwood) as well as Melaleuca (Paperbark) species.	No population of this species was recorded during flora surveys across the disturbance footprints, however, it was recorded in the surrounding area by RPS (April 2012). Therefore, it is considered **unlikely** for this species to occur within the disturbance footprints.	No suitable habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Herpetofauna			
Heleioporus australiacus Giant Burrowing Frog (V, V*)	Generally restricted to sandstone areas of the Sydney Basin. Found in heath, woodland and open dry sclerophyll forest on a variety of soil types except those that are clay based. Spends more than 95% of its time in non-breeding habitat in areas up to 300 m from breeding sites. Whilst in non-breeding habitat it burrows below the soil surface or in the leaf litter.	This species is generally restricted to Hawkesbury Sandstone which is not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Hoplocephalus bungaroides Broad-headed Snake (E, V*)	Largely confined to Triassic sandstones, including the Hawkesbury, Narellan and Shoalhaven formations, within the coast and ranges. Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter and spring. Moves from the sandstone rocks to shelters in hollows in large trees within 200 m of escarpments in summer.	Suitable habitats for this species (sandstone escarpments with rock shelters etc) are not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Hoplocephalus stephensii Stephens' Banded Snake (V)	Rainforest and eucalypt forests and rocky areas up to 950 m in altitude. Stephens' Banded Snake is nocturnal, and shelters between loose bark and tree trunks, amongst vines, or in hollow trunks limbs, rock crevices or under slabs during the day. At night, it hunts frogs, lizards, birds and small mammals.	Due to the presence of suitable habitat, this species has **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2.**
Litoria littlejohni Little John's Tree Frog (V, V*)	A pale brown frog with dark speckles which occurs along permanent rocky creeks with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. Occurs on the plateaus and eastern plains of the Great Dividing Range. Records within the Hunter Region occur from within the Watagan State Forest.	Suitable habitats for this species (permanent rocky creeks) are not present within the disturbance footprints. Furthermore, this species typically prefers habitats within sandstone escarpments such as the Watagan Mountains to the south of the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Litoria aurea Green and Golden Bell Frog (E, V*)	Inhabits swamps, lagoons, streams and ponds as well as dams, drains and storm water basins. Thought to be displaced from more established sites by other frog species, thus explaining its existence on disturbed sites. Previously widespread within the region, but now sparsely distributed within the Lower Hunter and Central Coast areas. A relatively stable population occurs on Kooragang Island.	The field survey did not record this species within the disturbance footprints. This species only persists in areas which exhibit a saline influence and records from Western Lake Macquarie are historical only. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	Due to the current isolated populations of this species and lack of suitable habitat within the disturbance footprints, it is unlikely to occur and thus unlikely to be affected by the proposed activities within the disturbance footprints. Therefore, AoS for this species is not required.
Litoria brevipalmata Green-thighed Frog (V)	Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland.	Suitable habitats for this species (rainforest and moist eucalypt forest) are not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Mixophyes balbus Stuttering Frog (E, V*)	Found in rainforest and wet, tall open forest in the foothills and escarpment on the eastern side of the Great Dividing Range. Breed in streams during summer after heavy rain, outside the breeding season adults live in deep leaf litter and thick understorey vegetation on the forest floor. Eggs are laid on rock shelves or shallow riffles in small, flowing streams.	Suitable habitats for this species (rainforest and wet, tall open forests in the foothills and escarpment and undisturbed rocky streams) are not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Mixophyes iteratus Giant Barred Frog (E, E*)	Mostly restricted to wet sclerophyll forest and rainforest, including Antarctic Beech forest. Usually found within close proximity to permanent running water (Robinson, M, 1998). Hunter Region records are largely confined to the Watagan National Park and to the north of Heaton State Forest (Atlas of NSW Wildlife data).	Suitable habitats for this species (wet sclerophyll forest and rainforest) are not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Crinia tinnula Wallum Froglet (V)	Wallum Froglets are found in a wide range of habitats, usually associated with acidic swamps on coastal sand plains. They occur in sedgelands, wet heathlands, paperbark swamps and drainage lines within other vegetation communities. They will also persist in disturbed areas. The species breeds in swamps with permanent water as well as shallow ephemeral pools and drainage ditches.	Suitable habitats for this species are not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Pseudophryne australis Red-crowned Toadlet (V)	It is confined to the Sydney Basin, from Pokolbin in the north, the Nowra area to the south, and west to Mt Victoria in the Blue Mountains. Occurs in open forests, mostly on Hawkesbury and Narrabeen Sandstones. Inhabits periodically wet drainage lines below sandstone ridges that often have shale lenses or capping.	This species is generally restricted to Hawkesbury Sandstone which is not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Avifauna			
Anthochaera phrygia Regent Honeyeater (CE, E*)	Nomadic Honeyeater that disperses to non-breeding areas, including the coast, in winter, where flowering trees are sought. Within the region, mostly recorded in Box-Ironbark Eucalypt associations along creek flats, river valleys and foothills. Coastal swamp forests in Lower Hunter are used when more western resources fail. The main feed tree for coastal areas is *E. robusta* (Swamp Mahogany). Hunter records are more common in near coastal areas such as Cessnock LGA. Feed trees in this region are *C. maculata* (Spotted Gum), *E. fibrosa* (Broad-leaved Ironbark), *E. crebra* (Narrow-leaved Ironbark) and various stringybark sp.. Nests mainly west of the divide, although local breeding attempts have occurred at Quorrobolong.	This species was not recorded during field surveys, however, preferred winter-flowering tree species (*E. robusta* and *C. maculata*) are known from the region. Therefore, there is **potential** for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**, as well as an AoS (EPBC Act 1999) in **Appendix 3**.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Botaurus poiciloptilus Australasian Bittern (E, E*)	The distribution of this species ranges from south-east Queensland to south-east South Australia, Tasmania and south-west of Western Australia. Preferred habitat includes permanent and seasonal freshwater habitats. It forages in shallow water in wetlands with tall dense vegetation (Garnett et al. 2010).	This species was not recorded during field surveys and no suitable habitat exists within the sites. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
Burhinus grallarius Bush Stone-curlew (E)	Inhabits open forests and woodlands with a sparse grassy groundlayer and fallen timber.	This species was not recorded during field surveys and no suitable habitat exists within the disturbance footprints. It is therefore, considered **unlikely** to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
Calidris ferruginea Curlew Sandpiper (E)	This species has a widespread distribution in NSW east of the Great Divide, particularly in coastal regions. The Curlew Sandpiper inhabits intertidal mudflats in estuaries and bays, lakes and lagoons.	No suitable habitat in the form of mudflats, estuaries or lagoons occurs within the disturbance footprints. Therefore, it is **unlikely** to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
Callocephalon fimbriatum Gang-gang Cockatoo (V)	In summer, generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter, may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. Move to lower altitudes in winter, preferring more open eucalypt forests and woodlands, particularly in box-ironbark assemblages, or in dry forest in coastal areas. Favours old growth attributes for nesting and roosting.	This species was not detected during field surveys. However, potential foraging habitat occurs within Site 1. Therefore, this species has the **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Calyptorhynchus lathami Glossy Black-Cockatoo (V)	Occurs in forests and woodlands where it forages predominantly on *Allocasuarina* cones. Requires large Eucalypt tree hollows for nesting. Sparse occurrences on the valley floor, but resident in ranges and adjacent areas surrounding the Hunter Valley. Most commonly encountered around the south and south western areas of the lake and in the Watagan Mountains N.P. These locations have good stands of *Allocasuarina* sp., especially *A. littoralis* (Black She-oak).	It is considered that the disturbance footprints provide potential foraging habitat for this species within the scattered occurrences of *Allocasuarina littoralis* and *A. torulosa*. However, this species or evidence of it (chewed *Allocasuarina* sp. cones) was not observed within the disturbance footprints during field surveys. Some tree hollows located within the disturbance footprints may also provide nesting habitat for this species; however, preferred nesting is typically located within high densities of *Allocasuarina* sp. which were not observed within the disturbance footprints. Therefore, there is **potential** for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Charadrius mongolus Lesser Sand Plover (V)	When in Australia, this migratory species inhabits sheltered bays, harbours and estuaries with large intertidal sand flats or mudflats. Prey includes molluscs, worms, crustaceans and insects. Low numbers of this species visit the Hunter estuary during the austral summer.	The survey did not record this species within the disturbance footprints. The disturbance footprints lack suitable habitat as this species primarily inhabits coastal areas. It is therefore, considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Chthonicola sagittata Speckled Warbler (V)	Occupies Eucalypt and Cypress woodlands in drier coastal areas and on the western slopes of the Great Dividing Range. Appears unable to persist in districts where no forested fragments larger than 100 ha remain. Occurs in the central and southern Hunter Region where suitable habitat exists. Associated with extensive stands of *B. spinosa* (Blackthorn) in some areas (HBOC).	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species which is typically found in more western habitats. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
Circus assimilis Spotted Harrier (V)	Occurs throughout the Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Found most commonly in native grassland, but also occurs in agricultural land, foraging over open habitats including edges of inland wetlands. Hunts for small terrestrial mammals including bandicoots, bettongs and rabbits. Nest constructed in open or remnant woodland.	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species which is typically found in more open grassland habitats. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
Climacteris picumnus victoriae Brown Treecreeper (V)	Frequents drier forests and woodlands, particularly open woodland lacking a dense understorey. Also found in grasslands in proximity to wooded areas where there are sufficient logs, stumps and dead trees nearby. Occasionally found in mallee and *E. camaldulensis* (River Red Gum) forest bordering wetlands with an open understorey of *Acacia* sp., *Muehlenbeckia* sp. (Lignum), *Typha sp*. (Cumbungi) and *Poa* sp. (grasses). Feeds on invertebrate larvae and small insects, particularly ants. Utilises hollows for roosting/nesting.	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species which is typically found in more western habitats. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, AoS for this species is not required.
Daphoenositta chrysoptera Varied Sittella (V)	Inhabits eucalypt forests and woodlands, especially those containing rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland.	The species has not been recorded within the wider area by any previous surveys although some suitable habitat is present in the form of rough-barked and smooth-barked gums. It is therefore, considered as having **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Dasyornis brachypterus Eastern Bristlebird (E, E*)	The Eastern Bristlebird occurs in three separate populations; one in south-east Queensland and north-east NSW and the other two south of Wollongong (NSW). It inhabits a wide range of habitats including sedgeland, heathland, schlerophyll forest, woodland and rainforest.	The disturbance footprints are located outside of the known distribution range of this species. It is therefore, considered **unlikely** to occur within the disturbance footprints.	Due to the current isolated populations of this species, it is considered unlikely to be affected by the proposed activities within the disturbance footprints. Therefore, AoS for this species is not required.
Ephippiorhynchus asiaticus Black-necked Stork (E)	Inhabits swamps associated with river systems and large permanent pools but sometimes appears on the coast or in estuaries. It has also been recorded on farm dams and sewage treatment ponds. Within the Hunter Region it occurs spasmodically on freshwater or estuarine wetlands, along coastal and near coastal environments such as Gloucester.	The disturbance footprints lack potential habitat suitable for this species having no swamps, permanent pools or estuarine habitats. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Epthianura albifrons White-fronted Chat (V)	*Epthianura albifrons* is found in damp open habitats, particularly estuarine and marshy grounds, as well as wetlands containing Saltmarsh, bordered by open grasslands or lightly timbered lands (Higgins et al. 2001). The species is also observed in open grasslands and sometimes in low shrubs bordering wetland areas. Inland, the White-fronted Chat is often observed in open grassy plains, saltlakes and saltpans that are along the margins of rivers and waterways (Higgins et al. 2001; Barrett et al. 2003). The species is sensitive to human disturbance and is not found in built areas. *Epthianura albifrons* (White-fronted Chat) is endemic to Australia, extending across the southern half of Australia. Found mostly in temperate to arid climates and very rarely seen in sub-tropical areas, *E. albifrons* occupies foothills and lowlands below 1000 m above sea level (Higgins et al. 2001; Barrett et al. 2003).	No suitable habitat in the form of saltmarsh, estuaries or open grassy plains occurs within the disturbance footprints. Therefore, it is **unlikely** to occur within the disturbance footprints.	No potential habitat is present within the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Erythrotriorchis radiatus Red Goshawk (CE, V*)	The Red Goshawk is sparsely distributed from western Kimberley to the northeastern NSW. Preferred habitat in NSW includes subtropical rainforest and Melaleuca forest along coastal rivers. Records in NSW are rare.	The disturbance footprints are located outside of the known distribution range of this species and no potential habitat is present. It is therefore, considered **unlikely** to occur within the disturbance footprints.	Out of range and no potential habitat is present within the disturbance footprints. Thus, this species is unlikely to be affected by the proposed activities; therefore, AoS for this species is not required.
Falco subniger Black Falcon (V)	The Black Falcon inhabits woodland, shrubland and grassland in the arid and semi-arid zones, especially wooded watercourses and agricultural land with scattered remnant trees. The Black Falcon is usually associated with streams or wetlands, visiting them in search of prey and often using standing dead trees as lookout posts. Habitat selection is generally influenced more by prey densities than by specific aspects of habitat floristics or condition, although in agricultural landscapes the Black Falcon tends to nest in healthy, riparian woodland remnants with a diverse avifauna. Much of the best habitat of the Black Falcon in New South Wales is likely to occur on private land (i.e. agricultural or pastoral land), rather than in reserves.	This species was not detected within the Study Area during field surveys. They are generally not found along the Central Coast as they prefer arid and semi-arid areas. Therefore it is considered **unlikely** to occur within the Study Area based on population occurrence records.	No potential habitat is present in the Study Area, and thus this species is **unlikely** to be affected by the Project, therefore an AoS for this species is not required.
Glossopsitta pusilla Little Lorikeet (V)	*Glossopsitta pusilla* extends from Cairns to Adelaide coastally and to inland locations. Commonly found in dry, open eucalypt forests and woodlands. Can be found in roadside vegetation to woodland remnants. *G. pusilla* feeds on abundant flowering Eucalypts, but will also take nectar from *Melaleuca* sp and *Mistletoe* sp. *E. albens* (White Box) and *E. melliodora* (Yellow Box) are favoured food sources on the western slopes in NSW. On the eastern slopes and coastal areas favoured food sources are *C. maculata* (Spotted Gum), *E. fibrosa* (Broad-leaved Ironbark), *E. robusta* (Swamp Mahogany) and *E. pilularis* (Blackbutt). Nesting takes place in hollow-bearing trees.	This species was **recorded** during diurnal surveys flying over both sites. Suitable habitat for this highly mobile species exists within flowering canopy species within the disturbance footprints and potential nesting sites exist in hollow-bearing trees.	The proposed activities may impact on this species habitat A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2.**
Haematopus fuliginosus Sooty Oystercatcher (V)	Favours rocky headlands, rocky shelves, exposed reefs with rock pools, beaches and muddy estuaries. Forages on exposed rock or coral at low tide for foods such as limpets and mussels.	No potential habitat exists within the disturbance footprints with this species inhabiting primarily coastal estuarine areas. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Haematopus longirostris Pied Oystercatcher (E)	This species prefers undisturbed sandy shell-grit or pebble beaches, sandspits and sandbars, tidal mudflats and estuaries, coastal islands. Occasionally rocky reefs, shores rock-stacks, brackish or saline wetlands. Also grassy paddocks, golf-courses or parks near coast. Forages for molluscs, crustaceans, polychaetes, ascidians, echinoderms and small fish, probes for worms in short wet grass. In the Hunter, this species is relatively common in the Hunter Estuary in small numbers and more common on the open beaches and river mouths around sandspits.	No potential habitat exists within the disturbance footprints with this species inhabiting primarily coastal estuarine areas. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Hieraaetus morphnoides Little Eagle (V)	Can be found across most of Australia, but more commonly found near coastal to inland regions in NSW and Victoria. This species is part-migratory to nomadic and dispersive in some areas.	Due to the presence of suitable habitat, this species has **potential** to occur within the disturbance footprints.	This species is highly mobile, with large home ranges, of which the site may represent an incremental part. Thus, it is unlikely to be affected by the proposed activities; therefore, AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Irediparra gallinacea Comb-crested Jacana (V)	This species inhabits mostly deep permanent freshwater wetlands that are abundant with floating aquatic vegetation that forms dense mats or rafts on the surface of the water. Known to breed within the Hunter as far south as Mandalong. Has been known to arrive at suitable temporary vegetation e.g. Rathluba Lagoon at East Maitland. Hunter records have regularly come from Colliery Dam in the Mulbring area, which contains floating aquatic vegetation. Breeding records have also been recorded from Colliery Dam.	The field survey did not record this species within the disturbance footprints. The site lacks permanent freshwater wetlands with floating aquatic vegetation. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Ixobrychus flavicollis Black Bittern (V)	Solitary species, living near water (estuarine to brackish) in mangroves and other trees which need to form only a narrow fringe of cover. A riparian species that occasionally ventures into the open within estuarine habitats. Sedentary resident along Dora and Stockton Creeks in western Lake Macquarie has also been recorded semi-regularly in the Paterson River but is likely to occur in any brackish to estuarine forested coastal creeks in the lower NSW coast.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat suitable for this species, having no estuarine or brackish wetland habitat. Therefore, it is considered **unlikely** to occur across the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Lathamus discolor Swift Parrot (E, E*)	On the mainland this species frequents Eucalypt forests and woodlands with large trees having high nectar production during winter. Mainland winter foraging sites often vary from year to year. Nests only in Tasmania, but regularly visits the Hunter Region in winter. Visits the Hunter Region when food sources are abundant or food sources are lacking in other areas. Food sources used in the Hunter include *E. robusta* (Swamp Mahogany) on the coast, and near coastal to inland *Lathamus discolour* uses *C. maculata* (Spotted Gum), *E. fibrosa* (Broad-leaved Ironbark) and *E. crebra* (Narrow-leaved Ironbark). Occasional records have come from *E. alba* (White Box) and *E. sideroxylon* (Mugga Ironbark). These food source trees have been recorded as roosting sites for *L. discolor*.	This species was not recorded within the disturbance footprints during field surveys. Preferred winter-flowering tree species (*E. robusta* and *C. maculata*) are known from the wider area and the NSW Atlas shows several records from the Awaba district. Therefore, there is **potential** for this species to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2** as well as an AoS (EPBC Act 1999) in **Appendix 3**.
Neophema pulchella Turquoise Parrot (V)	Lives on the edges of eucalypt woodland adjoining clearings, timbered ridges and creeks in farmland.	This species was not recorded within the disturbance footprints during field surveys. Potential foraging, nesting and roosting habitat exists, however, chance of occurrence is considered low as only a few records exist within the 10 km radius of the disturbance footprints (Atlas of NSW Wildlife data). Therefore, it is considered **unlikely** to occur.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, an AoS for this species is not required.
Lophoictinia isura Square-tailed Kite (V)	Found in a variety of timbered habitats including dry woodlands and open forests. Shows a particular preference for timbered watercourses. Nest sites generally located along or near watercourses, in a fork or on large horizontal limbs.	This species was not recorded during field surveys. The Square-tailed Kite occurs in a wide variety of habitats, some of which are present within the disturbance footprints. However, this uncommon species is rarely observed in the local area. It is therefore, considered as having **potential** to occur.	Despite there being potential for this species to occur, due to the small amount of potential habitat to be removed or modified, in relation to the large home range of the species, it is unlikely to be affected by the proposed activities. Therefore, an AoS for this species is not required.
Oxyura australis Blue-billed Duck (V)	The Blue-billed Duck prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. The species is completely aquatic, swimming low in the water along the edge of dense cover. It will fly if disturbed, but prefers to dive if approached. Young birds disperse in April-May from their breeding swamps in inland NSW to non-breeding areas on the Murray River system and coastal lakes.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (deep water in large permanent wetlands) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Pandion cristatus Eastern Osprey (V)	Ospreys are found right around the Australian coast line, except for Victoria and Tasmania. They are common around the northern NSW coast, especially on rocky shorelines, islands and reefs. The species is uncommon to rare or absent from closely settled parts of south eastern Australia. There are few records from inland areas.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (large wetlands and ocean with medium sized fish species) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Petroica boodang Scarlet Robin (V)	Ranges from SE Qld to the Victoria coast into South Australia. Also occurs in Western Australia in the south west. *P. boodang* occur in single, pairs, in summer, forages in stringybark, other eucalypt woodland, from stumps, low branches (Pizzey and Knight 2007). Perches prominently, flying down swiftly to seize prey. Is part migratory in which in autumn/winter moves to more open habitats. Habitat are foothill forests, woodlands, watercourses, in autumn/winter more open habitats, river red gum woodlands, golf courses, parks, orchards and gardens (Pizzey and Knight 2007).	This species has not been recorded within surrounding area by any previous surveys although Some suitable habitat is present in the form of stringybark and red gums. It therefore, has **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Melanodryas cucullata cucullata Hooded Robin (south-eastern form) (V)	This species prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Requires structurally diverse habitats featuring mature eucalypts, saplings, some small shrubs and a ground layer of moderately tall native grasses.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (open woodlands) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Stagonopleura guttata Diamond Firetail (V)	Found in grassy eucalypt woodlands, including Box-Gum Woodlands and Snow Gum *Eucalyptus pauciflora* Woodlands. Also occurs in open forest, mallee, Natural Temperate Grassland, and in secondary grassland derived from other communities. Often found in riparian areas (rivers and creeks), and sometimes in lightly wooded farmland. Has been recorded in some towns and near farm houses.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (open woodlands) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Pomatostomus temporalis temporalis Grey-crowned Babbler (eastern subspecies) (V)	Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (open woodlands) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Ptilinopus regina Rose-crowned Fruit-Dove (V)	Rose-crowned Fruit-doves occur mainly in sub-tropical and dry rainforest and occasionally in moist eucalypt forest and swamp forest, where fruit is plentiful. They feed entirely on fruit from vines, shrubs, large trees and palms, and are thought to be locally nomadic as they follow the ripening of fruits.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (rainforest) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Ptilinopus superbus Superb Fruit-Dove (V)	Inhabits rainforest and similar closed forests where it forages high in the canopy, eating the fruits of many tree species such as figs and palms. It may also forage in eucalypt or acacia woodland where there are fruit-bearing trees.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential habitat (rainforest) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Ninox connivens Barking Owl (V)	The Barking Owl is found throughout continental Australia except for the central arid regions. Although common in parts of northern Australia, the species has declined greatly in southern Australia and now occurs in a wide but sparse distribution in NSW. Core populations exist on the western slopes and plains (especially the Pilliga) and in some northeast coastal and escarpment forests. They inhabit woodland and open forest, including fragmented remnants and partly cleared farmland. It is flexible in its habitat use, and hunting can extend in to closed forest and more open areas. Sometimes able to successfully breed along timbered watercourses in heavily cleared habitats (e.g. western NSW) due to the higher density of prey on these fertile soils.	This species was not recorded during owl call back or nocturnal spotlighting surveys. This species is rarely recorded in coastal regions; however, a number of widely scattered records for this species occur within the Lower Hunter. However, the possibility that the disturbance footprints are part of the home range of individuals or pairs is considered unlikely. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and is highly mobile, thus this species is unlikely to be affected by the proposed activities, and therefore, an AoS for this species is not required.
Ninox strenua Powerful Owl (V)	Occurs in wet or dry sclerophyll forests and woodlands where suitable prey species occur (being predominantly arboreal mammals). Requires large hollows, usually in Eucalypt trees, for nesting. Roosts in dense vegetation within such areas. Roosts in dense vegetation within such species as *S. glomulifera* (Turpentine), *A. littoralis* (Black She-Oak), *A. melanoxylon* (Blackwood), *A. floribunda* (Rough-barked Apple), *E. cupressiformis* (Cherry Ballart) and *M. nodosa* (Ball Honeymyrtle). Many coastal records exist across the Hunter region.	This species was not recorded during owl call back or nocturnal spotlighting surveys and has not been detected by previous surveys. Potential prey species such as Common Ringtail Possums are present within the disturbance footprints and potential roosting habitat exists within some denser riparian vegetation. Therefore, there is **potential** for this species to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Rostratula australis Australian Painted Snipe (E, V*)	This species has a widespread distribution along the east coast of Australia. Preferred habitats include shallow freshwater wetlands, swamps and inundated grassland.	No suitable habitat present across the disturbance footprints. This species is therefore, considered **unlikely** to occur within the disturbance footprints.	No suitable habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, and therefore, an AoS for this species is not required.
Sternula nereis nereis Fairy Tern (V*)	Fairy Terns utilise a variety of habitats including offshore, estuarine or lacustrine (lake) islands, wetlands, beaches and spits. Fairy Terns nest in small colonies on coral shingle on continental islands or coral cays, on sandy islands and beaches inside estuaries, and on open sandy beaches.	This species is restricted to coastal environments which are not present within the disturbance footprints. Therefore, it is considered **unlikely** to occur across the disturbance footprints.	No potential habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Stictonetta naevosa Freckled Duck (V)	Found in association with large temporary swamps created by floods in the Bulloo and Lake Eyre basins and the Murray-Darling system, particularly along the Paroo and Lachlan Rivers. Disperses during extensive inland droughts when it may be found along the east coast. Nests in dense vegetation at or near water level. Forages for aquatic vegetation.	The field survey did not record this species within the disturbance footprints. The disturbance footprints lack potential dispersive nesting habitat (in dense vegetation at or near water level) suitable for this species. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	No preferred habitat is present in the disturbance footprints, and thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Tyto novaehollandiae Masked Owl (V)	Found in a range of habitats, locally within sclerophyll forests and woodlands where appropriate/preferred prey species occur (being predominantly terrestrial mammals). Requires large Eucalypt hollows for nesting and prefers to roost in these hollows as well.	This species has been recorded within the wider area previously by Cumberland Ecology (2007). Suitable habitat and prey items are available throughout the disturbance footprints. Terrestrial prey items (Bush Rats, Antechinus) were also captured throughout the disturbance footprints. It is therefore, considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2.**
Tyto tenebricosa Sooty Owl (V)	Occurs in wet Eucalypt forest and rainforest with tall emergent trees, often in easterly facing gullies. Within these areas this species hunts for a range of mainly mammalian prey at all levels of the forest strata, even recorded feeding on ground (RPS ecologist pers. obs.). Roosts in tree hollow or dense canopy vegetation. Also nests in large Eucalypt tree hollows. Most Hunter records exist from the Watagan mountains (OEH 2014), but this species has also been observed to the southwest of Awaba (RPS per obs.).	This species was not recorded by RPS during targeted owl call back and nocturnal spotlighting surveys, although it has been previously recorded by Cumberland Ecology (2007). This species is therefore, considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2.**

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Mammals			
Cercartetus nanus Eastern Pygmy-possum (V)	Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (eg. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	Suboptimal habitat occurs for this species within the disturbance footprints, however, it was not detected during field surveys and no local records exist. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, an AoS for this species is not required.
Dasyurus maculatus maculatus Spotted-tailed Quoll (V, E*)	Found in a variety of forested habitats. This species creates a den in fallen hollow logs or among rocky outcrops. Generally does not occur in otherwise suitable habitats that are in close proximity to urban development. Hunter Region records are largely confined to the surrounding ranges (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Road kill animals have been recorded in the past 10 years in Western Lake Macquarie, suggesting that at least a transient population does occur. Suitable foraging and den habitat exists within all vegetation communities within the disturbance footprints, in particular in areas with large fallen logs and hollow-bearing trees. Therefore, it is considered as having **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**, as well as an AoS (EPBC Act 1999) in **Appendix 3**.
Petaurus australis Yellow-bellied Glider (V)	Usually associated with tall, mature wet Eucalypt forest. Also known from tall dry open forest and mature woodland. The diverse diet of this species is primarily made up of Eucalypt nectar, sap, honey dew, manna and invertebrates found under decorticating bark and pollen. Tree hollows for nest sites are essential, as are suitable food trees in close proximity. Most records in the Lower Hunter Region occur in the Watagan Mountains and other areas exhibiting significant stands of forest (OEH 2014).	This species or feeding incisions on tree trunks were not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species with no tall, mature and wet Eucalypt forests present. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and suboptimal habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Petaurus norfolcensis Squirrel Glider (V)	Occurs in eucalypt forests and woodlands where it feeds on sap exudates and blossoms. In these areas tree hollows are utilised for nesting sites. This species also requires winter foraging resources when the availability of normal food resources may be limited, such as winter-flowering shrub and small tree species. Widely distributed across the lower hunter region (OEH 2014).	This species was recorded within the surrounding area by Gunninah (1998) and adjacent to the disturbance footprint by RPS. The disturbance footprints provide suitable resources for this species in the form of eucalypts and tree hollows. Therefore, it is considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2.**
Petrogale penicillata Brush-tailed Rock Wallaby (E, V*)	Occurs in forests and woodlands along the Great Divide and on the western slopes in escarpment country with rocky outcrops, steep rocky slopes, gorges, boulders and isolated rocky areas. The majority of populations favour north-facing aspects, but some southern aspects have been recorded. Apart from the critical rock structure *Petrogale penicillata* also requires adjacent vegetation types, associated types include, dense rainforest, wet sclerophyll, vine thicket, dry sclerophyll forest and open forest. They also require suitable caves and rocky overhangs for shelter and also for 'lookout' posts. Records exist from the Watagan Mountains where it is associated with the above habitats (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. No suitable habitat exists within the disturbance footprints with no critical rock structures present. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Phascogale tapoatafa Brush-tailed Phascogale (V)	Prefer dry sclerophyll open forest with sparse groundcover of herbs, grasses, shrubs or leaf litter. Also inhabit heath, swamps, rainforest and wet sclerophyll forest. Agile climber foraging preferentially in rough barked trees of 25 cm DBH or greater. Feeds mostly on arthropods but will also eat other invertebrates, nectar and sometimes small vertebrates. Females have exclusive territories of approximately 20 - 40 ha, while males have overlapping territories often greater than 100 ha. Nest and shelter in tree hollows with entrances 2.5 - 4 cm wide and use many different hollows over a short time span (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Habitat within the disturbance footprints are considered suboptimal for this species with general lack of hollows for nesting. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and suboptimal habitat exists within the disturbance footprints, thus, this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Phascolarctos cinereus Koala (V, V*)	Occurs in forests and woodlands where it requires suitable feed trees (particularly *Eucalyptus* spp.) and habitat linkages. Will occasionally cross open areas, although it becomes more vulnerable to predator attack and road mortality during these excursions. Records from the Lower Hunter Region are largely confined to the greater Port Stephens area, the Lake Macquarie hinterland and the Watagan Mountains, with a small number of records from Cessnock LGA (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Potential habitat occurs in the communities containing Forest Red Gum, Grey Gum, Scribbly Gum and Swamp Mahogany vegetation communities, or be it suboptimal. Local records exist, however, a local population, should it exist is likely to occur at low density. Despite this, as individual occurrence cannot be ruled out, it is considered to have the **potential** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Potorous tridactylus tridactylus Long-nosed Potoroo (V, V*)	Prefers cool rainforest, wet sclerophyll forest and heathland. Sleeps by day in a nest on the ground, and digs for succulent roots, tubers, fungi and subterranean insects. Some diggings seemingly attributable to this species may belong to *Isoodon macrourus* (Northern Brown Bandicoot). Records exist from the Karuah vicinity (Gunninah 1999) and the Gosford LGA (OEH 2014).	This species or diggings were not recorded within the disturbance footprints during field surveys and suitable habitat is not present. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and suboptimal habitat exists within the disturbance footprints, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Pteropus poliocephalus Grey-headed Flying-fox (V, V*)	This species forages over a large area for nectar/fruits. Seasonally roosts in communal base camps situated within wet sclerophyll forests or rainforests. Frequently observed to forage in flowering Eucalypts. May occur anywhere within the Hunter Region where food or roosting resources are available.	This species was **recorded** within Site 1. Limited roosting habitat exists along the creekline, however, foraging habitat is prevalent with the occurrence of potential flowering and fruiting feed trees within the disturbance footprints and adjacent areas.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**, as well as an AoS (EPBC Act 1999) in **Appendix 3**.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Pseudomys novaehollandiae New Holland Mouse (V*)	This species has a patchy distribution within open woodlands, heathlands and in hind dune vegetation throughout Eastern Australia. In the Hunter Region the species stronghold is in the Myall Lakes region.	This species is typically found in more sparse, open habitats. Suitable habitat does not occur within the disturbance footprints. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and only suboptimal habitat exists, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Chalinolobus dwyeri Large-eared Pied Bat (V, V*)	This species forages in tall open forests and the edges of rainforest. It roosts in mine shafts and similar structures. Roosts in caves (near their entrances), crevices in cliffs, old mine workings and in the disused, bottle-shaped mud nests of *H. ariel* (Fairy Martin), frequenting low to mid-elevation dry open forest and woodland close to these features. Females have been recorded raising young in maternity roosts (c. 20-40 females) from November through to January in roof domes in sandstone caves. They remain loyal to the same cave over many years. Found in well-timbered areas containing gullies. The relatively short, broad wing combined with the low weight per unit area of wing indicates manoeuvrable flight. This species probably forages for small, flying insects below the forest canopy. Hunter Region records for this species are largely confined to the Watagan Mountains, but it has been recorded on the southern side of Port Stephens (OEH 2014).	This species was **recorded** during field surveys by RPS and it has been recorded within the wider area previously by Cumberland Ecology (2007) and HLA (2006). Suitable roosting habitat occurs within the cave located in Site 1, with possible foraging habitat throughout the woodland areas of the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**, as well as an AoS (EPBC Act 1999) in **Appendix 3**.
Falsistrellus tasmaniensis Eastern False Pipistrelle (V)	This species is found in a variety of forest types such as open forests, woodlands and wetter sclerophyll forests (usually with trees >20m). This species roosts in tree hollows and caves. Appears to locally favour upland habitats. A limited number of records occur on the central coast and the Lower Hunter Region (OEH 2014).	This species has been recorded within the wider area by HLA (2006). Foraging habitat within the disturbance footprints are suitable for supporting this species. Possible roosting habitat also exists within the numerous tree hollows across the disturbance footprints and the cave located in Site 1 (Bat Alley). Therefore, it is considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Miniopterus australis Little Bentwing-bat (V)	Prefers to forage in well-vegetated areas, such as within wet and dry sclerophyll forests and rainforests. Requires caves or similar structures for roosting habitat. Largely confined to more coastal areas in the Lower Hunter Region (OEH 2014).	This species was **recorded** by RPS in Site 1 during field surveys. Suitable roosting habitats occur across the disturbance footprints within the numerous tree hollows and in the cave in Site 1.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Miniopterus schreibersii oceanensis Eastern Bentwing-bat (V)	This species utilises a range of habitats for foraging, including rainforest, wet and dry sclerophyll forests, woodlands and open grasslands. Requires caves or similar structures for roosting habitat. Widely distributed across the Lower Hunter Region (OEH 2014).	This species has been recorded within the wider area by Gunninah (1998) and HLA (2006). Potential roosting habitat occurs in the cave located in Site 1. Therefore, it is considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Mormopterus norfolkensis Eastern Freetail-bat (V)	This species is distributed south of Sydney extending north into south-eastern Queensland. There are no records west of the Great Dividing Range. Most records of this species have been reported from dry Eucalypt forest and woodland. It is expected that open forested areas and the cleared land adjacent to bushland, constitutes important habitat for this species. It is a predominantly tree-dwelling species, roosting in hollows or behind loose bark in mature Eucalypts. Widely distributed across the Lower Hunter Region (OEH 2014).	This species was recorded within the wider area previously by Cumberland Ecology (2007) and HLA (2006). Possible roosting habitat also exists within the numerous tree hollows across the disturbance footprints. Therefore, it is considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this recorded species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Phoniscus *papuensis* *(Syn. Kerivoula papuensis*) Golden-tipped Bat (V)	Found in rainforest and adjacent wet and dry sclerophyll forest up to 1000m. Also recorded in tall open forest, *Casuarina*-dominated riparian forest and coastal *Melaleuca* forests. Roost mainly in abandoned hanging Yellow-throated Scrubwren and Brown Gerygone nests, also in tree hollows, dense foliage and epiphytes; located in rainforest gullies on small first- and second-order streams. Will fly up to two kilometres from roosts to forage in rainforest and sclerophyll forest on mid and upper-slopes.	This species was not recorded across the disturbance footprints during field surveys. Habitats within the disturbance footprints are considered to be suitable for this species, or be it suboptimal. However, only scattered records for this species exists within the locality. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and few records exist for this species, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Myotis macropus Southern Myotis (V)	Usually found near bodies of water, including estuaries, lakes, reservoirs, rivers and large streams, often in close proximity to their roost site. Although usually recorded foraging over wet areas, it also utilises a variety of wooded habitats adjacent to such areas including rainforest, wet and dry sclerophyll forest, woodland, and swamp forest. Roosts in small colonies of between 15 and several hundred individuals in caves, mines and disused railway tunnels. A number of records from the Central Coast, with fewer numbers in the Lower Hunter Region (OEH 2014) and Central Hunter Region (RPS pers. obs.).	This species was not recorded within the disturbance footprints or the wider area during previous surveys. However, potential roosting habitat occurs within the cave in Site 1, with possible foraging habitat within the open water habitats in Site 2. Therefore, it is considered as having **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Saccolaimus flaviventris Yellow-bellied Sheathtail-bat (V)	Range of habitats from rainforest to arid shrubland, roosts in tree-hollows. A limited number of records occur on the central coast and the Lower Hunter Region (OEH 2014).	This species has been previously recorded within the surrounding area during field surveys by Cumberland Ecology (2007). Foraging habitat within the disturbance footprints are considered likely to support this species. Possible roosting habitat also exists within the numerous tree hollows of the disturbance footprints. Therefore, it is considered **likely** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Scoteanax rueppellii Greater Broad-nosed Bat (V)	Forages in moister gullies and wet sclerophyll forests as well as in lightly wooded areas and open spaces/ecotones. This species roosts in tree hollows and is relatively widespread within the Lower Hunter Region (OEH 2014).	This species was not recorded within the disturbance footprints during field surveys. Possible roosting habitat exists within the numerous tree hollows of the disturbance footprints. Therefore, it is considered as having **potential** to occur within the disturbance footprints.	The proposed activities may impact on this species habitat. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Vespadelus troughtoni Eastern Cave Bat (V)	A cave dweller, known from wet sclerophyll forest and tropical woodlands from the coast and Dividing Range to the drier forests of the semi-arid zone. It has been found roosting in small groups in sandstone overhangs, in mine tunnels and occasionally in buildings. In all situations, the roost sites are frequently in reasonably well-lit areas. The distribution of this species is largely to the north of the Hunter Region (Strahan 1995).	This species was not recorded across the disturbance footprints during field surveys. Habitats within the disturbance footprints are considered to be suitable for the species and potential roosting habitat also exists within the cave located in Site 1. However, only scattered records for this species exists within the locality. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This species was not recorded within the disturbance footprints and few records exist for this species, thus this species is unlikely to be affected by the proposed activities, therefore, AoS for this species is not required.
Threatened Ecological Communities			
Themeda Grassland on sea cliffs and coastal headlands in the NSW North Coast, Sydney Basin and South East Corner bioregions (E)	Community occurring on sandstone, old sand dunes and basalt, which is characterised by *Themeda australis* (Kangaroo Grass). *T. australis* within the community is sometimes limited to only a few metres square, but on some substrates, such as old sand dunes the community can be relatively extensive in size. *T. australis* within the community is often stunted and prostrate as are the shrubs and trees occurring within the community. In the Lower Hunter and Central Coast regions this community occurs on coastal landforms with *Pimelea linifolia* (Slender Rice Flower), *Westringia fruticosa* (Coast Rosemary), and *Banksia integrifolia* (Coastal Banksia) the most commonly associated species.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions (E)	Found on gentle slopes arising from depressions and drainage flats on Permian sediments of the Hunter Valley floor in the Sydney Basin and NSW North Coast Bioregions. Dominant canopy species include *Eucalyptus tereticornis, E. amplifolia* (Cabbage Gum) and *E. moluccana* (Grey Box) with scattered other Eucalypt species also present. Classified by the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy (LHCCREMS) as Map Unit (MU) 19.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E, CE*)	Littoral rainforest occurs on both sand dunes and on soils derived from underlying rocks. Littoral Rainforest is a closed forest in structure, and the species composition is strongly influenced by the close proximity to the ocean. The floristic composition consists of predominantly rainforest species with evergreen mesic or coriaceous leaves. Several species have compound leaves, and vines may be a major component of the canopy. Littoral Rainforest comprises the *Cupaniopsis anacardioides – Acmena* spp. alliance of Floyd (1990). This alliance as described by Floyd includes five sub-alliances – *Syzygium luehmannii – Acmena hemilampra, Cupaniopsis anacardioides, Lophostemon confertus, Drypetes – Sarcomelicope – Cassinia – Podocarpus* and *Acmena smithii – Ficus - Livistona – Podocarpus.* While the canopy is dominated by rainforest species, scattered emergent individuals of sclerophyll species, such as *Angophora costata* (Smooth-barked Apple), *Banksia integrifolia* (Coastal Banksia), *Eucalyptus botryoides* (Bangalay) and *E. tereticornis* (Forest Red Gum) occur in many stands.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
Lower Hunter Spotted Gum - Ironbark Forest in the Sydney Basin Bioregion (E)	This community is widespread throughout the central to lower Hunter Valley, with forests between Cessnock and Beresfield forming the core of its distribution. This community is dominated by *Corymbia maculata* (Spotted Gum) and *Eucalyptus fibrosa* (Broad-leaved Ironbark) with occasional occurrences of *E. punctata* (Grey Gum) and *E. crebra* (Grey Ironbark). Classified by the Lower Hunter Central Coast Regional Biodiversity Conservation Strategy (LHCCREMS) as Map Unit (MU) 17.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.
River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	Associated with silts, clay-loams and sandy loams, on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains. Composition of the tree stratum varies considerably, the most widespread and abundant dominant trees include *Eucalyptus tereticornis* (Forest Red Gum), *E. amplifolia* (Cabbage Gum), *Angophora floribunda* (Rough-barked Apple) and *A. subvelutina* (Broad-leaved Apple). Correlates with LHCCREMS communities - 'Central Hunter Riparian Forest' Map Unit (MU) 13, 'Wollombi Redgum-River Oak Woodland' MU14 and 'Redgum Roughbarked Apple Swamp Forest' MU38.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. However, areas of 'Redgum Roughbarked Apple Swamp Forest' ((MU38) NPWS, 2000) are mapped as occurring within the lower reaches of the Newstan LDP and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This community (MU38) is considered to be commensurate with River-Flat Eucalypt Forest on Coastal Floodplains (EEC).	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
White Box Yellow Box Blakely's Red Gum Woodland (E) White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (CE*)	White Box Yellow Box Blakely's Red Gum Woodland (commonly referred to as Box-Gum Woodland) is an open woodland community (sometimes occurring as a forest formation), in which the most obvious species are one or more of the following: *Eucalyptus albens* (White Box), *E. melliodora* (Yellow Box) and *E. blakelyi* (Blakely's Red Gum). Intact sites contain a high diversity of plant species, including the main tree species, additional tree species, some shrub species, several climbing plant species, many grasses and a very high diversity of herbs.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered **unlikely** to occur within the disturbance footprints.	This community was not recorded within the disturbance footprints, thus it is unlikely to be affected by the proposed activities, and therefore, AoS for this community is not required.

Species / Community	Habitat Description	Likelihood of Occurrence	Potential for Impact
Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	The most widespread and abundant dominant trees include *Eucalyptus robusta* (Swamp Mahogany), *Melaleuca quinquenervia* (Broad-leaved Paperbark) and, south from Sydney, *Eucalyptus botryoides* (Bangalay) and *Eucalyptus longifolia* (Woollybutt). Other trees may be scattered throughout at low abundance or may be locally common at few sites. Shrubs include *Acacia longifolia*, *Dodonaea triquetra*, *Ficus coronata*, *Leptospermum polygalifolium subsp. polygalifolium* and *Melaleuca* spp. The groundcover is composed of abundant sedges, ferns, forbs, and grasses including *Gahnia clarkei*, *Pteridium esculentum*, *Hypolepis muelleri*, *Calochlaena dubia*, *Dianella caerulea*, *Viola hederacea*, *Lomandra longifolia*, *Entolasia marginata* and *Imperata cylindrica*.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. However, areas of 'Riparian Melaleuca Swamp Woodland ' ((MU42) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. In addition, areas of 'Swamp Mahogany – Paperbark Forest'(MU37) are mapped as occurring within the lower reaches of the Newstan LDPs and the proposed Hawkmount Quarry LDP. Both of these areas will potentially be subject to an increase in mine water discharge and these communities (MU42 and MU37) are considered to be commensurate with Swamp Sclerophyll Forest on Coastal Floodplains (EEC).	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.
Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	This community is found on the coastal floodplains of NSW. It has a dense to sparse tree layer in which *Casuarina glauca* (Swamp Oak) is the dominant species northwards from Bermagui. Other trees including *Acmena smithii* (Lilly Pilly), *Glochidion* spp. (cheese trees) and *Melaleuca* spp. (paperbarks) may be present as subordinate species, and are found most frequently in stands of the community northwards from Gosford. Tree diversity decreases with latitude, and *Melaleuca ericifolia* is the only abundant tree in this community south of Bermagui. The understorey is characterised by frequent occurrences of vines, *Parsonsia straminea, Geitonoplesium cymosum* and *Stephania japonica var. discolor*, a sparse cover of shrubs, and a continuous groundcover of forbs, sedges, grasses and leaf litter.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. However, areas of 'Swamp Oak – Rushland Forest' ((MU40) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This vegetation community (MU40) is considered to be commensurate with Swamp Oak Floodplain Forest (EEC).	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 3**.
Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (E)	Coastal Saltmarsh occurs in the intertidal zone on the shores of estuaries and lagoons that are permanently or intermittently open to the sea. It is frequently found as a zone on the landward side of mangrove stands. Characteristic plants include *Baumea juncea, Juncus krausii, Sarcocornia quinqueflora, Sporobolus virginicus, Triglochin striata, Isolepis nodosa, Samolus repens, Selliera radicans, Suaeda australis* and *Zoysia macrantha*. Occasionally mangroves are scattered through the saltmarsh. Tall reeds may also occur, as well as salt pans.	The vegetation communities mapped within the disturbance footprints are not considered to be commensurate with this EEC. Therefore, it is considered **unlikely** to occur within the disturbance footprints. An area of 'Mangrove - Estuarine Complex and Saltmarsh ' ((MU47) NPWS, 2000) is mapped as occurring within the lower reaches of the Cooranbong Entry site which will potentially be subject to an increase in mine water discharge. This community is considered to be commensurate with Coastal Saltmarsh.	The proposed activities may impact on this community. A 7-part test of significance (TSC Act 1995) has been applied to this species in **Appendix 2**.

Notes: (V) = Vulnerable Species listed under the NSW TSC Act 1995.
(E) = Endangered Species listed under the NSW TSC Act 1995.
(E-pop) = Endangered population of a Species listed under the NSW TSC Act 1995.
(CE) = Critically Endangered Species listed under the NSW TSC Act 1995.
(V*) = Vulnerable Species listed under the Commonwealth EPBC Act 1999.
(E*) = Endangered Species listed under the Commonwealth EPBC Act 1999.
(CE*) = Critically Endangered Species listed under the Commonwealth EPBC Act 1999.

6.0 Predicted Impacts

6.1 Surface Impacts

The Project involves surface disturbance at two sites being Site 1 and Site 2. Site 1 will be the location of additional coal handling infrastructure at the Newstan Colliery Surface Site. Site 2 at the Hawkmount Quarry will be utilised for coarse reject emplacement. The two proposed surface disturbance footprints areas total 21.38 ha and require the modification of both native vegetation and cleared / disturbed land.

6.1.1 Vegetation

The Project proposes a total disturbance footprint (Site 1 plus Site 2) of 21.38 ha. Of this, 6.75 ha is existing as relatively intact native vegetation comprising MU 6 Coastal Narrabeen Moist Forest (0.10 ha), MU 15 Coastal Foothills Spotted Gum – Ironbark Forest (3.50 ha) and MU 30 Coastal Plains Smooth-barked Apple Woodland (3.15 ha). The remainder of the proposed footprint exists as regenerating modified native vegetation (2 ha) and Cleared / Disturbed Land (12.63 ha (refer to **Figure 4** and **Figure 5**)).

The native vegetation communities are not commensurate with any threatened ecological communities listed within the TSC Act 1995 and/or EPBC Act 1999.

6.1.2 Habitat

The native vegetation to be removed as a result of the Project within Site 1 and Site 2, totals 8.75 ha. This vegetation provides suitable habitat for a number of common and threatened flora and fauna species which are known to occur within similar vegetation types in the locality.

The vegetation types which are to be impacted upon are common and widespread in the locality. A further 12.63 ha of Cleared / Disturbed Land in the form of roads and existing infrastructure is located within the proposed disturbance area.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints.

6.1.3 Threatened Species

Within the 8.75 ha of native vegetation, which is proposed to be impacted upon, approximately 376 clumps of *Tetratheca juncea* are present and proposed to be removed from within Site 1, and a single specimen of *Grevillea parviflora* subsp *parviflora* is present and proposed to be removed from within Site 2.

The original layout of Site 1 contained an additional 425 clumps of *T. juncea* to the immediate north of Site 1 (refer to **Figure 4**). However, a re-design of Site 1 has avoided impacts to these additional 425 clumps.

The initial layout for Site 2 involved the removal of 132 specimens of *G. parviflora* subsp. *parviflora* and 219 clumps of *T. juncea*. The layout of Site 2 boundary has been re-designed to avoid all clumps of *T. juncea* and all but one *G. parviflora* subsp. *parviflora* stem (refer to **Figure 5**).

Further information pertaining to the significance of these impacts upon listed threatened species is provided in **Section 6.5.**

6.1.4 SEPP 44 – Koala Habitat Protection

SEPP 44 applies to the Lake Macquarie Local Government Area. This policy states that there is potential habitat for the Koalas (Phascolarctos cinereus) if there is 15% density or more of Koala feed trees as listed in Schedule 2 of SEPP 44. One feed tree species was detected within Site 1 namely Eucalyptus punctata (Grey Gum) but was below the 15% composition threshold. No other signs of Koalas were detected within Site 1. No feed trees were found within Site 2 and no signs of koalas were detected. Therefore, both Site 1 and Site 2 do not constitute 'Potential' or 'Core' Koala habitat as defined by SEPP 44

6.1.5 Groundwater Dependent Ecosystems

This section relates to potential impacts upon groundwater dependent ecosystems (GDEs) as a result of the Project. Whilst changes to surface water discharge is a component of the Project, underground mining and changes to groundwater systems as a result of the Project are not and therefore, have not been considered herewith.

For the purposes of this report the definitions for GDEs, within the following three literature sources, have been adopted:

- The NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002) defines GDEs as: '*Ecosystems which have their species composition and their natural ecological process determined by groundwater'* (ARNCANZ & ANZECC, 1996 as cited in DLWC, 2002).
- Identifying groundwater dependent ecosystems, A guide for land and water managers (Eamus, 2009) defines GDEs as: *'ecosystems whose current composition, structure and function are reliant on a supply of groundwater'*
- Risk assessment guidelines for groundwater dependent ecosystems (Serov *et. al.,* 2012) defines GDEs as: '*any ecosystem that uses groundwater at any time or for any duration in order to maintain its composition and condition*'.

Given this, a single vegetation type within the proposed disturbance footprints is considered to have the potential to be influenced by groundwater flows and, therefore, may be considered as a GDEs. This vegetation type is Coastal Narrabeen Moist Forest (MU 6). Approximately, 0.10 ha of this community is proposed to be removed from within Site 2. This community is part of the drainage line that runs into Lords Creek and is fed by overflow of the sedimentation basin within Site 2. LHCCREMS (NPWS, 2000) vegetation mapping downstream between the site and Lords Creek shows similar vegetation along this drainage line, namely MU 42 Riparian Melaleuca Swamp Woodland. Bell and Driscoll (2012) did not recognised this community, however mapped MU 37 Swamp Mahogany - Paperbark Forest further downstream along Lords Creek.

Whilst the Project may involve the removal the 0.10 ha of Coastal Narrabeen Moist Forest, earthworks and other activities that may impact on the groundwater system are not proposed at Site 2. Therefore, the Project is unlikely to impact upon GDEs outside of the PAA.

6.2 Mine Water Discharge

6.2.1 SEPP 14 – Coastal Wetlands

The Coal Logistics project will not be directly impacting upon any SEPP 14 Coastal Wetlands. Potential indirect impacts will be associated with discharges from the Licensed Discharge Points. The SEPP 14 wetlands recorded within the locality occur at the confluences of the watercourses and Lake Macquarie, in the majority of cases the LDPs are a considerable distance from the wetlands and are relatively high up in their respective catchments.

This Project will continue the discharge of water from LDPs at the Newstan Colliery Surface Site and Cooranbong Entry Site, and also establish a LDP at Hawkmount Quarry for surface water discharge. The potential impacts from increased mine water discharge include increases in flow and changes to water quality, particularly increases in salinity.

Newstan Colliery Surface Site

- Newstan LDP001 – discharges in to LT Creek. Seeking an increase to the volumetric discharges from the current approved 11 ML per day to 14.5 ML per day.
- Newstan LDP002 – discharges in to LT Creek during significant rainfall events.
- Newstan LDP003 - proposed new LDP for the SREA to discharge into the south arm of LT Creek during significant rainfall events.
- Newstan LDP017 - discharges via the Stony Creek pipeline into Stony Creek when water levels in to the Fassifern Underground Storage exceed 16.6 metres below ground level during wet weather periods. No change to this LDP as a result of the Project.

Cooranbong Entry Site

- Cooranbong LDP001 – discharges in to an unnamed drainage path that reports to Muddy Lake. The project will be seeking approval for an increase to the volumetric discharges from the current approved 5 ML per day to up to 8 ML per day.
- Cooranbong LDP002 – discharges in to an unnamed drainage path that report to Muddy Lake during prolonged wet weather.

Hawkmount Quarry

- Hawkmount Quarry LDP - proposed new LDP for the proposed Sediment Dam at Hawkmount Quarry to discharge into an unnamed tributary of Lords Creek.

Water Quality

GHD (2014) have used data which has been collected from a monitoring sites, combined with levels recommended by the ANZECC and ARMCANZ (2000) to establish site-specific trigger values (SSTVs) for discharges.

ANZECC and ARMCANZ (2000) define trigger values as: *'the concentrations (or loads) of the key performance indicators measured for the ecosystem, below which there exists a low risk that adverse biological (ecological) effects will occur. They indicate a risk of impact if exceeded and should 'trigger' some action, either further ecosystem specific investigations or implementation of management/remedial actions'.*

The water which is to be discharged will be diluted or treated within a water management system. SSTVs have been set for all potential toxicants and as they are derived from naturally occurring levels upstream or within tolerance levels for flora and fauna set out by ANZECC and ARMCANZ (2000). Therefore, the discharges are not expected to have an adverse impact on the recorded SEPP 14 wetlands or potentially occurring threatened flora and fauna downstream.

Water Quantity

The expected increase in flows has been assessed for its potential to affect bank stability through erosion. GHD (2014) noted that there is no evidence from the model predictions that the likelihood of the bank instability will be increased as a result of the Project. This has been based on the evaluation of the sites current values and known permissible velocities for different channel conditions and or channel linings. Therefore, the increases in discharges are not expected to have an adverse impact on the creek stability

downstream. Consequently, recorded SEPP 14 wetlands and potentially occurring flora and fauna downstream are not considered likely to be impacted upon by sedimentation and erosion as a result of the Project.

6.2.2 Newstan LDP001

The Project proposes to increase the water discharge via Newstan LDP001 at Newstan Colliery Surface Site from the currently approved 11 ML/day to 14.5 ML/day. It is predicted that the increased discharge will potentially result in creek geomorphic stability and water quality impacts on the receiving waters of the north arm of LT Creek.

Due to the potential for contamination of LT Creek as a result of increased coal stockpile size (Site 2), part of the north arm of LT Creek just downstream from Newstan LDP001 is proposed to be enclosed into a pipeline. The pipe will enclose LT Creek from the downstream side of the By-Wash Dam in the upper catchment to the south of the rail loading facility. This pipe will be built to withstand the predicted increase in discharge. An Aquatic Ecology Impact Assessment prepared by Cardno (2013) to assess the impacts associated with the pipeline proposal is contained in **Appendix 8**.

The Project will require the discharge of 14.5 ML/day at the commencement of the Project, as such there will not be a gradual increase to the daily discharge rate. In its current form, the north arm of LT Creek is relatively stable with a decent level of vegetation through the creek. From Newstan LDP001 down to the tidal channel feeding into Lake Macquarie, the creek can be characterised through six typical reach types. Of most significance and at highest risk for potential geomorphic change, as a result of increased discharges through Newstan LDP001, is the extent around the Fassifern Archery Club (southern side of Miller Road). It is expected that under increased discharges of 14.5 ML/day the hydraulic nature of LT Creek will change minimally under dry conditions, considering waterway velocity, water depth and extent. The stability of the creek through the Archery Club will be increased with the construction of small placed rock bed control structures in place of current unstable root masses present within the flow area. Quarterly and event based waterway visual inspections of LT Creek will be undertaken during the initial period of increased discharges through Newstan LDP001 until stability of the creek under the new flow regime can be confirmed.

Considering rainfall events, an estimation of a peak 1 year ARI storm event down the north arm of LT Creek to the railway culvert indicated that existing and proposed discharges via Newstan LDP001 account for approximately 4 and 6 percent of flow ,respectively. Given the size of the catchment contributing to the north arm of LT Creek (240 ha at the railway culvert), the creek has significant capacity to cater for runoff events and it is unlikely that the increase in discharge of 14.5 ML/day will create any additional impact.

Vegetation downstream of Newstan LDP001, LDP002 and LDP003 transitions from woodland on the hills and slopes, through to floodplain and estuarine communities where LT Creek discharges into Lake Macquarie. This riparian zone contains vegetation communities which are potentially commensurate with two EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). Therefore, the potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

Salt and metal loads discharged to the receiving environment of the north arm of LT Creek will subsequently increase with the increased volumetric discharge through Newstan LDP001, although concentrations will generally remain unchanged. From the recent previous increases in discharges from 7 to 11 ML/day, aquatic ecology monitoring has indicated no significant impact. It is expected that the further increase in discharges from 11 to 14.5 ML/day will have similar results. It is predicted that the mixing zone will remain within the extents of the By-Wash Dam under the increased discharge regime of the Project.

6.2.3 Piping of LT Creek

A reach of the North Arm of LT Creek just downstream from Newstan LDP001 is proposed to be enclosed into a pipeline in order to mitigate any potential contamination from the increase in coal stockpile. The pipe will enclose LT Creek from the downstream side of the By-Wash Dam in the upper catchment to the south of the rail loading facility. This pipe will be built to withstand the predicted increase in discharge. An Aquatic Ecology Impact Assessment prepared by Cardno (2013) to assess the impacts associated with the pipeline proposal (refer to **Appendix 8**).

With the extension of piping of LT Creek, it is expected that velocities would be greater than occurring within areas of the original creek. Changes in grade and flow area would most likely result in velocity changes. These predicted changes are to be mitigated as part of the Project through the construction of flow baffles and other energy dissipating devices along with scour protection of remaining natural creek areas.

6.2.4 Proposed Newstan LDP LDP003

The proposed LDP003 is to cater for emergency discharge from the Clean Water Dam only where the dam manages water from the southern reject emplacement area. The clean water dam level is managed through pumping to other storages around site. The water quality for LDP003 when discharges occur typically contains; total suspended solids (TSS) – 29mg/L (50th percentile) with a conductivity of 484 uS/cm. pH is around neutral with a 95th percent of 8.5.

From water balance modelling the existing conditions indicate that discharges from proposed LDP003 occur very rarely, approximately 1.3% of days supporting the fact that it is an emergency discharge location. As a result of the project it is expected that the likelihood of discharges will increase to approximately 3.6% of days. This increase in likelihood of discharge is as a result of the need to manage more water at the surface of Newstan due to the extension of the underground increasing the groundwater make.

The project will increase the likelihood of discharges from LDP003, as indicated though it is predicted to have a decrease in maximum discharge from 60 ML/day to 39 ML/day (0.45 m^3/s). This daily predicted maximum discharge from the proposed LDP003 is expected to be managed through the existing creek conditions.

Clean water diversions are in place to the north and south of the clean water dam and continue to convey water to the south arm of LT Creek. The water balance has not modelled runoff from these clean water diversion but would provide a better indication to overall flow regime to the creek. GHD (2014) will include these into the model making a comment on their operation.

Vegetation downstream of Newstan LDP003 is the same as that which is listed for above for Newstan LDP001. Therefore, this riparian zone contains vegetation communities which are potentially commensurate with two EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). Therefore, the potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

The SSTVs for LDP003 will be set with respect to both the Newstan SSTVs for LDP001 and EPA water quality limits that exist. There is no evidence from the model predictions that the likelihood of the bank stability will be increased as a result of the Project. This has been based on the evaluation of the site currently and known permissible velocities for different channel conditions and or channel linings. Therefore, the discharges are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

6.2.5 Cooranbong LDP001

Mine affected water will be discharged at the Cooranbong Entry Site via Cooranbong LDP001 into an unnamed waterway which flows into Muddy Lake, which flows in to Lake Macquarie. The upper sections of

the waterway were identified as a low sinuosity fine grained creek. As the waterway heads south, an electrical easement and access track form a dam like structure on the creek which has formed a large pool over time. As the waterway heads south towards Muddy Lake, it can be classified back to a low sinuosity fine grained stream type before entering the coastal lagoon Muddy Lake, a SEPP 14 Wetland.

Overall, the waterway is generally well vegetated and stable, with significant lengths consisting of a low capacity channel inset within 'swampy' environments, allowing overbank flows to dissipate readily. Muddy Lake is an estuarine coastal lagoon/wetland connected to Lake Macquarie via an aqueduct that crosses the Eraring Power Station cooling water inlet canal. This allows for tidal and freshwater flows to be exchanged between Muddy Lake and Lake Macquarie without being influenced by the cooling water discharges from Eraring Power Station.

The Project proposes to increase the permissible daily discharge from the current approved 5 ML/day (although currently discharging on average around 1.59 ML/day) to up to 8 ML/day, though typically discharges will be on average 7.1 ML/day, considering an end of mine year of 2036. This value is based in the maximum predicted inflow of groundwater in to the Mandalong Mine underground workings (dewatered to Cooranbong Entry Site) of 5.9 mega litres per day towards the cessation of mining in 2035 and an allowance for contributing rainfall volumes (GHD 2014).

Using the predicted peak discharges through Cooranbong LDP001 during periods of heavy rainfall the potential increase in depth within Muddy Lake has been predicted to be 30 mm (GHD 2014). As this wetland occurs within a relatively flat coastal plains landscape with a relatively low average channel gradient of 0.003 m/m an increase of water depth in millimetres will, in some places, potentially result in a relatively minor lateral increase to the wetland boundary.

The increase in discharge will cause a modest change in the natural discharge regime through the upper reaches and potentially will cause a low level change further downstream. However, the waterway downstream of Cooranbong LDP001 is generally stable, well-vegetated and of relatively low gradient. This means that discharge flows will be of low energy and would be incapable of generating any significant geomorphic response. Based on this assessment no significant impact on the morphology of the waterway downstream of Cooranbong LDP001 is expected from the proposed increased discharge of 8 ML/day (GHD 2014).

Estuarine coastal lagoon/wetland ecosystems are highly adaptive to variable water level conditions. This variability is based on three parameters; frequency, duration and depth of flow events. Plant community boundaries occur along a gradient from those that require constant inundation (submerged macrophytes) to those that can tolerate regular inundation (emergent macrophytes), those that can tolerate periodic inundation (Riparian Vegetation) to those that can only tolerate very infrequent and short duration flooding (surrounding woodland etc).

Vegetation mapping along the unnamed waterway, which receives water from the Cooranbong LDP001 and LDP002, contains vegetation communities which are potentially commensurate with three EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). The potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2.**

Due to the extended duration of the predicted increased water levels there is likely to be a lateral gradient shift within the aquatic and riparian vegetation communities. Increased discharges through Cooranbong LDP001 will be incremental from 2015 through to a predicted maximum at the end of mining in 2036, therefore, the impact will be spread over 21 years, which should allow for vegetation communities to adjust to the altered flow regimes predicted. This increase in water flow is therefore, not enough to result in any significant impacts to the aquatic and riparian vegetation within the Muddy Lake wetland.

6.2.6 Proposed Hawkmount Quarry LDP

Hawkmount Quarry, in which there is an existing pool of water, is proposed to be dewatered and this water discharged in to a proposed sedimentation basin before being discharged from the site via a proposed new LDP in to Lords Creek. Ongoing dewatering (after heavy rainfall events) will also take place via a pipeline into a proposed sedimentation basin for subsequent discharge via the new LDP. The Hawkmount Quarry LDP will not be a constant discharge arrangement. During 'construction' phase for the quarry, existing water management storages on site will be dewatered down to manageable levels, where they will be maintained during operations. Discharges will only occur as a result of rainfall which will involve; 1. Capture water, 2. Treat water and 3. dewatering the volume to the downstream environment at a controlled rate. The intention is to apply standard water management techniques used in construction of this site.

Water balance modelling has been undertaken by GHD (2014) for the complete timeline of the project, it considers the initial requirements of dewatering and the maintenance during operation. The estimates of potential maximum discharges as a result of the initial dewatering is expected to be a maximum 142 ML/yr within the first year with approximately the first six months of the construction period requiring an increased pump rate (3 ML/day). This increased pump rate is required to draw down the existing filled storage down to appropriate management levels. Average volume per year of water contributing to the creek during operations from 113 years of re-sampled rainfall data = 40 ML/yr (0.11 m^3/s).

There is no evidence from the model predictions that the likelihood of the bank stability will be increased as a result of the Project. This has been based on the evaluation of the site currently and known permissible velocities for different channel conditions and or channel linings. Downstream of the haul road an existing energy dissipation device will further mitigate any potential variation in the average discharge velocity as it mitigates downstream of the discharge point.

As the Hawkmount Quarry is a proposed operation and not current, the water quality assessment will be categorising the existing water quality conditions, which will develop from surrounding catchments, and then predict what the likely sources of degradation to water quality will be. It is the intention of the project to have suitable water quality at the point of dewatering into the downstream environment and not have a potential water quality change within the tributary of Lords Creek. The water quality will be assessed against the trigger values set out by ANZECC and ARMCANZ (2000). SSTVs have been set for all potential toxicants and as they are derived from naturally occurring tolerance levels for flora and fauna they are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

The vegetation downstream of the proposed sedimentation basin and Hawkmount LDP transitions from woodland on the hills and slopes through to floodplain and estuarine communities where the water flows into Lake Macquarie. The name of the creek that the Hawkmount LDP will discharge into changes name as it flows towards Lake Macquarie; it is known as Lords Creek in the upper reaches near the quarry; it becomes Jigadee Creek as the terrain flattens; and where it widens out and becomes tidal it is named Dora Creek. This riparian zone contains vegetation communities which are potentially commensurate with three EECs listed under the TSC Act (refer to **Section 4.4.1.2** and **Table 10**). The potential for impact upon these communities is further assessed via 7-part tests within **Appendix 2**.

Three threatened flora species (*Syzygium paniculatum, Melaleuca biconvexa and Maundia triglochinoides*) occur or are likely to occur within the riparian zone downstream from Hawkmount Quarry (Site 2 (refer to **Table 10**)). There is potential for impact upon these species as a result of the water discharge via the proposed Hawkmount LDP. Therefore, potential impacts are further assessed via 7-part tests within **Appendix 2**.

In summary, mitigation of potential water quality impacts will be undertaken through activities to apply treatments to the water captured within the sedimentation basin before discharging it downstream. This will

be supported with water quality monitoring which can be in the vicinity of the species identified. In addition, the amounts to be released at any one time will be minimised in order to decrease the erosive capability of the discharged water.

6.3 Increased Truck Movements

The Project will result in an increase in truck movements along the existing private haul roads linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Cooranbong Entry Site and Hawkmount Quarry from the current maximum of 28 movements per hour (14 two way trips per hour) to 32 movements per hour (16 two way trips per hour). The increase in truck movements along these private haul roads poses a potential adverse impact upon native fauna due to an increased risk of collisions with wildlife.

The Cooranbong Private Haul Road, which comprises 3.4 km linking the Cooranbong Entry Site to the Newstan-Eraring Private Haul Road, has been designed and constructed to minimise the potential for impacts to wildlife as a result of truck movements. Three fauna underpasses and three fauna overpasses have been installed along this stretch of private haul road. The installation of these structures is designed to reduce the potential for wildlife entering on to the haul road itself while still maintaining connectivity to adjacent intact native vegetation. Monitoring of these structures was undertaken via remote sensing infrared cameras in October 2010 and March 2011 by Ecobiological. Swamp Wallaby, Red Fox, Eastern Grey Kangaroo and Brushtail Possum were recorded utilising the underpasses. There was no fauna species recorded utilising the overpasses during these monitoring events, however, coal haul truck drivers have provided anecdotal evidence of fauna utilising the overpasses.

Fauna fencing has been installed on the eastern side of the Cooranbong Private Haul Road to funnel fauna into the underpasses and reduce the potential for them entering the haul road corridor. Additionally, the entire western permitter of the haul road has been fenced to reduce the potential for fauna entering the haul road corridor. Fauna escape passages have been installed in the fencing along the western permitter to allow for fauna that enter the haul road corridor to escape without having to re-enter back on to the haul road, reducing the potential for collisions with trucks. Speed limits are also in force along all haul roads to restrict vehicles to a maximum of 80 km/hour.

Monitoring and recording of injured wildlife along the 3.4 km stretch of the Cooranbong Private Haul Road has been undertaken since the haul road became operational in 2010. Monitoring of incidents involving wildlife along the Newstan-Eraring Private Haul Road indicates an average of two incidents a year involving wallabies.

Due to the current design measures in place along the haul roads and the relatively small increase in truck movements proposed by the Project, it is anticipated that relatively low levels of incidents involving wildlife will be maintained. Further measures to minimise and/or mitigate potential impacts on native fauna are detailed in **Section 7** of this report.

6.4 Indirect Impacts

6.4.1 Air Quality

Dust emissions generated from increased vehicular and operational activities and wind erosion within the sites are likely to incrementally increase atmospheric pollutants into the air. SLR (2014) conducted dispersion modelling at eight scenarios associated with operations at Newstan Colliery Surface Site and two scenarios associated with the operations at the Cooranbong Entry Site. The results concluded that the annual average of deposited dust, Total Suspended Particulate matter concentrations, PM_{10} concentrations and $PM_{2.5}$ concentrations were unlikely to exceed the relevant criterion for both the Newstan Colliery Surface

Site and the Cooranbong Entry Site. Where parameters were found to marginally exceed the relevant criterion for 24-hour averages, mitigation measures were recommended to ensure emissions were reduced.

The Annual Average and 24-hour Average deposition of Particulate Matter parameters fell below the relevant criterion outlined by the Environmental Protection Authority (EPA) and World Health Organisation (WHO) (SLR 2014). These levels have been set to protect both human and non human life. Thus, it can be concluded that since the particulate matter deposition levels determined by SLR (2014) are lower than those predicted to affect humans, it is unlikely that any flora and fauna occurring on site, including threatened species, are to be significantly impacted by dust emissions.

6.5 Key Threatening Processes

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act 1995. There are seven KTPs that have the potential to affect the PAA as a consequence of the Project, these being:

- Loss of hollow-bearing trees;
- Removal of dead wood and dead trees;
- Clearing of native vegetation;
- Infection of native plants by Phytophthora cinnamomi;
- Invasion, establishment and spread of Lantana camara (Lantana);
- Anthropogenic climate change;
- Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae; and
- Invasion of native plant communities by exotic perennial grasses.

"Loss of hollow-bearing trees"

The Project will require the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints. Consequently, the Project will contribute to the Key Threatening Process "Removal of Hollow-bearing Trees".

"Removal of dead wood and dead trees"

The Project will require the removal of a small area of dead trees and ground debris and as such will contribute to the KTP "Removal of Dead Wood and Dead Trees" in a small capacity.

"Infection of native plants by *Phytophthora cinnamomi*"

The proposal has the potential to contribute to this KTP due to the regular occurrence of vehicles within the disturbance footprints that could be carrying and spreading the fungus. Appropriate mitigation measures involving vehicles within the disturbance footprints will provide an opportunity to ameliorate this KTP. Provided the mitigation measures provided in **Section 7.2.1** of this report are adhered to, the project is unlikely to significantly contribute to this process.

"Clearing of Native Vegetation"

The Project will require the removal of approximately 8.75 ha of native vegetation and as such is likely to incrementally contribute to the KTP "Clearing of Native Vegetation" on a small scale.

"Invasion, establishment and spread of Lantana, (*Lantana camara*)"

The Project has potential to contribute to the KTP "*Lantana camara*" due to the dense thickets of *L. camara* located in Site 1. *L. camara* could be encouraged to spread as a result of the disturbances being created. The Project will provide an opportunity to enact a weed control program to ameliorate this KTP.

"Anthropogenic Climate Change"

The Project will contribute to the KTP "Human Caused Climate Change" due to the small amount of clearing proposed and the greenhouse gas emissions to be generated by the Project. The contribution and impact from the Projects contribution is considered to be insignificant.

"Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae"

The Project may increase the level of stress and lower resistance of some members of the family Myrtaceae due to slight alteration of their habitat within the PAA. Exotic Rust Fungi may be introduced into the PAA by increased movement of plant, vehicles and workers across the PAA. It is expected that anti-contamination procedures be enacted for personnel and equipment to minimise the chance of infection.

"Invasion of native plant communities by exotic perennial grasses"

The Project is unlikely to directly contribute to the KTP "Invasion of native plant communities by exotic perennial grasses" due to only a small area of surface vegetation to be removed for the Project. However, some disturbed areas within the PAA already contain exotic perennial grasses. The Project will provide an opportunity to enact a weed control program to ameliorate this KTP

6.6 Matters of National Environmental Significance

Considerations have been made under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999). An EPBC Act 1999 Protected Matters Search was undertaken within the DoE on-line database (accessed January 2014) to generate a list of those matters of National Environmental Significance (NES) within 10 km of the PAA, which may have the potential to occur within the proposed disturbance footprints. This data, combined with other local knowledge and records, was utilised to assess whether the type of activity proposed within the PAA will have, or is likely to have a significant impact upon a matter of NES, or on the environment of Commonwealth land.

Additionally, a referral was submitted (Ref: 2013/6906) to the DoE. As a result of the referral process, the proposed action has been deemed to be a Controlled Action and, as such, the Project needs to be assessed through Preliminary Documentation. It was determined that the proposed action was likely to have a significant impact on 'Listed threatened species and communities (s18/18A)'. Whilst this section has considered all protected matters, particular attention has been afforded to listed threatened species in order to satisfy the requirements of the additional information.

The matters of NES and site-specific responses are listed below.

World Heritage Properties

The PAA is not a World Heritage Property, and is not in close proximity to any such area. Therefore, the proposal will not impact upon any World Heritage Property.

National Heritage Places

The PAA is not a National Heritage Place, and is not in close proximity to any such area. Therefore, the proposal will not impact upon any National Heritage Place.

Wetlands of International Importance (declared Ramsar wetlands)

The Ramsar listed Hunter Estuary Wetland, which comprises Kooragang Nature Reserve and Shortland Wetlands, is located approximately 30 km north of the PAA. The proposed activity of clearing is not expected to have an impact on any connected body of water; therefore, the proposal will not impact upon the Hunter Estuary Wetland.

The Great Barrier Reef Marine Park

The Great Barrier Reef Marine Park does not occur within or adjacent to the PAA, therefore, the proposal will not impact upon any areas of the Great Barrier Reef Marine Park.

Commonwealth Marine Area

The PAA is not a Commonwealth Marine Area, and is not in close proximity to any such area. Therefore, the proposal will not impact upon any Commonwealth Marine Area.

Nationally listed threatened species and ecological communities

A total of 41 threatened species (five of which are wholly marine) and two threatened ecological communities listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the PAA. The Project will remove habitat and individuals of two threatened flora species, namely *Tetratheca juncea* and *Grevillea parviflora* subsp. *parviflora*.

Grevillea parviflora subsp. *parviflora*

A total of 132 stems of *G. parviflora* subsp. *parviflora* were recorded within the original layout of Site 2. However, the boundary of Site 2 was re-designed to avoid impacts upon 131 stems of *G. parviflora* subsp. *parviflora,* therefore, only one individual stem is to be removed as part of the Project.

Tetratheca juncea

A total of 376 *T. juncea* clumps are located and proposed to be removed from within Site 1. The original layout of Site 1 contained an additional 425 clumps of *T. juncea* to the immediate north of Site 1 (refer to **Figure 4**). However, a redesign of Site 1 has avoided impacts to these 425 clumps.

The original layout of Site 2 contained 219 *T. juncea* clumps. However, following the re-design of the site layout, all 219 recorded clumps of *T. juncea* within Site 2 will be avoided as part of the Project. Therefore, the Project proposes the direct removal of the 376 clumps at Site 1 only.

The EPBC Act referral guidelines for *T. juncea* (DSEWPaC 2011) define a population as an important population if it meets any of the following criteria:

(1) has greater than 1000 plant clumps;

(2) an area of habitat has an average estimated plant clump density of 20 clumps/hectare or greater;

(3) occurs in rare habitat;

(4) in an area of “important habitat” as defined in Maps provided in DSEWPaC (2011) and has greater than 500 plant clumps;

(5) occurs at or near the distributional limits of Black-eyed Susan; and

(6) occurs in close proximity to a protected area (e.g. National Park) where Black-eyed Susan is known to occur. Close proximity refers to:

(a) within 500 m if connected by a suitable habitat corridor such as native vegetation; or

(b) within 100 m over disturbed habitat or non-native vegetation.

Populations of *T. juncea* within the PAA constitute important populations based on the above definitions as it is comprised of greater than 1,000 clumps.

The proposed action involves the removal of 376 clumps of *T. juncea* from Site 1. The immediate surrounding vegetation type (MU30) is preferred habitat for *T. juncea* and following additional targeted surveys it has been established that the individuals within Site 1 are part of a larger subpopulation extending to the north and west which number at least 1,958 clumps (refer to **Figure 6**). This sub-population estimate is a conservative estimate and additional surveys within the region would most likely result in a much larger estimate of this subpopulation. Given the current information, the removal of 376 clumps equates to the removal of up to approximately 19.2% of the recorded sub-population of *T. juncea*.

The information gained above has been utilised to conduct an assessment of the significance of the residual impact to the Black-eyed Susan (*Tetratheca juncea*) as guided by **Appendix 1** and DSEWPAC (2011), including whether the proposed action will result in:

- ***Indirect Impacts, for example from dust, altered hydrology and/or edge effects;***

As previously discussed in **Section 6.4.1**, SLR (2014) concluded that particulate matter deposition would not increase above those predicted by the EPA and WHO to impact human health. Therefore, it is unlikely that dust emissions produced by activities occurring on site will significantly impact upon the remaining *Tetratheca juncea*.

The altered hydrology is unlikely to significantly impact upon the *T. juncea* populations which are to be retained , because, they occur at a higher altitude than the disturbance footprints.

The increase in edge effects may impact upon the *T. juncea* populations which are to be retained. However, many populations persist in areas which are exposed to edge effects particularly those which persist within powerline easements (*Pers. obs*.). **Figure 6** depicts some locations of individuals which are persisting within powerline easements and which are subjected to edge effects such as; increased competition from weed species, increased dust and increased UV levels as a result of a reduction surrounding shade from overstorey plant species.

- ***Loss of greater than 25 % of plant clumps within the affected area; or***

As aforementioned, the removal of 376 clumps equates to the removal of approximately 19.2% of the recorded subpopulation of *T. juncea*.

- ***Fragmentation of a subpopulation by greater than 500m within native vegetation, or 100m within degraded or cleared land.***

Site 1 occurs immediately north of already cleared areas associated with the Newstan Colliery Surface Site. The removal of the 376 clumps of *T. juncea* and associated habitat will incrementally fragment habitat between recorded clumps to the east and west of Site 1 and increase the distance between *T. juncea* recorded to the immediate north and south of Site 1. Habitats surrounding the recorded *T. juncea* subpopulation and Site 1 are predominately vegetation and maintain connectivity for this sub-population. Areas outside of Site 1, which were not surveyed for *T. juncea* are likely to contain additional plants

comprising part of the subpopulation. Therefore, whilst the Project incrementally fragments the sub-population it does not constitute isolation of any areas containing potential or known habitat for *T. juncea*.

Nationally listed migratory species

A total of 23 migratory species listed under the EPBC Act 1999 have been recorded or have suitable habitat within a 10 km radius of the PAA.

A total of six of the listed migratory species inhabit wetland and seven species are strictly marine and have, therefore, not been considered further in this report as no suitable habitat exists within the PAA.

The following seven species are terrestrial migratory species and have potential to occur within the proposed disturbance footprints. Of these species, only the Regent Honeyeater is listed under the EPBC Act 1999.

- Regent Honeyeater (*Anthochaera phrygia*);
- White-bellied Sea-Eagle (*Haliaeetus leucogaster*);
- White-throated Needletail (*Hirundapus caudacutus*);
- Rainbow Bee-eater (*Merops ornatus*);
- Black-faced Monarch (*Monarcha melanopsis*);
- Satin Flycatcher (*Myiagra cyanoleuca*); and
- Rufous Fantail (*Rhipidura rufifrons*)

Due to the small amount of habitat proposed to be removed, the Project is unlikely to substantially modify, destroy or isolate an area of important habitat, result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat or seriously disrupt the lifecycle of an ecological significant proportion of the population of a migratory species.

Summary Statement:

Based on the above and with reference to the assessment within **Appendix 3**, it is considered that the Project, whilst unlikely to be significant, will reduce the area of occupied habitat for threatened species listed under the EPBC Act 1999. A referral was submitted under the EPBC Act and the Project was deemed a controlled action due to the clearing of native vegetation known to provide habitat for threatened species such as *Tetratheca juncea*. Furthermore, a letter written by DoE (**Appendix 1**) outlines the decision on the referral, including that the Project is to be assessed by preliminary documentation. **Appendix 1** specifically requests additional information to be supplied in order to assess the relevant impacts of the action, therefore, all attempts have been made to provide the requested further information within this FFA.

6.7 Cumulative Impacts

Wallarah 2 Coal Project

The Wallarah 2 Coal Project proposes underground extraction of export quality thermal coal with associated surface facilities and infrastructure. The project is comprised of an underground longwall mine, a coal handling plant (dry processing only) and storage facilities, rail loop and loading infrastructure, an underground drift entry, ventilation shafts and gas management facility.

The combined Wallarah and Great Northern Seams, averaging around 6 m thick, will be mined by a longwall system, conveyed to the surface via a drift conveyor system and processed to produce 4-5 million Tpa of product coal from the mine. The coal processing consists of crushing only and, because the mine will not require a coal washing plant, no tailings or bulk reject will be produced. Water generated by the mine will be

used in the crushing and stockpiling process and any excess water will be treated before discharge or transfer to appropriate re-use.

The Wallarah 2 Coal Project consists of the following surface and underground impact areas:

- Buttonderry Area – ventilation shafts and surface infrastructure (5 ha);
- Tooheys Road Area – coal handling infrastructure and rail loop (80 ha + 117 ha = 197 ha);
- Hue Hue Road Ecological Offset Investigation Area (75 ha +159 ha = 234 ha);
- Western Area – the Western Mining Lease Area (includes Jilliby State Conservation Area (SCA), Wyong State Forest (SF), Yarramalong and Dooralong Valleys (defined as the proposed subsidence zone)); and
- Eastern Mining Areas – predominantly near and under the southern half of Tuggerah Lake.

The direct impacts will be restricted to areas of surface infrastructure totalling 202 ha. Threatened flora and habitats proposed to be removed for the proposed rail loop and other facilities include *Angophora inopina* and *Tetratheca juncea*. Additionally, the construction of a proposed rail crossing and access road will impinge on an area of River Flat Eucalypt Forest on Coastal Floodplain EEC in addition to direct impacts to 3.2 ha of Lower Hunter Spotted Gum Ironbark Forest EEC. In relation to the Northern Coal Logistics Project, the Wallarah 2 Coal Project would represent a cumulative loss of individuals and habitat of *T. juncea*, as well as habitat for threatened fauna species.

Indirect impacts primarily from the expected subsidence are expected to affect vegetation within the Jilliby SCA, Wyong SF, Yarramalong and Dooralong Valleys. To offset these impacts up to 234 ha of land may be set aside as ecological offsets for the proposal.

After due consideration of the relevant key thresholds assessment criteria, as set out within Draft Guidelines for Threatened Species Assessment for Part 3A Applications, the Wallarah 2 Coal Project is not expected to have a significant impact on the ecology within the project application area, including threatened flora, threatened fauna or EECs that are known or expected to occur therein. This is due to the low levels of impact expected from the subsidence resulting from the longwall mining.

The proposed Wallarah 2 Coal Project is approximately 17km to the south of the Northern Coal Logistics Project, with townships such as Morisset and Wyee fragmenting direct habitat connectivity between the two projects. For plants and many fauna species with low mobility, the habitats within and surrounding the projects would likely contain separate local populations for these species.

Mandalong Southern Extension Project

The Mandalong Southern Extension Project proposes the extension of the existing Mandalong Mine (longwall mine) located west of Wyee on the western side of Lake Macquarie. The Mandalong Southern Extension Project application area extends from Wyee to Lemon Tree and encompasses most of the suburbs of Jilliby, Lemon Tree, Wyee and Mandalong. The proposed mine extension area covers approximately 4,467 ha.

The proposed Mandalong South Surface Site and access road corridor encompass a total area of approximately 20 ha. This impact area is comprised of approximately 4.4 ha of Cleared / Disturbed Land and 15.6 ha of native vegetation. The native vegetation consists of Map Unit 15 – Coastal Foothills Spotted Gum / Ironbark Forest which is not commensurate with any threatened ecological community listed within the TSC Act 1995 or EPBC Act 1999. All individuals of the recorded threatened plant species (*G. parviflora* subsp. *parviflora, T. juncea* and *M. biconvexa*) were recorded outside the areas proposed to be used for the provision of surface infrastructure.

Maximum first and final subsidence ranges from 0.16 m to 1.35 m. Subsidence can lead to potential impacts to flora and fauna through habitat modification resulting from surface cracking, soil erosion due to slumping and changes in gradients, mixing increases of groundwater and surface water and hydrological changes to groundwater and surface water, including ponding.

Surface cracks of between 20 mm and 70 mm are predicted above low lying areas and up to 400 mm wide on steep slopes and ridge crests. The crack depths are likely to range between 5 m and 10 m but could reach 15 m to 20 m at some locations on steep slopes.

The main habitat types that are considered to be affected by surface cracking are those that permanently or semi-permanently waterlogged, either by surface or groundwater influences. The creek beds of 3rd and 4th order streams, which would contain these habitats, are considered very unlikely to develop cracks due to the strain properties of surface alluvium along these streams. Therefore, freshwater aquatic or swamp habitats are unlikely to be affected by surface cracking.

The subsidence from longwall panels can lead to increased ponding. Existing ponding depths range from 0.1 m to 1.4 m along existing watercourses. Potential ponding depths may increase to a range between 0.15 m and 1.9 m after the proposed mining is complete within longwalls 25 to 64. The minor subsidence impacts are expected to have a minor or temporary effect on ponding within the local watercourses and are not likely to significantly affect riparian vegetation, EECs or threatened species or their habitat.

The affects of longwall mining subsidence on wetlands has been monitored for the existing Mandalong Mine operations, using floristic diversity and abundance, and water analysis of several nutrient and chemical components, and abiotic properties. The results indicated that despite one of the wetlands being subject to subsidence for at least 12 months, there was no detectable impact when compared to control sites. These results indicate that increased ponding from subsidence has not had a significant adverse affect on the local wetlands.

The seven-part tests under the TSC Act 1995 and Assessment of Significance under the EPBC Act 1999 conducted for threatened flora and fauna species recorded or considered likely to occur within the site concluded that the proposal will not have a significant impact on threatened species or ecological communities recorded or suspected to occur within the project application area for the Mandalong Southern Extension Project.

No threatened flora species have been recorded within the proposed clearing footprint for the Mandalong Southern Extension Project. Additionally, the impacts of subsidence are not expected to significantly impact upon recorded or potentially occurring threatened species. In relation to the Northern Coal Logistics Project, the Mandalong Southern Extension Project would represent a cumulative loss of habitat for threatened fauna species that have potential to occur, including the loss of hollow-bearing trees and foraging resources, as a result of required vegetation clearing to accommodate the proposed Mandalong South Surface Site and access road.

7.0 Avoidance, Mitigation and Offset Strategy

7.1 Avoidance

Avoidance measures of the Project design include the following:

- utilising areas that are predominantly already cleared and disturbed;
- piping of the section of LT Creek that passes through the Newstan Colliery Surface Site to reduce the potential for material from construction and operations at the Newstan Colliery Surface Site entering the waterway and causing potential downstream impacts on water quality;
- locating surface disturbance footprints adjacent to established access routes so as to limit the amount of vegetation required to be disturbed;
- re-design of the site boundary for the proposed Site 1 disturbance area to maintain a buffer of vegetation around the disused mine drift entrance known as Bat Alley to reduce the potential for direct impacts on bat species utilising this site;
- installation of a wall around the proposed coal stockpile area at Site 1 to reduce the potential for impacts from noise and light on bat species utilising Bat Alley;
- re-design of the Site 1 boundary to avoid 425 clumps of *T. juncea;*
- re-design of the proposed Site 2 disturbance area to avoid 131 stems of *G. parviflora* subsp. *parviflora* and 219 clumps of *T. juncea;*
- re-design of the disturbance footprints at both Site 1 and Site 2 to avoid four hollow-bearing trees; and
- avoiding where possible recorded threatened species, populations or ecological communities listed under the TSC Act 1995 or EPBC 1999.

7.2 Mitigation

The following mitigation measures have been recommended to minimise the potential impacts of the Project.

General

- All machinery to be clean of foreign soil and propogative matter to avoid the importation of *Phytophthora cinnamomi* pathogenic fungus (Myrtle Rust) transmission and weed seed dispersal.
- Strict erosion and sediment control measures should be installed, monitored and maintained to prevent the erosion and sedimentation impact on adjacent areas;
- Dust mitigation measures are outlined in SLR (2014) and include, but are not limited to, measures such as watering of roads and sealing of roads, regular maintenance of all vehicles and modifying construction activities during high winds. Ongoing dust monitoring should continue to ensure relevant levels of dust deposition are achieved;
- Minimise potential impacts arising from stormwater runoff into riparian areas by designing and installing appropriate stormwater detention and/or filtering devices;
- Barricade vegetation prior to construction activities to reduce damage from uncontrolled or accidental access;
- Stockpiling of materials should occur within already disturbed areas and not within retained vegetation;
- Strict weed management, monitoring and control practices should be implemented to minimise the spread of exotic species into natural areas within the PAA; and
- The water from the sedimentation basin at Hawkmount Quarry should only be released (via the proposed

Hawkmount LDP) after its quality has reached an acceptable level. In addition, the amounts to be released at any one time should be minimised in order to decrease the erosive capability of the discharged water.

Threatened Species

- Vegetation to be removed is to be clearly marked in the field using temporary fencing (flagging tape or similar exclusion tape) so that boundaries are clearly established and to minimise the potential for equipment to accidently enter areas to be retained.
- Where possible, clearing activities should be timed to avoid removal of hollow-bearing trees during breeding season of threatened species; and
- An ecologist is to be present to supervise clearing of hollow bearing trees within the disturbance footprints and ensure hollow bearing trees are removed in the following manner:

  (a) Hollow-bearing trees are to be clearly marked (spray paint or flagging tape) by a qualified ecologist within the disturbance footprints prior to any vegetation clearing commencing;

  (b) Non habitat vegetation should be removed at least one day prior to felling of hollow-bearing trees to encourage resident fauna to self relocate before felling of remaining habitat trees;

  (c) Immediately prior to the felling of hollow-bearing trees, trees should be given two sharp taps with the machinery arm/bucket to encourage fauna to escape. After waiting 1–2 minutes after tapping the tree, the hollow-bearing tree should be felled as gently as possible; and

  (d) An ecologist is to inspect each felled hollow-bearing tree (once safe) to recover any injured fauna and seek appropriate treatment and relocate uninjured fauna into vegetation to be retained immediately adjacent to the disturbance footprints.

Bat Alley

The *Strategy for the Conservation of Bats in Derelict Mines* (NPWS 2001, cited in SLR 2014a) will be followed. In addition:

- A 50 metre exclusion or non-disturbance zone will be maintained around Bat Alley
- The Project design will incorporate light and sound barrier walls around the proposed ROM coal stockpile in this locality.

Water Discharges

- Newstan Colliery - The stability of LT Creek through the Fassifern Archery Club should be increased with the construction of small placed rock bed control structures in place of current unstable root masses present within the flow area. Quarterly and event based waterway visual inspections of LT Creek should be undertaken during the initial period of increased discharges through Newstan LDP001 until stability of the creek under the new flow regime can be confirmed.

  Proposed Hawkmount Quarry LDP - The water from the sedimentation basin at Hawkmount Quarry will only be released after its quality has been improved to an acceptable level. In addition, the amounts to be released at any one time will be minimised in order to decrease the erosive capability of the discharged water.

7.3 Offsets

A variety of indirect offset measures are proposed to offset the potential impacts of this Project. Compensatory measures will include translocation trials, installation of nest boxes and research programmes. It is proposed as part of the compensation measures to:

- Develop and implement a *Tetratheca juncea* translocation research programme to build on the current knowledge regarding translocation of this species. The 376 clumps of *Tetratheca juncea* from within Site

1 will be translocated and monitored in accordance with the proposed research programme;

- Install nest boxes at a ratio of 1:1 (i.e. one nest box for every habitat hollow removed). The design and installation of nest boxes will draw on the information obtained from the 5 year research programme undertaken by Centennial Mandalong into the utilisation of different nest box designs and aspects; and
- Fund the development and implementation of a research proposal to investigate genetic patterns among and within populations of *Tetratheca juncea* from a range of habitat types. The benefits of this research will assist in determining whether conservation and offsetting actions can protect the genetic diversity of *Tetratheca juncea*.

The proposed research programme has been developed with a focus on addressing the priority actions identified by the Office of Environment and Heritage and the Commonwealth DoE for *Tetratheca juncea* as part of this species Recovery Plan.

7.3.1 Proposed Translocation Trial

Centennial Coal has previously undertaken a translocation trial in association with the construction of the Cooranbong Private Haul Road. The translocation trial was approved for the *Grevillea parviflora* subsp. *parviflora* and *Tetratheca juncea* (Driscoll, 2009).

Translocation was carried out between 27 April 2009 and 6 May 2009 inclusive. There was one recipient site for *Grevillea parviflora* subsp *parviflora* and three sites for *Tetratheca juncea.* These sites have been monitored every year thereafter.

The efficacy of the transplant trial of *T. juncea* is questionable, as the populations have continued to decline over time. However, Driscoll (2012) states that there may have been other contributing factors such as grazing (presumed to be wallabies) and dry weather. Although, this translocation trial has not been immensely successful to date there are some lessons that have been learnt from it, including exclusion fencing, and possibly some initial watering could potentially increase the success rate. Notwithstanding, translocation is still a viable option even if it is only partially successful as the alternative of simply removing the individuals is assured to impact upon all of them.

Grevillea parviflora subsp. *parviflora* translocation has been immensely successful. The initial transplant monitoring recorded 75 individuals in January 2010. The most recent monitoring event recorded up to 137 individuals in December 2012 (Driscoll 2012). Therefore, the translocated population has not only been maintained, but it has actually reproduced significantly to almost double its original size.

In summary, the efficacy of transplanting *T. juncea* is questionable; however, it yielded some positive results when compared to a do nothing approach. Conversely, the transplant of *Grevillea parviflora* subsp. *parviflora* has been immensely successful and it is highly recommended as a mitigation measure.

As such, Northern Coal Services will commit to developing and implementing a *T. juncea* translocation research program to build on the current knowledge regarding translocation of this species. *T. juncea* from within Site 1 will be translocated and monitored in accordance with the research program. The progress and outcome of the translocation program will be reported annually in the Project's Annual Environmental Management Report/Annual Review.

7.3.2 Rehabilitation and Decommissioning Strategy

A Decommissioning and Rehabilitation Strategy for the Project has been prepared by SLR Consulting Australia (2014). This Strategy proposes to decommission some of the more developed parcels of land and to control sediments and contaminants which may be left behind before releasing the land into either

industrial or public use. Some areas are still open to discussion and final post-mining land use will depend upon relevant stakeholder input.

The tailings and reject emplacement areas are proposed to be rehabilitated to native bushland and grasses. Private haul roads may either be dedicated as public roads or rehabilitated. Newstan Colliery Surface Site & Cooranbong Entry Site are likely to be utilised for industrial-based land use. Hawkmount Quarry will be rehabilitated to native vegetation commensurate with pre-operation ecological communities. This proposed rehabilitation would increase habitat availability for endemic flora and fauna and consequently, it would be advantageous to potentially occurring threatened species within the locality.

8.0 Conclusion

RPS was engaged by Northern Coal Services to undertake a FFA of the PAA for the Northern Coal Logistics Project. Within the PAA there are two proposed disturbance footprints, these being Site 1 (undeveloped land within the existing Newstan Colliery Surface Site) and Site 2 (within the disused Hawkmount Quarry site). By conducting flora and fauna survey using a range of methods across these proposes disturbance footprints and reviewing previous ecological surveys carried out within the region, the likely ecological issues for the Project have been identified.

Based on the potential for significant impacts upon threatened species listed under the EPBC Act 1999, a referral was submitted (Ref: 2013/6906) to the DoE. As a result of the referral process, the proposed action was deemed to be a Controlled Action and the Project is required to be assessed using Preliminary Documentation. The controlled action decision letter and request for additional information is provided in **Appendix 1**. This report has been written to satisfy the requirements of the additional information request letter.

Two disturbance footprints are proposed by the Project being:

- Site 1 – Undeveloped land comprising approximately 7.5 hectares (ha) within the Newstan Colliery Surface Site, which is proposed to be disturbed for the re-developed and upgrade of the coal handling and processing infrastructure within this surface site; and
- Site 2 – an area of approximately 13.9 ha within the Hawkmount Quarry site (disused gravel quarry) proposed to be disturbed for the purposes of reject emplacement.

In total, the Project will result in approximately 21.38 ha of disturbance. Of that area 12.63 ha is already cleared / disturbed with the remaining area made up of 8.75 ha of remnant native vegetation in varying condition. The proposed disturbance footprints are made up of the following:

Site 1

- 3.50 ha of MU 15: Coastal Foothills Spotted Gum - Ironbark Forest;
- 1.22 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 2.78 ha of Cleared (roads, tracks and powerlines).

Site 2

- 2.00 ha of Regrowth *Acacia decurrens*;
- 1.93 ha of MU 30: Coastal Plains Smooth-barked Apple Woodland; and
- 0.10 ha of MU 6: Coastal Narrabeen Moist Forest; and
- 9.85 ha of Cleared (roads, tracks and waterbodies).

In total, two threatened flora species were detected within the proposed disturbance footprints, namely *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea) and *Tetratheca juncea* (Black-eyed Susan), which are both listed as Vulnerable under the TSC Act 1995 and EPBC Act 1999. As a result of the Project, one individual of *G. parviflora* subsp. *parviflora* (within Site 2) and 376 clumps of *T. juncea* (within Site 1) will be removed.

Three additional threatened flora species (*Syzygium paniculatum, Melaleuca biconvexa and Maundia triglochinoides*) occur or are likely to occur within the riparian zone downstream from the Hawkmount Quarry

(Site 2 (refer to **Table 10**)). There is potential for impact upon these species as a result of water discharge from the sedimentation basin and associated LDP at this site. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon *S. paniculatum, M. biconvexa and M. triglochinoides*.

No threatened ecological communities or populations listed under the TSC Act 1995 or EPBC Act 1999 were detected within the disturbance footprints. However, four Endangered Ecological Communities (EECs) listed under the TSC Act 1995 occur downstream from proposed and existing LDPs. The Water Impact Assessment (GHD 2014) concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the Project is unlikely to have a significant impact upon these EECs.

The clearing of vegetation involves the removal of two hollow-bearing trees from Site 1 and three from Site 2. A total of 10 hollows, seven small (2–10 cm) and three medium (11–25 cm), have been identified within the five hollow-bearing trees. No large hollows (>25 cm) were identified within the proposed disturbance footprints.

The Project is likely to remove potential habitat for threatened fauna species, including Glossy Black-Cockatoo (*Calyptorhynchus lathami*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Regent Honeyeater (*Anthochaera phrygia*), Swift Parrot (*Lathamus discolor*), Varied Sittella (*Daphoenositta chrysoptera*), Little Lorikeet (*Glossopsitta pusilla*), Scarlet Robin (*Petroica boodang*), Powerful Owl (*Ninox strenua*), Masked Owl (*Tyto novaehollandiae*) and Sooty Owl (*Tyto tenebricosa*). Additionally, habitats within the disturbance footprints provide potential opportunities for threatened mammal species, including Spotted-tail Quoll (*Dasyurus maculatus maculatus*), Squirrel Glider (*Petaurus norfolcensis*), Grey-headed Flying-fox (*Pteropus poliocephalus*), Large-eared Pied Bat (*Chalinolobus dwyeri*), Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*), Little Bentwing-bat (*Miniopterus australis*), Eastern Freetail-bat (*Mormopterus norfolkensis*), Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Southern Myotis (*Myotis macropus*) and Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Previous surveys using harp traps placed at the entrance of Bat Alley (old drift entrance) near Site 1 detected the Little Bentwing Bat (*Miniopterus australis*) and Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*). The original area of the proposed Site 1 disturbance footprint has been redesigned to decrease potential impacts upon microbats utilising Bat Alley. A vegetation buffer has also been retained to ensure further protection of the microbats species, and additional mitigation measures have been proposed in this report. An annual ongoing monitoring program centred on Bat Alley has commenced.

With the exception of the Spotted-tail Quoll and Squirrel Glider the threatened fauna species which were considered to have potential to occur within the disturbance footprints are highly mobile and occupy large home ranges. Additionally, both of the disturbance footprints are adjacent to large areas of native vegetation providing additional habitat opportunities for those threatened fauna species. The relatively small area (8.75 ha) of native vegetation proposed to be disturbed is not expected to significantly impact upon the threatened fauna species considered, either by direct habitat loss or fragmentation. The potentially important bat roost area known as Bat Alley has been avoided and protected to ensure that no impact to potential breeding opportunities for the Little Bentwing Bat and Eastern Bentwing Bat occur.

The Project will result in an increase in truck movements within the existing private haul routes linking the Newstan Colliery Surface Site, Awaba Colliery Surface Site, Eraring Power Station, Hawkmount Quarry and Cooranbong Entry Site from the current maximum of 28 heavy vehicle movements per hour (14 two way trips per hour) to up to 32 heavy vehicle movements per hour (16 two way trips per hour). Due to the current design measures in place along the haul roads and the relatively small increase in truck movements

proposed by the Project, it is anticipated that relatively low levels of incidents involving wildlife will be maintained.

In addition to the direct surface impacts within Site 1 and Site 2 (disturbance footprints), the Project proposes to increase water discharge through existing Licensed Discharge Points (LDPs) at Cooranbong Entry Site and Newstan Colliery Surface Site), and also establish a new LDP at the Newstan Colliery Surface Site and a new LDP at Hawkmount Quarry.

The water which is to be discharged will be diluted or treated within a water management system. SSTVs have been set for all potential toxicants and as they are derived from naturally occurring levels upstream or within tolerance levels for flora and fauna set out by ANZECC and ARMCANZ (2000). GHD (2014) noted that there is no evidence from the model predictions that the likelihood of the bank stability will be increased as a result of the Project. This has been based on the evaluation of the site currently and known permissible velocities for different channel conditions and or channel linings. Therefore, the discharges are not expected to have an adverse impact on the potentially occurring threatened flora and fauna downstream.

The surface disturbance footprints for the Project have been designed through the detailed planning processes to avoid impacts to threatened flora species and significant fauna habitat as far as practical. Additionally, a range of measures have been incorporated into the Project (such as light and sound barriers) to further minimise potential impacts to threatened flora and fauna. Further mitigation measures will be adopted by Northern Coal Services during the construction and operational phases of the Project to ensure potential impacts to flora and fauna species are further reduced and the population of T. juncea within Site 1 will be translocated and monitored in accordance with a research program to be developed by Northern Coal Services. The proposed translocation research programme will be designed to build on the existing knowledge gained from previous translocation trials undertaken by Centennial Coal.

The seven-part tests conducted for threatened flora and fauna species and EECs recorded or considered likely to occur within the two proposed disturbance footprints and surface water discharge locations concluded that the Project is unlikely to have a significant impact (**Appendix 2**). The EPBC Act Assessment of Significant concluded that no threatened species which were detected or considered likely to occur, will be significantly impacted by the Project (**Appendix 3**).

9.0 Bibliography

ANZECC and ARMCANZ (2000), *Australian and New Zealand Guidelines for Fresh and Marine Water Quality. National Water Quality Management Strategy*. Australian and New Zealand Environment and Conservation Council Agriculture and Resource Management Council of Australia and New Zealand, October 2000.

Barrett, G., Silcocks, A., Barry, S. Cunningham, R. and Poulter, R. (2003). 'The new atlas of Australian birds.' (Royal Australian Ornithologists Union: Melbourne).

Bell, S. and Driscoll, C. (2012). Vegetation Mapping of Lake Macquarie LGA: Stage 3. Report to Lake Macquarie City Council.

Birdlife Australia (2012). Atlas and Birdata. Accessed online from: http://www.birdlife.org.au/projects/atlas-and-birdata

Cardno Ecology Lab (2013). Aquatic Ecology Impact Assessment for the Northern Coal Logistics Project.

Cumberland Ecology (2007). Newstan Colliery, modification to development consent, SEE, Ecological Impact Assessment.

Cumberland Ecology (2008). Newstan Colliery, Longwall Panel 25, REF, Ecological Impact Assessment.

Debus, S.J.S. (1995). Surveys of large forest owls in Northern New South Wales; methodology, calling behaviour and owl responses. *Corella* **19**: 38–50.

Department of the Environment (2014) Protected Matters Search. Most recently accessed, January 2014, online from: http://www.environment.gov.au/epbc/pmst/index.html

Department of the Environment (2012) *Rhizanthella slateri* SPRAT Profile. Accessed online from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=11768

Department of Environment and Conservation (NSW) (2004). Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft.

Department of the Environment, Climate Change and Water NSW (2009). Draft National Recovery Plan for the Grey-headed Flying-fox *Pteropus poliocephalus*.

Department of Environment and Resource Management (2011). National recovery plan for the large-eared pied bat *Chalinolobus dwyeri*. Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.

Department of Land and Water Conservation (DLWC, 2002) *The NSW State Groundwater Dependant Ecosystems Policy*. A Component Policy of the NSW State Groundwater Policy Framework Document. Department of Land and Water Conservation, NSW Government.

Department of Sustainability, Environment, Water, Population and Communities (2011) Environment Protection and Biodiversity Conservation Act 1999 referral guidelines for the vulnerable Black-eyed Susan, Tetratheca juncea.

Department of Sustainability, Environment, Water, Population and Communities (2012) Protected Matters Search. Accessed online from: http://www.environment.gov.au/epbc/pmst/index.html

Driscoll, C. (2010) *Centennial Coal, Cooranbong-Awaba Haul Road, Threatened Flora Translocation Report.* Report by Hunter Eco for Centennial Coal.

Eamus, D (2009) *Identifying groundwater dependent ecosystems, A guide for land and water managers*. Land and Water Australia. University of Technology, Sydney.

Eco Biological (2005). Awaba Outbye SMP.

Garnett, T.S., Szabo, J.K. and Dutson, G. (2010). The Action Plan for Australian Birds 2010, Environment Australia, Canberra.

GHD (2014) *Northern Coal Logistics Project, Water Impact Assessment, Northern Coal Services, March 2014*, GHD Newcastle, NSW

GSS Environmental (2013) Decommissioning and Rehabilitation Strategy- Northern Coal Logistics Project.

Gunninah (1998).Proposed waste emplacements and coal handling facilities upgrade. Flora and fauna assessment. Newstan Colliery.

Gunninah (1998b). Life Extension Project 1998 Flora and Fauna Assessment and SIS.

Harris, J.M. and Goldingay, R.L. (2005). Detection of the eastern pygmy-possum *Cercartetus nanus* (Marsupialia: Burramyidae) at Barren Grounds Nature Reserve, New South Wales. *Australian Mammalogy* **27**: 85–88.

Higgins, P.J., Peter, J.M. and Steele, W.K. (eds) (2001). 'Handbook of Australian, New Zealand and Antarctic birds. Volume 5: Tyrant-flycatchers to Chats.' (Oxford University Press: Melbourne).

HLA (2006). Flora and Fauna Impact Assessment Upgrade to Existing Ash Dam Eraring Power Station. Flora and Fauna Report. Appendix E. February 2006.

Hoye, G. (2012a) Results of microbat survey of adit and shaft. Bat Alley, Newstan Colliery, near Fassifern, NSW in August 2012. Fly By Night Bat Surveys, Belmont.

Hoye, G. (2012b) Results of microbat survey of adit and shaft. Bat Alley, Newstan Colliery, near Fassifern, NSW in December 2012. Fly By Night Bat Surveys, Belmont.

Hoye, G. (2013a) Results of microbat survey of adit and shaft. Bat Alley, Newstan Colliery, near Fassifern, NSW in January 2013. Fly By Night Bat Surveys, Belmont.

Hoye, G. (2013b) Results of microbat survey of adit and shaft. Bat Alley, Newstan Colliery, near Fassifern, NSW in March 2013. Fly By Night Bat Surveys, Belmont.

Hunter Eco (2008a). Awaba East Exploratory Drilling Program REF Stage 1 – Ecology. A Report for Centennial Coal.

Hunter Eco (2008b). Centennial Coal, Proposed Cooranbong Colliery to Awaba Haul Road, Threatened flora investigation.

Hunter Eco (2009). Awaba East Exploratory Drilling Program REF Stage 2 – Ecology. A Report for Centennial Coal.

Kavanagh, R.P. and Peake, P. (1993). Distribution and habitat of nocturnal forest birds in south eastern New South Wales. In: Olsen, P. (ed.). *Australian Raptor Studies*. Australasian Raptor Association, Royal Australasian Ornithologists Union, Melbourne pg. 101–125.

Lake Macquarie City Council (2011). Lake Macquarie Native Vegetation and Corridors Map. Version 1.Long, K.I. and Nelson, J.L. (2004). Recovery Plan for *Dasyurus maculatus* (Spotted-tailed Quoll) 2005 – 2009. Department of the Environment and Heritage, Canberra.

Marchant, S. and Higgins, P.J. (1993). (eds) Handbook of Australian, New Zealand and Antarctic Birds Volume 2 Raptors to Lapwings, Oxford University Press, Melbourne.

Morcombe, M. (2000). Field Guide to Australian Birds. Steve Parish Publishing, Archerfield.

National Parks and Wildlife Service (NPWS) (2000). Lower Hunter and Central Coast Regional Environment Management Strategy Vegetation Survey, Classification and Mapping; Lower Hunter and Central Coast Region (LHCCREMS).

National Parks and Wildlife Service (2001). Strategy for the conservation of Bats in Derelict Mines. February 2001.

Office of Environment and Heritage (NSW) (2011). Recovery Plan for Asterolasia elegans, Office of Environment and Heritage (NSW), Sydney.

Office of Environment and Heritage (2014) Atlas of NSW Wildlife Data. Most recently accessed January 2014 online from: http://www.bionet.nsw.gov.au/

Payne, R.J., Stevenson, D. and Wellington, R. (2002). *A Standardised Method for counting Black-eyed Susan Populations*. Technical Note, NPWS.

Pizzey, G. and Knight, F. (2007). Field to Guide to the birds of Australia, Harper Collins, Sydney. 8th Edition

Robinson, M. (1998). A Field Guide to Frogs of Australia. Reed New Holland, Sydney

RPS (2011).Flora and Fauna Survey Results. Newstan Lochiel Extension Area, Awaba. Report to Centennial Newstan. August 2011.

RPS (2012). Preliminary Ecological Impact Assessment: Newstan CLP EIS – Additional Disturbance footprint areas, Centennial Newstan (Ref No. PR110456-2).

SLR (2014) *Northern Coal Logistics Project Air Quality Impact Assessment*. SLR Consulting, Lane Cove.

Strahan, R. (Ed) (1995). The Mammals of Australia. The Australian Museum/Reed Books, Sydney.

Threatened Species Scientific Committee (TSSC) (2008). Commonwealth Conservation Advice on Eucalyptus camfieldii. Department of the Environment, Water, Heritage and the Arts. Available from: http://www.environment.gov.au/biodiversity/threatened/species/pubs/15460-conservation-advice.pdf.

Umwelt / Gunninah (1998). Life Extension Project 1998 Flora and Fauna Assessment and SIS.

Umwelt (2004). Centennial Newstan Longwall 22–23 Flora and Fauna Assessment.

Umwelt (2005). Summer targeted rare plants survey works for the Awaba open cut mine development environmental impact statement. Letter report to Centennial Coal. April 2005.

Appendix 1

Decision on Referral – Letter from the Department of Environment

EPBC Ref: 2013/6906

Mrs Mary-Anne Crawford
Group Approvals Manager
Centennial Northern Coal Services Pty Limited
PO Box 1000
Toronto NSW 2283

Mary-Anne

Dear Mrs Crawford

Decision on referral
Northern Coal Logistics Project (EPBC 2013/6906)

Thank you for submitting a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This is to advise you of my decision about the proposed action, to upgrade coal preparation, infrastructure, transport and water management activities at the existing Northern Coal Services Site, to the west of Lake Macquarie in New South Wales.

As a delegate of the Minister for Sustainability, Environment, Water, Population and Communities, I have decided that the proposed action is a controlled action and, as such, requires assessment and a decision on approval under the EPBC Act before it can proceed.

It appears that the proposed action is likely to have a significant impact on the following matters protected by the EPBC Act:

- Listed threatened species and communities (s18/18A)

For example, based on the information available in the referral, the proposed action is likely to have a significant impact because:

- it involves the clearing of approximately 9.6 ha of native vegetation that is known to provide habitat for nationally threatened species, including *Tetratheca juncea*.

Please note that this decision only relates to the potential for significant impact on the specific matters protected by the Australian Government under Chapter 2 of the EPBC Act.

I have also decided that the project will need to be assessed through preliminary documentation. A copy of the document recording these decisions is enclosed.

Each assessment approach requires different levels of information and involves different steps. All levels of assessment will include a public consultation phase, in which any third parties can comment on the proposed action.

Details on the assessment process for the project and the responsibilities of the proponent are set out in the enclosed fact sheet. Further information is available from the department's website at www.environment.gov.au/epbc.

While I have determined that your project will be assessed by preliminary documentation, I require some further information to be able to assess the relevant impacts of the action. Under section 95A of the EPBC Act I request you provide the following further information:

1. Details about the local population of the Black-eyed Susan (*Tetratheca juncea*), including an estimate of the number of individuals/clumps present in the vicinity of the project area derived from surveys in accordance with the methods recommended in the department's publication "Referral guidelines for the vulnerable black-eyed susan, *Tetratheca juncea*" (August 2011), available at: www.environment.gov.au/epbc/publications/black-eyed-susan.html.
2. Using the information gained from 1. above, an assessment of the residual impact to the Black-eyed Susan (*Tetratheca juncea*) including whether the proposed action will result in:
    - Indirect impacts, for example from dust, altered hydrology and/or edge effects.
    - Loss of greater than 25% of plant clumps within the affected area, or
    - Fragmentation of a subpopulation by greater than 500 m within native vegetation, or 100 m within degraded or cleared vegetation.
3. Details of proposed impact avoidance, mitigation and monitoring actions, including sediment and erosion control, weed and *Phytophthora cinnamomi* controls, and the proposed barrier to reduce noise and light impacts to bat species utilising the abandoned mine drift entrance.
4. Details of the proposed translocation trial for Black-eyed Susan (*Tetratheca juncea*) and *Grevillea parviflora* subsp. *parviflora*. Please note that the department does not support translocation as a mitigation measure. Translocation may be considered as part of an offset package, where its long-term success has been established using rigerous scientific methods.
5. Where impacts cannot be avoided or mitigated, an offset package to compensate for any predicted or potential residual significant impacts on matters of national environmental significance. Offsets should demonstrate consistency with the Commonwealth EPBC Act Environmental Offsets Policy (October 2012, or subsequent versions), available at www.environment.gov.au/epbc/publications/environmental-offsets-policy.html. Please find attached the department's information requirements in relation to EPBC Act offset proposals.
6. Rehabilitation and decommissioning plans, including how these activities may impact threatened species.
7. Other information, as relevant to the controlling provision, listed threatened species and communities.

In any correspondence with the department please quote the title of the action and EPBC reference, as shown on the beginning of this letter. You can send information to us:

by letter NSW Section
South-Eastern Australia Environment Assessments
Department of Sustainability, Environment, Water, Population & Communities
GPO Box 787
CANBERRA ACT 2601

by email tess.burdon@environment.gov.au

Once the department receives satisfactory information, a direction to publish will be issued so that the preliminary documentation is made available for public comment.

Please also note that once a proposal to take an action has been referred under the EPBC Act, it is an offence under Section 74AA to take the action while the decision making process is on-going (unless that action is specifically excluded from the referral or other exemptions apply). This provision of the EPBC Act carries a maximum penalty of $425,000. The EPBC Act is available on line at: www.environment.gov.au/epbc/about/index.html.

The department has recently published an *Environmental Impact Assessment Client Service Charter* (the Charter) which outlines the department's commitments when undertaking environmental impact assessments under the EPBC Act. A copy of the Charter can be found at: www.environment.gov.au/epbc/publications/index.html.

If you have any questions about the referral process or this decision, please contact the project manager, Tess Burdon, by email to tess.burdon@environment.gov.au, or telephone 02 6274 1841 and quote the EPBC reference number shown at the beginning of this letter.

Yours sincerely

James Tregurtha
Assistant Secretary
South-Eastern Australia Environment Assessments
26 July 2013

Information requirements for EPBC Act offset proposals

- Details in relation to the proposed offsets package, including:
    - the location and size, in hectares, of any offset site(s);
    - maps clearly showing for each offset site:
        - the relevant ecological features;
        - the landscape context; and
        - the cadastre boundary.
    - the current tenure arrangements (including zoning and ownership) of any proposed offset sites;
    - confirmed records of presence (or otherwise) of relevant protected matter(s) on the offset site(s); and
    - detailed information regarding the presence and quality of habitat for relevant protected matter(s) on the offset site. The quality of habitat should be assessed in a manner consistent with the approach outlined in the document titled *How to use the offset assessment guide* available at: http://www.environment.gov.au/epbc/publications/environmental-offsets-policy.html.
- Provide information and justification regarding how the offsets package will deliver a conservation outcome that will maintain or improve the viability of the protected matter(s) consistent with the *EPBC Act environmental offsets policy* (October 2012) including:
    - management actions that will be undertaken that improve or maintain the quality of the proposed offset site(s) for the relevant protected matter(s). Management actions must be clearly described, planned and resourced as to justify any proposed improvements in quality for the protected matter(s) over time;
    - the time over which management actions will deliver any proposed improvement or maintenance of habitat quality for the relevant protected matter(s);
    - the risk of damage, degradation or destruction to any proposed offset site(s) in the absence of any formal protection and/or management over a foreseeable time period (20 years). Such risk assessments may be based on:
        - presence of pending development applications, mining leases or other activities on or near the proposed offset site(s) that indicate development intent;
        - average risk of loss for similar sites; and
        - presence and strength of formal protection mechanisms currently in place.
    - the legal mechanism(s) that are proposed to protect offset site(s) into the future and avert any risk of damage, degradation or destruction.
- Provide information regarding how the proposed offsets package is additional to what is already required, as determined by law or planning regulations, agreed to under other schemes or programs or required under an existing duty-of-care.
- The overall cost of the proposed offsets package; including costs associated with, but not limited to:
    - acquisition and transfer of lands/property;
    - implementation of all related management actions; and
    - monitoring, reporting and auditing of offset performance.

Appendix 2

TSC Act 1995 Assessment of Significance (7-Part Test)

Threatened Flora and Fauna

Section 6 identified the following species as requiring an assessment of significance under the seven part test;

Flora

Endangered Species

- *Acacia bynoeana*
- *Corybas dowlingii*

Vulnerable Species

- *Maundia triglochinoides*
- *Cryptostylis hunteriana*
- *Syzygium paniculatum*
- *Grevillea parviflora* subsp. *parviflora*
- *Tetratheca juncea*
- *Melaleuca biconvexa*

Fauna

Critically Endangered Species

- Regent Honeyeater

Endangered Species

- Swift Parrot

Vulnerable Species

- Glossy Black-Cockatoo
- Gang-gang Cockatoo
- Varied Sittella
- Little Lorikeet
- Powerful Owl
- Masked Owl
- Sooty Owl
- Scarlet Robin
- Squirrel Glider
- Grey-headed Flying-fox
- Large-eared Pied Bat
- Eastern Bentwing-bat
- Eastern Freetail-bat
- Yellow-bellied Sheath-tailed Bat
- Eastern False Pipistrelle

Endangered Ecological Communities

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions
- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

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

Threatened Flora

- *Acacia bynoeana* (Bynoe's Wattle)

Acacia bynoeana is endemic to NSW and is currently known from 34 locations with a total population estimated to consist of only a few hundred individuals. It occurs mainly in the Blue Mountains area, south of Dora Creek-Morisset to Berrima and the Illawarra region, as well as near Kurri Kurri in the Hunter Valley. Occurring mainly in heath and dry sclerophyll forest, this species is found in sandy and well-drained soils. Associated overstorey species often include; *Eucalyptus haemastoma*, *Corymbia gummifera* and *E. sclerophylla*.

This species was not detected during extensive field work across the disturbance footprints, however, it has been recorded in the surrounding area previously by Umwelt (2005), Cumberland Ecology (2007, 2008) and Hunter Eco (2008a, 2008b). A review of these studies found that this species has been recorded locally predominately within Coastal Plains Scribbly Gum Woodland, but also within Coastal Plains Smooth Barked Apple Forest.

This species was not detected within the disturbance footprints, despite targeted surveys being performed during September (the start of their flowering period). This species can, however, be difficult to detect amongst other vegetation due to its small stature and semi-decumbant growth form. Therefore, its presence within either Site 1 or Site 2 cannot be discounted. The proposal will remove potentially occupied habitats, however, as there is no Coastal Plains Scribbly Gum Woodland within either site, which this species has been predominately recorded within nearby, there is less likelihood of this species occurring in large numbers. The clearing as a result of the Project will not affect populations of this species known to occur in the vicinity of the disturbance footprints.

Due to the occurrence of more suitable habitat (Coastal Plains Scribbly Gum Woodland) close by to the disturbance footprints in which this species is known to occur, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Corybas dowlingii* (Red Helmet Orchid)

Corybas dowlingii is restricted to the central coast and Hunter regions of New South Wales where it is currently known from the Port Stephens, Bulahdelah, Lake Macquarie and Freemans Waterhole areas. It grows in sheltered areas such as; gullies and southerly slopes in tall open forest on well-drained gravelly soil at elevations of 10–200 m.

Potential habitat occurs within the native vegetation on the disturbance footprints. However, this species was not detected during surveys despite targeted surveys being performed within its flowering period (June–August). Large areas of suitable habitat can also be found adjacent to the disturbance footprints. Due to the relatively small area to be cleared and the large extent of suitable habitat surrounding the disturbance footprints, the Project is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Cryptostylis hunteriana* (Leafless-tongue Orchid)

The distribution of the species ranges from East Gippsland in Victoria through coastal NSW and up to southern Queensland. *Cryptostylis hunteriana* grows in a wide variety of habitats including heathy woodlands, coastal areas and sedgelands on often moist and sandy soils. The Central Coast populations

have been observed in Coastal Plains Scribbly Gum Woodland communities with *E. haemastoma* and *C. gummifera*. A population has been observed in Freemans Waterhole, Awaba State Forest in Coastal Plains Smooth-barked Apple Woodland with common overstorey species such as *E. capitellata, E. umbra* and *Angophora costata*.

This species is cryptic and can be very difficult to identify outside of its flowering season (November–February). Targeted surveys for *C. hunteriana* were conducted in January and they failed to identify this species within the disturbance footprints. However, with Coastal Plains Smooth-barked Apple Woodland occurring in both sites and Coastal Plains Scribbly Gum Woodland present in the adjacent area, there is potential that *C. hunteriana* is present in the area. Due to the relatively small area to be cleared and the large extent of suitable habitat surrounding the disturbance footprints, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Grevillea parviflora* subsp. *parviflora* (Small-flower Grevillea)

Grevillea parviflora subsp. *parviflora* is endemic to NSW and has a widespread but patchy distribution. It occurs on sandstone in the Sydney region, in Kurri Kurri and Heddon Greta in the Lower Hunter Valley and Awaba on the Central Coast. This species grows in a wide range of habitats from heathy to scrubby woodlands and often along roads in relatively open and disturbed areas with very infertile soil.

G. parviflora subsp. *parviflora* is capable of suckering from underground rhizomes. Due to this habit it is often difficult to determine the numbers of plants present at a site and population estimates are essentially a reflection of the number of suckers rather than individual plants. Populations may, therefore, be smaller and less genetically diverse than they appear.

RPS has recorded several nearby occurrences of this species within the Newstan lease area. This includes the recording of 173 stems at three locations within habitat immediately adjacent to the proposed Site 2 footprint, as well as an additional 230 stems at 54 locations within vegetated habitats, all located between 1 km and 4 km from the population recorded within Site 2.

G. parviflora subsp. *parviflora* was primarily detected in the southern portion of Site 2. Little information is available on the ecology of this species, including the distance in which sucker stems (rhizomatous ramets) can appear from parent plants. On average, the recorded 173 stems occurred in patches of 3 or 4, with one patch recorded as having 16 stems. Due to the limited information available for this species, including the ecology surrounding seed dispersal (hence affecting genetic diversity), determining whether the recorded population is part of an important population is difficult. Therefore, the precautionary approach has been taken and further consideration has been afforded to this species. A boundary re-alignment of Site 2 has been undertaken to avoid impacts upon 131 stems of this species. Due to this avoidance strategy, only one individual stem of *G. parviflora* subsp *parviflora* is proposed to be removed as a result of the Project.

A small area of habitat (Site 1: 4.72 ha of native vegetation and Site 2: 2.03 ha of native vegetation) will be removed as a result of constructing surface facilities at the two sites. Site 2 is currently occupied habitat for this species. Although, this species was detected within Site 2 and one individual will be removed as a result of the proposal, its widespread distribution within the surrounding area is large enough to support the population of this species. The surrounding individuals are within large areas of intact vegetated habitat.

This species is relatively common in the larger area (surveys in the southern part of Site 2 and has been recorded within the surrounding area by Umwelt (2005), Eco biological (2005), Cumberland Ecology (2007; 2008), Hunter Eco (2008a; 2008b) and RPS (2011; April 2012) and due to its wide distribution and habitat requirements the proposed development will represent a relatively small impact on potential habitat. With a large amount of potential habitat occurring within the greater locality, the proposed development is not likely

to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Tetratheca juncea* (Black-eyed Susan)

Tetratheca juncea is endemic to NSW and its current distribution ranges from the local government areas of Wyong, Lake Macquarie, Newcastle, Port Stephens, Great Lakes and Cessnock. This species grows within dense understoreys, mainly in open woodlands on cooler southern aspects with infertile soils. Associated canopy species include *A. costata*, *E. haemastoma*, *E. capitellata* and *C. gummifera*. A preference for ridges or upper slopes has been observed for this species.

Targeted surveys for *T. juncea* were preformed during its flowering period September and October, in accordance with the EPBC 1999 survey guidelines for the species. The species is considered to be common in the local area due the wide spread distribution of suitable habitat (Gunninah 1998; Umwelt 2004, 2005; Eco biological 2005; Cumberland Ecology 2007, 2008; Hunter Eco 2008a, 2008b; RPS 2011).

T. juncea was found within the original Site 1 and Site 2 layouts with 376 and 219 clumps occurring respectively. A boundary re-alignment of Site 2 has been undertaken to avoid all the 219 *T. juncea* clumps present. Similarly, a redesign of the boundary for Site 1 to avoid a potential bat cave also led to the avoidance of 425 clumps in the northern corner of the area. The vegetation immediate surrounding Site 1 has been surveyed further for the presence of *T. juncea* to determine whether the population located within the disturbance footprints is in fact part of a larger population of at least 1,958 clumps. This sub-population estimate is a conservative estimate and additional surveys within the region would most likely result in a much larger estimate of the local population. Given the current information, the removal of 376 clumps equates to the removal of up to approximately 19.2% of the recorded sub-population of *T. juncea*. The proposed action involves the removal of 4.72 ha of known and potential habitat at Site 1 and 3.93 ha at Site 2.

In relation to dust impacts, SLR (2014) concluded that particulate matter deposition would not increase above those predicted by the EPA and WHO to impact human health. Therefore, it is unlikely that dust emissions produced by activities occurring on site will significantly impact upon the remaining *Tetratheca juncea*.

T. juncea is abundant within the wider area (within 10 km) with multiple known sub-populations. Even though the removal of 376 *T. juncea* clumps from the sites will reduce the size of the local population by up to 19.2%, there is sufficient occurrence of habitat and connectivity for this species in the immediate and wider area to maintain a viable population throughout the area. The area of habitat to be removed is comparatively small with a large amount of potential habitat occurring within the greater locality. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Maundia triglochinoides*

Maundia triglochinoides is restricted to coastal NSW and extending into southern Queensland. The current southern limit is Wyong. It grows in swamps, lagoons, dams, channels, creeks or shallow freshwater 30–60 cm deep on heavy clay, low nutrients. This species was not detected during surveys despite targeted surveys. This species has been recorded within close proximity (~120 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then impacts upon this riparian species are considered unlikely. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial

enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Melaleuca biconvexa*

A shrub to small tree, which grows in poorly drained areas on the Central Coast with outlying populations at Jervis Bay and Port Macquarie. Records in the Hunter Region are confined to western Lake Macquarie (Atlas of NSW Wildlife data). It may occur in dense stands adjacent to watercourses, in association with other Melaleuca species or as an understorey species in wet forest. Potential habitat for this species exists along the creekline within Site 1; however, it was not detected during flora surveys by RPS or by previous studies. This species has been recorded within close proximity (~15 metres) to Jigadee Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then impacts upon this riparian species are unlikely. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

- *Syzygium paniculatum*

A shrub to small tree found in sub-tropical and littoral rainforest on sandy soils or sheltered gullies mostly near watercourses. Distributed between Bulahdelah and Jervis Bay. Hunter Region records are confined to the Lake Macquarie hinterland (Atlas of NSW Wildlife data). There is no suitable habitat (Littoral Rainforest) present within the disturbance footprints for this species. However, this species has been recorded within close proximity (~20 metres) to Dora Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then impacts upon this species are unlikely. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, the proposed development is not likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

Threatened Fauna

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

The Little Lorikeet was the only species of TSC Act 1995 listed Woodland/Forest birds detected during fauna surveys within the disturbance footprints. This species feeds on nectar and pollen primarily from flowering eucalypts but also melaleucas and mistletoes. Thus, the proposal may affect potential foraging habitat for this species. Little Lorikeets nest in hollow openings mainly in smooth-barked eucalypts such as *E. viminalis*, *E. blakelyi* and *E. dealbata*. These tree species were not detected across the disturbance footprints and consequently only marginal breeding habitat occurs for Little Lorikeets within the disturbance footprints.

Neither the Regent Honeyeater or Swift Parrot were detected within the disturbance footprints, however, the habitat is suitable for foraging during winter migration. Both species commonly feed on nectar produced by winter-flowering eucalypts such as *E. albens*, *C. maculata* and *C. gummifera* and hence, potential foraging habitat for these species may be impacted by the proposal. The proposal represents an incremental loss of potential foraging habitat for these species. The sites are within larger areas of commensurate habitat for these species, which may attract them during favourable conditions. Thus, it is unlikely that the proposal will affect the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

Both the Varied Sittella and Scarlet Robin feed on invertebrates taken from tree trunks, dead branches, logs and other woody debris. The proposal represents an incremental loss of potential foraging habitat for these species. The sites are within larger areas of commensurate habitat for these species, which may attract them during favourable conditions. Thus, it is unlikely that the proposal will affect the life cycle of these species such that a viable local population is likely to be placed at risk of extinction.

Within NSW, the Glossy Black-Cockatoo shows a strong preference for *Allocasuarina littoralis* and *Allocasuarina torulosa*, which were both detected during flora surveys of Site 2 and consequently, potential habitat occurs within the disturbance footprints. However, this species or evidence of it (chewed *Allocasuarina* sp. cones) were not observed within the disturbance footprints during field surveys. There exists an abundance of the two preferred feed trees for Glossy Black-Cockatoo within the local area, hence the removal of these trees within the disturbance footprints are not likely to significantly affect the species. Only a small number of breeding records are available for the species, which may relate to the scarcity of hollow-bearing trees or the lack of connectivity between nests and foraging opportunities. Potential nesting habitat may therefore, be impacted by the proposal as a result of the removal of the hollow-bearing trees within the disturbance footprints. Due to the higher abundance of *A. littoralis* and *A. torulosa* in the wider area it is unlikely that the disturbance footprints would be of significant conservation priority for the Glossy Black-Cockatoo. Thus, it is unlikely that the proposal will affect the life cycle of the Glossy Black-Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.

In summer the Gang-gang Cockatoo are generally found in tall mountain forests and woodlands, particularly in heavily timbered and mature wet sclerophyll forests. In winter it may occur at lower altitudes in drier more open eucalypt forests and woodlands, and often found in urban areas. Whilst potential foraging habitat and breeding habitat occurs for this species (particularly within Site 1) this species was not detected. Due to the small area of potential habitat to be removed, it is unlikely that the proposal will affect the life cycle of the Gang-gang Cockatoo such that a viable local population of the species is likely to be placed at risk of extinction.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

These forest owl species occur in wet or dry sclerophyll forests and woodlands in the coastal, tablelands and to the western plains of NSW where they hunt for a range of mammalian prey. These species nest in large

hollows, preferably Eucalypt trees. Roosting can also occur in dense canopy vegetation, commonly within *S. glomulifera*, *A. littoralis* and *A. melanoxylon*. These owls are specialist predators of arboreal marsupials such as the Common Brushtail Possum, Greater Glider, Sugar Glider and Grey-headed Flying-fox. In addition, some terrestrial mammals commonly taken include the Bush Rat and Brown Antechinus. A high density of small mammals (many of which are hollow-dependent), is required for a suitable foraging habitat for these Forest Owls.

Both the Masked Owl and Sooty Owl have been observed within the wider area as part of previous studies, however, none of the forest owls were detected during fauna surveys within the disturbance footprints. Apart from Greater Gliders, all of the common prey-species as well as hollow-bearing trees were detected during surveys of the disturbance footprints. The medium hollows may also be sufficient to provide sub-optimal breeding/nesting habitat for owl and large parrot species. However, no large hollows (>25 cm) which provide important breeding/roosting habitat for these species were identified within the proposed disturbance footprints. The proposal may therefore, impact on potential foraging nesting and roosting habitat for the three forest owls within the disturbance footprints. However, due to their widespread distributions, it is considered unlikely that the proposal will affect the life cycle of the Forest Owls such that a viable local population of the species is likely to be placed at risk of extinction.

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

The distribution of the Spotted-tail Quoll ranges from South Queensland to Kosciuszko NP, mainly within 200 km of the coast. A total of 44 known sites have been recorded in NSW, however, detailed distribution and abundance records of this species are absent due to the scale of its entire range. The Spotted-tail Quoll inhabits a wide variety of forest types including rainforest, wet and dry sclerophyll forest, coastal heathlands and woodlands. Habitat requirements include hollow logs, hollow-bearing trees, rock shelters or other suitable den sites as well as relatively dense vegetation for foraging. This species is an opportunistic carnivore and hunts a wide range of prey such as small mammals like possums, gliders and rats as well as birds, reptiles and invertebrates.

The Spotted-tail Quoll was not recorded within the disturbance footprints during fauna surveys although the area is considered suitable in terms of both food supply and shelter. The loss of large hollow logs and hollow-bearing trees as a result of the proposal has been identified as a potential threat to the species. However, due to the nearby human activities associated with the mining operations, it is unlikely that this species has a den in this location. The proposal will represent an incremental loss of potential hunting habitat for this species, however, it is considered unlikely that the proposal will affect the life cycle of the Spotted-tail Quoll such that a viable local population of the species is likely to be placed at risk of extinction.

- Squirrel Glider (*Petaurus norfolcensis*)

The distribution of the Squirrel Glider ranges from western Victoria up to north Queensland mainly inland of the Great Dividing Range. A separate population exists along the coast between southern QLD and southern NSW. The species is widely distributed in the Hunter region and has been recorded within adjacent areas of the disturbance footprints. Squirrel Gliders inhabit dry sclerophyll forests, woodlands and swamp forests where it feeds on sap exudates and blossoms. Hollow-bearing trees are used as dens for shelter and breeding and are consequently an essential part of the habitat.

This species was not recorded within the disturbance footprints despite targeted surveys. However, due to previous records within the wider area and the suitability of the disturbance footprints in terms of both food supply and shelter, it is considered likely that Squirrel Gliders are utilising the disturbance footprints. The loss of hollow-bearing trees as a result of the proposal has been identified as a potential threat to the species. However, due to the large amount of suitable habitat surrounding the sites, the proposal will not affect the life cycle of the Squirrel Glider such that a viable local population of the species is likely to be placed at risk of extinction.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

The Grey-headed Flying-fox is distributed from Melbourne, Victoria up to Bundaberg in Queensland and mainly inhabits sclerophyll forests, woodlands, subtropical and temperate rainforests as wells as heaths and swamps. The selection of habitat is dependent on the availability of foraging opportunities in the form of nectar, pollen and fruits. Common feed trees include Eucalyptus, Melaleuca and Banksia. Grey-headed Flying-foxes are known to migrate long distances in response to foraging availability as nectar and pollen varies over time. Communal roost sites are commonly located in close proximity to a reliable food source and near water bodies, in coastal areas within rainforest patches, mangroves or riparian vegetation.

Grey-headed Flying-foxes were detected adjacent to Site 1 and have been observed within the wider area in previous studies. Foraging habitat is present within the disturbance footprints as well as potential roosting habitat along the creekline or near the waterbodies. However, it is unlikely that an existing base camp would go undetected during surveys as the Grey-headed Flying-foxes form large aggregations and returns to the same camp every day. It can therefore, be considered that this species only uses the site for foraging on a transient basis. Potential impacts of the proposal of this species would therefore, be limited to the removal of foraging opportunities. Due to the widespread distribution of potential feed trees within the region and migration patterns of this species, it is considered unlikely that the proposal will affect the life cycle of the Grey-headed Flying-fox such that a viable local population of the species is likely to be placed at risk of extinction.

Cave-roosting bats

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

Both the Little Bentwing-bat and Eastern Bentwing-bat have a widespread distribution ranging from Cape York to NSW with Eastern Bentwing-bat spreading down to Central Victoria. Large-eared Pied Bat has a more restrictive distribution ranging from Shoalwater Bay, QLD south to Ulladulla in NSW, However, most of the known distribution of this species occurs in NSW. These insectivorous bats commonly inhabit wet and dry sclerophyll forests as well as rainforests. All these species require caves or similar structures with specific characteristics for roosting purposes. Suitable roost sites are not common and should therefore, be considered of high conservation significance.

The presence of these cave-roosting bat species have been reported in the wider area and RPS detected both the Large-eared Pied Bat and Little Bentwing-bat in Site 1. Suitable roosting habitat exists within the cave (drift entrance) adjacent to Site 1. There is a minimum distance of approximately 30 metres between the cave entrance and the proposal, which will retain connectivity between roost sites and native vegetation. Therefore, the proposal will not affect the life cycle of the above cave-roosting bats such that a viable local population of the species is likely to be placed at risk of extinction.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

All the hollow-roosting Bats have widespread distributions ranging mainly in coastal areas from southern QLD to Victoria with the exception of the Yellow-bellied Sheathtail-bat, which is distributed over most of Australia. The Southern Myotis prefers wetland habitat near estuaries and large lakes while all the other Hollow-roosting bats inhabit wet or dry sclerophyll forests, rainforests or woodlands. These species roost mainly in tree hollows but also under bark and in crevices. The Southern Myotis roost in caves and similar habitats as well as tree hollows.

None of these species were detected during fauna surveys of the disturbance footprint, however, all of them except the Southern Myotis and Greater Broad-nosed Bat have been recorded in the wider area previously. The *Eucalyptus* woodland within the disturbance footprints provides potential habitat for both feeding and/or roosting, therefore, the site does represent potential breeding habitat for all Hollow-roosting bat species with the exception of the Southern Myotis. However, due to the widespread distribution of these species it is considered unlikely that the proposal will affect the life cycle of the above Hollow-roosting bats such that a viable local population of the species is likely to be placed at risk of extinction.

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

There was no endangered population considered to have a potential of occurring within the disturbance footprints. Therefore, the above assessment is not applicable.

(g) **In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:**

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

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

No endangered ecological communities or critically endangered ecological communities occur within the disturbance footprints. However, the following endangered ecological communities are mapped as occurring within the areas which are proposed to receive increased mine water discharges as a result of the Project:

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Redgum Roughbarked Apple Swamp Forest' ((MU38) NPWS, 2000) are mapped as occurring within the lower reaches of the Newstan LDP and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This community (MU38) is commensurate with River-Flat Eucalypt Forest on Coastal Floodplains (EEC).

A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely.

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of ‘Riparian Melaleuca Swamp Woodland ' ((MU42) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. In addition, areas of ‘Swamp Mahogany – Paperbark Forest’(MU37) are mapped as occurring within the lower reaches of the Newstan LDPs and the proposed Hawkmount Quarry LDP. Both of these areas will potentially be subject to an increase in mine water discharge and these communities (MU42 and MU37)

are commensurate with Swamp Sclerophyll Forest on Coastal Floodplains (EEC).

- A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely. Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Swamp Oak – Rushland Forest' ((MU40) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This vegetation community (MU40) is commensurate with Swamp Oak Floodplain Forest (EEC).

- A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely. Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

An area of 'Mangrove - Estuarine Complex and Saltmarsh ' ((MU47) NPWS, 2000) is mapped as occurring within the lower reaches of the Cooranbong Entry site which will potentially be subject to an increase in mine water discharge. This community is commensurate with Coastal Saltmarsh EEC.

(h) A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Given this, it is likely that the water which is proposed to be released will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. Therefore, impacts upon this vegetation community are considered unlikely. **In relation to the habitat of a threatened species, population or ecological community:**

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

Flora

- *Acacia bynoeana*

This species was not detected within the disturbance footprints, however, marginal habitat exists within the Coastal Plains Smooth-barked Apple Woodland (MU30) and Coastal Foothills Spotted Gum – Ironbark Forest (MU15) in both sites. Consequently, approximately 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Corybas dowlingii*

This species was not detected within the disturbance footprints, however, marginal habitat exists within the Coastal Plains Smooth-barked Apple Woodland (MU30) and Coastal Foothills Spotted Gum – Ironbark Forest (MU15) in both sites. Consequently, approximately 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Cryptostylis hunteriana*

This species was not detected within the disturbance footprint, however, suitable habitat occurs within the Coastal Plains Smooth-barked Apple Woodland (MU30). Consequently, approximately 1.22 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively as a result of the proposed activities.

- *Grevillea parviflora* subsp. *parviflora*

This species was detected in Site 2 within the Coastal Plains Smooth-barked Apple Woodland (MU30) and the *Acacia decurrens* regrowth area. Consequently, approximately 1.22 ha and 3.93 ha of suitable habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Tetratheca juncea*

This species was detected in Site 1 within the Coastal Plains Smooth-barked Apple Woodland (MU30) and Coastal Foothills Spotted Gum – Ironbark Forest (MU15). Consequently, approximately 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

- *Maundia triglochinoides*

No areas of habitat are to be removed by the Project. However, this species has been recorded within close proximity (~120 metres) to Jigadee Creek which is the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the disturbance footprints and the area which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this riparian species are considered unlikely.

- *Melaleuca biconvexa*

No areas of habitat are to be removed by the Project. However, this species has been recorded within close proximity (~15 metres) to Jigadee Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this riparian species are considered unlikely.

- *Syzygium paniculatum*

There is no suitable habitat (Littoral Rainforest) present within the disturbance footprints for this species. However, this species has been recorded within close proximity (~20 metres) to Dora Creek, which are the receiving waters of the proposed Hawkmount Quarry LDP. Therefore, there is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. Provided the water which is proposed to be released into Jigadee Creek are of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this riparian species are considered unlikely.

Fauna

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);

- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

Potential foraging and breeding habitat for all Woodland/Forest bird species occurs within the disturbance footprints. All these species could potentially forage within the disturbance footprints, however, the hollows which occur within the disturbance footprints are too small for breeding or roosting habitats for the larger parrots and the Swift Parrot, only breeds in Tasmania. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

Both potential foraging and breeding habitat for all Forest Owl species exists within the disturbance footprints. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. A total of three medium hollows (11–25 cm), have been identified within the disturbance footprints, of which some may be sufficient to provide sub-optimal habitat for these species. However, no large hollows (>25 cm) which provide important breeding/roosting habitat for these species were identified within the proposed disturbance footprints.

- Spotted-tail Quoll (Dasyurus maculatus maculatus)

Both potential foraging and breeding habitat for *the* Spotted-tail Quoll exists within the disturbance footprints. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. In addition, five hollow-bearing trees will be removed, which provide important breeding/roosting habitat for this species.

- Squirrel Glider (*Petaurus norfolcensis*)

Both potential foraging and breeding habitat exist within the disturbance footprints for the Squirrel Glider. Consequently, a total of 4.72 ha and 3.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. In addition, five hollow-bearing trees will be removed, which provide important breeding/roosting habitat for this species.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

Both potential foraging and breeding habitat exist within the disturbance footprints for the Grey-headed Flying-fox. Consequently, a total of 4.72 ha and 1.93 ha of potential habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities.

Cave-roosting bats

- Large eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

Potential foraging habitat occurs across the extent of each site for all three Cave-roosting bats. Approximately, a total of 7.5 ha and 13.9 ha of potential foraging habitat will be removed from Site 1 and Site

2 respectively. However, the cave roosting habitat utilised by these species will be whole retained and protects as a result of the proposed activities.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

The disturbance footprints provide suitable foraging and breeding habitat for all the hollow-roosting Bats except the Southern Myotis, which prefers wetlands at Site 2. Consequently, a total of 7.5 ha and 13.9 ha of potential foraging habitat will be removed from Site 1 and Site 2 respectively, as a result of the proposed activities. In addition, at least six hollow-bearing trees will be removed, which provide important breeding/roosting habitat.

Endangered Ecological Communities

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Redgum Rough-barked Apple Swamp Forest' ((MU38) NPWS, 2000) are mapped as occurring within the lower reaches of the Newstan LDP and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This community (MU38) is considered to be commensurate with River-Flat Eucalypt Forest on Coastal Floodplains (EEC). Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, then modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Riparian Melaleuca Swamp Woodland ' ((MU42) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. In addition, areas of 'Swamp Mahogany – Paperbark Forest'(MU37) are mapped as occurring within the lower reaches of the Newstan LDPs and the proposed Hawkmount Quarry LDP. Both of these areas will potentially be subject to an increase in mine water discharge and these communities (MU42 and MU37) are considered to be commensurate with Swamp Sclerophyll Forest on Coastal Floodplains (EEC). Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

Areas of 'Swamp Oak – Rushland Forest' ((MU40) NPWS, 2000) are mapped as occurring within the lower reaches of the Cooranbong Entry site and the proposed Hawkmount Quarry LDP. These areas will potentially be subject to an increase in mine water discharge. This vegetation community (MU40) is considered to be commensurate with Swamp Oak Floodplain Forest (EEC). Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by

GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

An area of 'Mangrove - Estuarine Complex and Saltmarsh ' ((MU47) NPWS, 2000) is mapped as occurring within the lower reaches of the Cooranbong Entry site which will potentially be subject to an increase in mine water discharge. This community is considered to be commensurate with Coastal Saltmarsh. Provided the water which is proposed to be released is of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging. A Water Impact Assessment has been undertaken by GHD (2014), which concluded that the water quality and intensity of the receiving waters are not substantial enough to cause modification to the ecosystems or morphology of the downstream watercourses. Therefore, modifications to the habitat of this vegetation community are considered unlikely.

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

Due to the small area of the disturbance footprints and the large extent of surrounding vegetation, no fragmentation or isolation of habitats is likely to occur for any of the species as a result of the proposal.

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

Flora

- *Acacia bynoeana*

Only marginal habitat occurs within the disturbance footprints for this species, hence the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Corybas dowlingii*

Only marginal habitat occurs within the disturbance footprints for this species, hence the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Cryptostylis hunteriana*

Due the present of large amounts of suitable habitat found outside the disturbance footprint, the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Grevillea parviflora* subsp. *parviflora*

Due the present of large amounts of suitable habitat found outside the disturbance footprint, the habitat present on the disturbance footprints are considered not to be significantly important for the long-term survival of the species in the locality.

- *Tetratheca juncea*

Due to the presence of large amounts of suitable habitat found outside the disturbance footprints, the habitat present within the disturbance footprints are considered not to be significantly important for the long-term survival of this species in the locality.

- *Maundia triglochinoides*

The southern boundary of Site 1 provides sub-optimal habitat as the substrate is sandy. Due the suboptimal nature of the habitat for this species, the habitat present on the Site 1 is considered not to be significantly important for the long-term survival of the species in the locality. Furthermore, the water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, impacts upon this riparian species' habitat are considered unlikely.

- *Melaleuca biconvexa*

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, impacts upon this riparian species' habitat are considered unlikely

- *Syzygium paniculatum*

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, impacts upon this riparian species' habitat are considered unlikely.

Fauna

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of these species, populations or ecological communities in the locality.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of these species, populations or ecological communities in the locality.

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of this species, population or ecological community in the locality.

- Squirrel Glider (*Petaurus norfolcensis*)

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of this species, population or ecological community in the locality.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of this species, population or ecological community in the locality.

Cave-roosting Bats

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

The cave (drift entrance) adjacent to Site 1 will have a minimum of approximately 30 m from the proposal and will have connective with the native vegetation retained. Therefore, the habitat for the above cave-roosting species to be removed is considered to not be significant for the long-term survival of these species due to the scarcity of suitable breeding/roosting sites.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

The potential foraging and/or breeding habitat present within the disturbance footprints are not considered to be significant for the long-term survival of these species, populations or ecological communities in the locality.

Endangered Ecological Communities

- River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

- Coastal Saltmarsh in the New South Wales North Coast, Sydney Basin and South East Corner Bioregions

The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, therefore, modifications to the habitat of this vegetation community are considered unlikely.

(i) **Whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly)**

No areas of critical habitat occur within the disturbance footprints.

(j) **Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan**

Flora

Of the threatened flora species under consideration within this assessment, none of the species had a recovery plan or threat abatement plan.

Woodland/Forest Birds

- Glossy Black-Cockatoo (*Calyptorhynchus lathami*);
- Gang-gang Cockatoo (*Callocephalon fimbriatum*);
- Regent Honeyeater (*Anthochaera phrygia*);
- Swift Parrot (*Lathamus discolor*);
- Varied Sittella (*Daphoenositta chrysoptera*);
- Little Lorikeet (*Glossopsitta pusilla*); and
- Scarlet Robin (*Petroica boodang*).

Of the threatened woodland/forest birds under consideration within this assessment, none of the species has a recovery plan or threat abatement plan.

Forest Owls

- Powerful Owl (*Ninox strenua*);
- Masked Owl (*Tyto novaehollandiae*); and
- Sooty Owl (*Tyto tenebricosa*).

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 5 (minimise loss and fragmentation of owl habitat areas) of the large forest owl recovery plan (DEC 2006).

- Spotted-tail Quoll (*Dasyurus maculatus maculatus*)

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 4.1 (reduce the rate of loss and fragmentation of Spotted-tailed Quoll habitat) of the Spotted-tailed Quoll draft recovery plan (Long and Nelson 2004).

- Squirrel Glider (*Petaurus norfolcensis*)

No recovery or threat abatement plans have been developed for the Squirrel Glider at this stage.

- Grey-headed Flying-fox (*Pteropus poliocephalus*)

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 1 (to identify and protect foraging habitat) and 2 (to protect and increase the extent of key winter and spring foraging habitat) of the Grey-headed Flying-fox draft recovery plan (DECCW 2009).

Cave-roosting Bats

- Large-eared Pied Bat (*Chalinolobus dwyeri*);
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*); and
- Little Bentwing-bat (*Miniopterus australis*).

As potential habitat will be removed during the current proposal, the proposal would be inconsistent with objective 2, Action 2.1 (Protection of known roosts and associated foraging habitats and management of threats) of the Large-eared Pied Bat recovery plan (DERM 2011).

No recovery or threat abatement plans have been developed for the Eastern Bentwing-bat or Little Bentwing-bat at this stage.

Hollow-roosting Bats

- Eastern Freetail-bat (*Mormopterus norfolkensis*);
- Yellow-bellied Sheathtail-bat (*Saccolaimus flaviventris*);
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*);
- Southern Myotis (*Myotis macropus*); and
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

No recovery or threat abatement plans have been developed any of the Hollow-roosting Bats at this stage.

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

Key Threatening Processes (KTPs) are listed under Schedule 3 of the TSC Act 1995. Each of the KTPs considered relevant to the proposal are described in **Section 6.4**.

Appendix 3

EPBC Act: Assessments of Significance

Assessment of Significance for Vulnerable and/or Endangered Flora

Significant Impacts	*Acacia bynoeana*	*Cryptostylis hunteriana*	*Grevillea parviflora* subsp. *parviflora*	*Tetratheca juncea*	*Melaleuca biconvexa*	*Syzygium paniculatum*
Lead to a long-term decrease in the size of an important population.	**Unlikely**. Although there is potential for the species to occur within the disturbance footprints, it would be a small number of individuals therefore, it would not constitute a significant proportion of the population. The impacts of the proposal are therefore, not expected to lead to a long-term decrease in the size of an important population.	**Unlikely .** This species was not recorded within the disturbance footprints, however, based on habitat preference, it is likely that *C. hunteriana* is present within the disturbance footprints. Due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to lead to a long-term decrease in the size of an important population.	**Unlikely.** This species was detected within the disturbance footprints and one individual plant will be removed as a result of the proposal. However, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to lead to a long-term decrease in the size of an important population.	**Unlikely.** This species was detected within the disturbance footprints and 376 individual clumps will be removed as a result of the proposal. However, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to lead to a long-term decrease in the size of an important population.	**Unlikely**. There is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, impacts upon this riparian species are not expected to lead to a long-term decrease in the size of an important population.	**Unlikely**. There is potential for this species to occur within the area, which will receive water discharges from the proposed Hawkmount Quarry LDP. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, impacts upon this riparian species are not expected to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of the species.	**Potential.** This species was not detected within the disturbance footprints, however, due to its inconspicuous appearance, there is potential for it to occur within the disturbance footprints. There is therefore, potential that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	**Potential.** This species was not detected within the disturbance footprints, however, due to its inconspicuous appearance out of the flowering period, there is potential for it to occur within the disturbance footprints. There is therefore, potential that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	**Yes**. This species was detected within the disturbance footprints and one clump of clonal stems will be removed from Site 2 as a result of the proposal. The area of its occupancy will therefore, be reduced.	**Yes**. This species was detected within the disturbance footprints and approximately 376 individual clumps will be removed from Sites 1 as a result of the proposal. The area of its occupancy will therefore, be reduced.	**Unlikely**. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, the area of its occupancy of this species would not be reduced.	**Unlikely**. The water which is proposed to be released into Jigadee Creek will be of a high enough quality not to cause any die back and a small enough quantity not to cause erosion and waterlogging, Therefore, the area of its occupancy of this species would not be reduced.
Fragment an existing important population into two or more populations.	**Potential.** There is potential for populations to exist within the disturbance footprints. Fragmentation of populations may therefore, occur as a result of the proposed action.	**Potential.** There is potential for populations to exist within the disturbance footprints. Fragmentation of populations may therefore, occur.	**Unlikely.** The disturbance footprints are surrounded by occupied habitat, with strong connectivity. The local population would not become fragmented as a result of this proposal.	**Unlikely.** The disturbance footprints are surrounded by occupied habitat, with strong connectivity. The local population would not become significantly fragmented as a result of this proposal. Only 10 individual clumps within the identified subpopulation of 1,958 will be potentially fragmented from 440m to 680m from the closest meta-population.	**Unlikely.** As the population known to occur south of the PAA is not affected to be reduced by the Project, no fragmentation of populations is expected.	**Unlikely.** As the population known to occur south of the PAA is not affected to be reduced by the Project, no fragmentation of populations is expected.
Adversely affect habitat critical to the survival of a species.	**No**. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	**No**. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	**No**. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	**No**. No critical habitat is known within the disturbance footprints and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	**No**. No critical habitat is known within the disturbance footprints of downstream and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.	**No**. No critical habitat is known within the disturbance footprints of downstream and the impacts of the proposal will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of a population.	**Potential.** There is potential for populations to exist within the disturbance footprints. The impacts of the proposal may therefore, disrupt the breeding cycle of a population.	**Unlikely**. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	**Unlikely**. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	**Unlikely**. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	**Unlikely**. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.	**Unlikely**. Due to large amounts of surrounding occupied habitat, pollution and seed dispersal for remaining plants should not be significantly affected by the proposed action.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely**. Only marginal habitat occurs within the disturbance footprints for this species, hence no quality habitat will be removed to the extent that the species is likely to decline.	**Unlikely**. Suitable habitat occurred within the disturbance footprints however, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to remove primary habitat to the extent that this species is likely to decline.	**Unlikely**. Suitable habitat occurred within the disturbance footprints however, due to its widespread distribution in the surrounding area, the impacts of the proposal are not expected to remove quality habitat to the extent that this species is likely to decline.	**Unlikely**. Only marginal habitat occurs within the disturbance footprints for this species, hence no primary habitat will be removed to the extent that the species is likely to decline.	**Unlikely**. The proposed minor changes to flow and water quality are unlikely to affect the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely**. The proposed minor changes to flow and water quality are unlikely to affect the availability or quality of habitat to the extent that the species is likely to decline

Significant Impacts	*Acacia bynoeana*	*Cryptostylis hunteriana*	*Grevillea parviflora* subsp. *parviflora*	*Tetratheca juncea*	*Melaleuca biconvexa*	*Syzygium paniculatum*
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely**. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	**Unlikely**. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	**Unlikely**. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	**Unlikely**. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	**Unlikely**. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.	**Unlikely**. It is unlikely that the affected area will experience an increase in non native species due to the proposed activities since it will be developed. However, the edges need to be managed to prevent weeds such as exotic perennial grasses, Bitou bush and Lantana from spreading to the surrounding area.
Introduce disease that may cause the species to decline.	**Unlikely**. The pathogen *Phytophthora cinnamomi* is a key threatening process causing species to decline and is widespread in coastal forests. However, this species or its preferred habitat is not known to be susceptible to *P. cinnamomi*.	**Unlikely**. This species or its preferred habitat is not known to be susceptible to *P. cinnamomi*. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	**Potential**. This species occur in habitat that may be adversely affected by *P. cinnamomi.* As a consequence the proposed activities have the potential to introduce diseases that may cause this species to decline.	**Unlikely**. This species or its preferred habitat is not known to be susceptible to *P. cinnamomi*. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	**Unlikely**. The proposed minor changes to flow and water quality are unlikely to introduce disease that may cause the species to decline.	**Unlikely**. The proposed minor changes to flow and water quality are unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species.	**Unlikely.** More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	**Unlikely.** There have been more records of this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	**Unlikely.** This species is relatively widespread within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	**Unlikely.** More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	**Unlikely.** The proposed minor changes to flow and water quality are unlikely interfere with the recovery of the species.	**Unlikely.** The proposed minor changes to flow and water quality are unlikely interfere with the recovery of the species.

Assessment of Significance for Vulnerable and/or Endangered Fauna

Significant Impacts	Grey-headed Flying-fox	Large-eared Pied bat
Lead to a long-term decrease in the size of an important population.	**Unlikely.** This species is highly mobile and will not be losing any significant habitat due to the proposed activities within the disturbance footprints. Therefore, no long-term decrease in population size will occur.	**Unlikely.** The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. Furthermore, the small area of foraging habitat to be cleared is considered unlikely to lead to a long-term decrease in the size of an important population.
Reduce the area of occupancy of the species.	**Unlikely.** No primary breeding habitat is being cleared as a result of the proposed activities and although potential feed trees are present it is not a limiting factor. Therefore, the area of occupancy will not be reduced.	**Unlikely.** The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. Large areas of potential foraging habitat will be retained in the locality. Therefore, it is considered that the small amount to foraging habitat clearing will not reduce the area of occupancy of the species.
Fragment an existing important population into two or more populations.	**Unlikely**. This species is highly mobile and it is therefore, unlikely that existing populations will be fragmented.	**Unlikely**. This species is highly mobile and it is therefore, unlikely that existing populations will be fragmented.
Adversely affect habitat critical to the survival of a species.	**Unlikely**. This species is highly mobile and critical habitat for this species survival does not exist within the disturbance footprints.	**Unlikely**. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. Therefore, no critical habitat for this species survival will be affected by the proposal.
Disrupt the breeding cycle of a population.	**Unlikely**. The area is mainly used for foraging not breeding and this species is capable of moving to other nearby areas easily if required.	**Unlikely**. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Therefore, its roosting habitat will not be affected by the proposal. A wall will prevent disturbance from noise or light from the mining activities. Therefore, the proposal is likely to disrupt the breeding cycle of the population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely**. This species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to cause the species to decline.	**Unlikely**. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. A wall will prevent disturbance from noise or light from the mining activities. Furthermore, this species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to cause the species to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	**Unlikely**. There are no invasive species associated with the decline of this species.	**Unlikely**. There are no invasive species associated with the decline of this species.
Introduce disease that may cause the species to decline.	**Unlikely**. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	**Unlikely**. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.
Interfere substantially with the recovery of the species.	**Unlikely.** No there is suitable habitat for this species in surrounding areas and this species is highly mobile-capable of moving freely to available habitat. Therefore, the proposed activity will not interfere substantially with the recovery of this species.	**Unlikely**. The drift entrance adjacent to Site 1 will have a buffer of approximately 30 meters from the proposed activities and will have connection with the native vegetation retained. Furthermore, this species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to interfere substantially with the recovery of this species.

Assessment of Significance for Endangered Species

Significant Impacts	Swift Parrot	Regent Honeyeater	Spotted-tail Quoll
Lead to a long-term decrease in the size of a population.	**Unlikely.** This species was not recorded within the disturbance footprints, however, suitable foraging habitat is present. This species is highly mobile and will not be losing any significant habitat due to the proposed activities within the disturbance footprints. Therefore, no long-term decrease in population size will occur.	**Unlikely.** This species was not recorded within the disturbance footprints, however, suitable foraging habitat is present. This species is highly mobile and will not be losing any significant habitat due to the proposed activities within the disturbance footprints. Therefore, no long-term decrease in population size will occur.	**Unlikely**. This species was not recorded within the disturbance footprints, however, suitable foraging and breeding habitat is present. However, due to its widespread distribution and habitat requirements, it is considered unlikely that the impacts of the proposal will lead to a long-term decrease in the size of a population.
Reduce the area of occupancy of the species.	**Unlikely**. This highly mobile species was not recorded within the disturbance footprints so it is unlikely that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	**Unlikely**. This highly mobile species was not recorded within the disturbance footprints so it is unlikely that its area of occupancy within the disturbance footprints will be reduced as a result of the proposed activities.	**Unlikely**. Due to its widespread distribution, the probability that this species is occupying the site is low. It is therefore, considered unlikely that the impacts of the proposed activities would reduce the area of occupancy of this species.
Fragment an existing important population into two or more populations.	**No**. No existing populations are known within the disturbance footprints so it is unlikely that any populations will be fragmented as a result of this project.	**No**. No existing populations are known within the disturbance footprints so it is unlikely that any populations will be fragmented as a result of this project.	**Unlikely**. This species is highly mobile and it is therefore, unlikely that existing populations will be fragmented.
Adversely affect habitat critical to the survival of a species.	**No.** This species is highly mobile and critical habitat for this species survival does not exist within the disturbance footprints.	**No.** This species is highly mobile and critical habitat for this species survival does not exist within the disturbance footprints.	**Unlikely.** The area affected is not considered critical habitat and is unlikely to affect the survival of this species.
Disrupt the breeding cycle of a population.	**Unlikely**. The area is potentially used for foraging not breeding and this species is capable of moving to other nearby areas easily if required.	**Unlikely**. The area is potentially used for foraging not breeding and this species is capable of moving to other nearby areas easily if required.	**Unlikely**. Due to its widespread distribution and the high mobility of the species, it is considered unlikely that the impacts of the proposed activities would disrupt the breeding cycle of a population.
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	**Unlikely**. This species is highly mobile and the removal of potential foraging habitats within the disturbance footprints are not likely to cause the species to decline.	**Unlikely**. This species is highly mobile and the removal of potential foraging habitat within the disturbance footprints is not likely to cause the species to decline.	**Unlikely**. Due to its widespread distribution and habitat requirements as well as high mobility, it is not likely that the impacts of the proposed activities will remove or decrease the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat.	**Unlikely**. It is unlikely that the affected area will experience an increase in invasive species due to the proposed activities.	**Unlikely**. It is unlikely that the affected area will experience an increase in invasive species due to the proposed activities.	**Unlikely**. It is unlikely that the affected area will experience an increase in invasive species due to the proposed activities.
Introduce disease that may cause the species to decline.	**Unlikely**. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	**Unlikely**. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.	**Unlikely**. There are no diseases which have been associated with the decline of this species. As a consequence the proposed activities are not expected to introduce any diseases that may cause this species to decline.
Interfere with the recovery of the species.	**Unlikely.** More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	**Unlikely.** More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.	**Unlikely.** More suitable habitat is available for this species within the surrounding area, it is therefore, considered unlikely that the impacts of the proposal will substantially interfere with the recovery of the species.

Appendix 4

Fauna Species List

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Frogs						
Myobatrachidae	*Crinia signifera*	Common Eastern Froglet	-	-		✓
Hylidae	*Litoria peronii*	Peron's Tree Frog	-	-	✓	
Hylidae	*Litoria revelata*	Whirring Treefrog	-	-		✓
Hylidae	*Litoria fallax*	Eastern Dwarf Tree Frog	-	-	✓	✓
Hylidae	*Litoria latopalmata*	Broad Palmed Frog	-	-	✓	✓
Reptiles						
Elapidae	*Pseudechis porphyriacus*	Red-bellied Black Snake	-	-		✓
Birds						
Anatidae	*Anas superciliosa*	Pacific Black Duck	-	-		✓
	Aythya australis	Hardhead (White-eyed) Duck	-	-		✓
Cacatuidae	*Calyptorhynchus funereus*	Yellow-tailed Black Cockatoo	-	-		✓
Campephagidae	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	-	-		✓
Climacteridae	*Cormobates leucophaea*	White-throated Treecreeper	-	-		✓
Corvidae	*Corvus coronoides*	Australian Raven	-	-	✓	✓
Cuculidae	*Cuculus variolosus*	Brush Cuckoo	-	-		✓
Dicaeidae	*Dicaeum hirundinaceum*	Mistletoebird	-	-		✓
Dicruridae	*Rhipidura albiscapa*	Grey Fantail	-	-	✓	✓
Maluridae	*Malurus cyaneus*	Superb Fairy-wren	-		✓	✓
	Malurus lamberti	Variegated Fairy-wren	-	-	✓	
Melipagidae	*Acanthorhynchus tenuirostris*	Eastern Spinebill	-	-		✓
	Lichenostomus chrysops	Yellow-faced Honeyeater	-	-	✓	✓
	Lichenostomus fuscus	Fuscous Honeyeater	-	-		✓
	Manorina melanophrys	Bell Miner	-	-	✓	
	Meliphaga lewinii	Lewin's Honeyeater	-	-	✓	✓
	Melithreptus lunatus	White-naped Honeyeater	-	-	✓	
	Myzomela sanguinolenta	Scarlet Honeyeater	-	-	✓	✓
	Philemon corniculatus	Noisy Friarbird	-	-		✓
Pachycephalidae	*Colluricincla harmonica*	Grey Shrike-thrush	-	-		✓
	Acanthiza nana	Yellow Thornbill	-	-		✓
	Pardalotus punctatus	Spotted Pardalote	-	-	✓	
	Pardalotus striatus	Striated Pardalote	-	-		✓
	Sericornis frontalis	White-browed Scrubwren	-	-	✓	
Ploceidae	*Neochmia temporalis*	Red-browed Finch	-	-	✓	✓
Podargidae	*Podargus strigoides*	Tawny Frogmouth	-	-		
Podicipedidae	*Tachybaptus novaehollandiae*	Australasian Grebe	-	-		
Psittacidae	***Glossopsitta pusilla***	**Little Lorikeet**	**V**	-	✓	✓
	Trichoglossus haematodus	Rainbow Lorikeet	-	-	✓	✓
	Trichoglossus rubritorquatus	Red-collared Lorikeet	-	-		
Mammals						
Dasyuridae	*Antechinus stuartii*	Brown Antechinus	-	-	✓	✓
	Antechinus swainsonii	Dusky Antechinus	-	-		✓
Macropodidae	*Wallabia bicolor*	Swamp Wallaby	-	-		✓
Muridae	*Rattus fuscipes*	Bush Rat	-	-	✓	✓
	Rattus Rattus	Black Rat	-	-	✓	✓
Petauridae	*Petaurus breviceps*	Sugar Glider	-	-	✓	✓
Pseudocheiridae	*Pseudocheirus peregrinus*	Common Ringtail Possum	-	-	✓	✓
Pteropodidae	***Pteropus poliocephalus***	**Grey-headed Flying-fox**	**V**	**V**	✓	

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Rhinolophidae	*Rhinolophus megaphyllus*	Eastern Horseshoe-bat	-	-	✓	
Tachyglossidae	*Tachyglossus aculeatus*	Short-beaked Echidna	-	-		✓
Vespertilionidae	*Vespadelus vulturnus*	Little Forest Bat	-	-	✓	
	Chalinolobus dwyeri	**Large-eared pied bat**	**V**	**V**	✓	
	Miniopterus australis	**Little bentwing-bat**	**V**	-	✓	

Appendix Key:	✓ = Species Detected
	* = Introduced species
	(E) = Species listed under NSW TSC Act 1995 as Endangered.
	(V) = Species listed under NSW TSC Act 1995 as Vulnerable.
	(V*) = Species listed under the Commonwealth EPBC Act 1999 as Vulnerable
	(E*) = Species listed under the Commonwealth EPBC Act 1999 as Endangered
	(M*) = Species listed under the Commonwealth EPBC Act 1999 as Migratory
	(C) = Species listed under CAMBA
	(J) = Species listed under JAMBA

Appendix 5

Flora Species List

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
Trees						
Casuarinaceae	*Allocasuarina littoralis*	Black She-oak	-	-		✓
	Allocasuarina torulosa	Forest Oak	-	-		✓
Euphorbiaceae	*Glochidion ferdinandii*	Cheese Tree	-	-		✓
Fabaceae	*Acacia irrorata* subsp. *irrorata*	Sydney Green Wattle	-	-	✓	
	Acacia parramattensis	Sydney Green Wattle	-	-		✓
Myrtaceae	*Angophora costata*	Smooth-barked Apple	-	-	✓	✓
	Corymbia gummifera	Red Bloodwood	-	-	✓	✓
	Corymbia maculata	Spotted Gum	-	-	✓	✓
	Eucalyptus acmenoides	White Mahogany	-	-	✓	
	Eucalyptus capitellata	Brown Stringybark	-	-		✓
	Eucalyptus fibrosa	Broad Leaved Ironbark	-	-	✓	
	Eucalyptus paniculata subsp. *paniculata*	Grey Ironbark	-	-	✓	
	Eucalyptus piperita	Sydney Peppermint	-	-	✓	✓
	Eucalyptus propinqua	Small Fruited Grey Gum	-	-	✓	
	Eucalyptus punctata	Grey Gum	-	-	✓	
	Eucalyptus resinifera subsp. *resinifera*	Red Mahogany	-	-	✓	
	Eucalyptus siderophloia	Northern Grey Ironbark	-	-	✓	
	Eucalyptus umbra	Broad-leaved White Mahogany	-	-	✓	✓
	Melaleuca linariifolia	Snow in Summer	-	-	✓	
	Melaleuca stypheloides	Prickly-leaved Tea Tree	-	-	✓	
Shrubs						
Asteraceae	*Cassinia uncata*	Sticky Cassinia	-	-	✓	
Epacridaceae	*Leucopogon lanceolatus*	Lance-leaf Beard-heath	-	-		✓
	Breynia oblongifolia	Coffee Bush	-	-	✓	
	Podolobium ilicifolium	Prickly Shaggy Pea	-	-	✓	
	Pultenaea villosa	Hairy Bush-pea	-	-	✓	✓
	Acacia floribunda	White Sally Wattle	-	-	✓	✓
	Acacia longifolia var. *longifolia*	Sydney Golden Wattle	-	-	✓	✓
	Acacia myrtifolia	Red Stem Wattle	-	-		✓
	Acacia suaveolens	Sweet Scented Wattle	-	-		✓
	Acacia terminalis	Sunshine Wattle	-	-	✓	
Myrtaceae	*Callistemon salignus*	Willow Bottlebrush	-	-	✓	
Pittosporaceae	*Bursaria spinosa* var. *spinosa*	Blackthorn	-	-	✓	
	Banksia spinulosa	Hairpin Banksia	-	-		✓
	Grevillea parviflora* subsp. *parviflora	**Small-flower Grevillea**	**V**	**V**		✓
	Hakea sericea	Needlebush	-	-	✓	
	Lambertia formosa	Mountain Devil	-	-		✓

Family	Scientific Name	Common Name	TSC Act 1995	EPBC Act 1999	Site 1	Site 2
	Persoonia levis	Broad-leaved Geebung	-	-		✓
	Persoonia linearis	Narrow-leaved Geebung	-	-	✓	✓
Sapindaceae	*Dodonaea triquetra*	Hop-bush	-	-	✓	✓
Verbenaceae	*Lantana camara**	Lantana	-	-	✓	✓
	*Verbena bonariensis**	Purple Top	-	-		✓
Ground Cover						
Apiaceae	*Centella asiatica*	Swamp Pennywort	-	-	✓	
Dennstaedtiaceae	*Pteridium esculentum*	Bracken	-	-	✓	✓
Doryanthaceae	*Doryanthes excelsa*	Gymea Lily	-	-	✓	✓
Lindsaeaceae	*Lindsaea linearis*	Screw Fern	-	-		
Lobeliaceae	*Pratia purpurascens*	Whiteroot	-	-	✓	
Lomandraceae	*Lomandra fluviatilis*		-	-	✓	
	Lomandra obliqua	Twisted Mat-rush	-	-	✓	
Poaceae	*Chloris gayana**	Rhodes Grass	-	-		✓
	Entolasia marginata	Bordered Panic	-	-	✓	
	Entolasia stricta	Wiry Panic	-	-	✓	✓
	Eragrostis brownii	Brown's Lovegrass	-	-		✓
	Imperata cylindrica	Blady Grass	-	-	✓	✓
	Joycea pallida	Silvertop Wallaby Grass	-	-		✓
	*Melinus repens**	Red Natal Grass	-	-		✓
	Microlaena stipoides var. *stipoides*	Weeping Rice Grass	-	-	✓	✓
	Themeda australis	Kangaroo Grass	-	-	✓	✓
Tremandraceae	*Tetratheca thymifolia*	Black-eyed Susan	-	-		✓
	Tetratheca juncea	**Black-eyed Susan**	**V**	**V**	✓	✓
Xanthorrhoaceae	*Xanthorrhoea* sp.	-	-	-		✓
Fabaceae	*Glycine microphylla*	Small-leaf Glycine	-	-	✓	
Luzuriagaceae	*Eustrephus latifolius*	Wombat Berry	-	-	✓	

Appendix Key:

✓ = Species Detected

* = Introduced species

(E) = Species listed under NSW TSC Act 1995 as Endangered.

(V) = Species listed under NSW TSC Act 1995 as Vulnerable.

(V*) = Species listed under the Commonwealth EPBC Act 1999 as Vulnerable

(E*) = Species listed under the Commonwealth EPBC Act 1999 as Endangered

(M*) = Species listed under the Commonwealth EPBC Act 1999 as Migratory

(C) = Species listed under CAMBA

(J) = Species listed under JAMBA

Appendix 6

Anabat Analysis

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BAT CALL ANALYSIS REPORT
Toronto, NSW
RPS Australia East Pty Ltd

8 June 2012

Job Reference: A025

This report has been prepared to document the analysis of digital ultrasonic bat echolocation calls received from a third party. The data was not collected by the author and as such no responsibility is taken for the quality of data collection or for the suitability of its subsequent use.

This report was authored by



Anna McConville
B.Env.Sc.

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1.0 INTRODUCTION

This report has been commissioned by RPS Australia East Pty Ltd to analyse bat echolocation call data (Anabat, Titley Electronics) collected from Toronto, NSW. Data was provided electronically to the author. This report documents the methods involved in analysing bat call data and the results obtained only.

2.0 METHODS

The identification of bat echolocation calls recorded during surveys was undertaken using AnalookW (Version 3.8m) software. The identification of calls was undertaken with reference to Pennay and others (2004) and through the comparison of recorded reference calls from north-eastern NSW and the Sydney Basin. Reference calls were obtained from the NSW database and from the authors personal collection.

Each call sequence ('pass') was assigned to one of five categories, according to the confidence with which an identification could be made, being:

- Definite - Pass identified to species level and could not be confused with another species
- Probable - Pass identified to species level and there is a low chance of confusion with another species
- Possible - Pass identified to species level but short duration or poor quality of the pass increases the chance of confusion with another species
- Species group - Pass could not be identified to species level and could belong to one of two or more species. Occurs more frequently when passes are short or of poor quality
- Unknown - Either background 'noise' files or passes by bats which are too short and/or of poor quality to confidently identify.

Call sequences that were less than three pulses in length were not analysed and were assigned to 'Unknown' and only search phase calls were analysed. Furthermore, some species are difficult to differentiate using bat call analysis due to overlapping call frequencies and similar shape of plotted calls and in these cases calls were assigned to species groups.

The total number of passes (call sequences) per unit per night was tallied to give an index of activity.

It should be noted that the activity levels recorded at different sites may not be readily able to be compared. Such comparisons are dependent on many variables which need to be carefully controlled during data collection and statistically analysed. Influential variables include wind, rain, temperature, duration of recording, season, detector and microphone sensitivity, detector placement, weather protection devices etc.

Description of the Characteristics Used to Differentiate Species

Miniopterus australis was differentiated from *Vespadelus pumilus* which it overlaps with, by the presence of a down-sweeping tail on pulses. Call sequences which had a majority of pulses containing an up-sweeping tail were assigned to *Vespadelus pumilus*. Call sequences where the

tail was difficult to differentiate and these were assigned to the *Vespadelus pumilus* / *Miniopterus australis* species complex.

3.0 RESULTS

A total of 4620 call sequences were recorded, of which 384 call sequences were able to be analysed (ie were not 'noise' files or bat calls of short length). Of the bat calls, 159 call sequences (41%) were able to be confidently identified (those classified as either definite or probable identifications) to species level (Table 1). Species recorded confidently within the site include:

- *Tadarida australis* (White-striped freetail bat)
- *Chalinolobus dwyeri* (Large-eared pied bat)
- *Miniopterus australis* (Little bentwing bat)
- *Rhinolophus megaphyllus* (Eastern horseshoe bat)

Additional bat species that are known to exist within the locality of the site, but could not be confidently identified to species (those classified as possible or as a species group), include:

- *Chalinolobus morio* (Chocolate wattled bat)
- *Miniopterus schreibersii oceanensis* (Eastern bentwing bat)
- *Vespadelus darlingtoni* (Large forest bat)
- *Vespadelus pumilus* (Eastern forest bat)
- *Vespadelus regulus* (Southern forest bat)
- *Vespadelus troughtoni* (Eastern cave bat)
- *Vespadelus vulturnus* (Little forest bat)

It should be noted that additional bat species may be present within the site but were not recorded by the detectors and habitat assessment should be used in conjunction with these results to determine the likelihood of occurrence of other bat species.

Additionally, bat activity has been show to decrease in cooler months in Australia and as such sampling during this time is unlikely to identify the full suite of insectivorous bats present within the area.

Table 1 below summarises the results of the bat call analysis

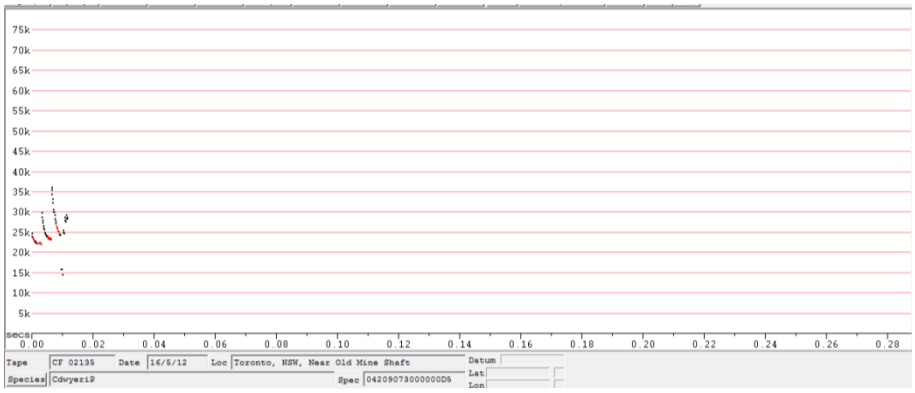
Table 1: Results of bat call analysis (number of passes per site per night)

IDENTIFICATION	Anabat 1 20120514 14/05/2012	Anabat 1 20120514 15/05/2012	Anabat 1 20120514 16/05/2012	Anabat 1 20120516 16/05/2012	Anabat 1 20120516 17/05/2012	Anabat 2 20120514 14/05/2012	Anabat 2 20120514 15/05/2012	Anabat 2 20120514 16/05/2012	Anabat 2 20120516 16/05/2012	Anabat 2 20120516 17/05/2012
DEFINITE										
Miniopterus australis	1	3	-	6	5	10	33	1	26	5
Rhinolophus megaphyllus	1	6	-	1	-	4	13	1	-	-
Tadarida australis	-	-	-	-	-	1	-	-	-	1
PROBABLE										
Chalinolobus dwyeri	-	-	-	1	-	-	-	-	-	-
Miniopterus australis	2	2	-	5	-	1	3	-	4	7
Rhinolophus megaphyllus	1	1	-	-	1	-	5	-	2	1
Vespadelus pumilus	-	-	-	-	-	-	-	-	-	-
POSSIBLE										
Miniopterus australis	-	2	-	-	-	-	-	-	-	-
Rhinolophus megaphyllus	-	-	-	1	-	-	-	-	-	-
Vespadelus pumilus	-	-	-	-	1	-	-	-	-	1
SPECIES GROUPS										
Chalinolobus morio / Miniopterus schreibersii oceanensis / Vespadelus vulturnus	-	-	-	-	1	-	-	-	-	-
Chalinolobus morio / Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	-	2	-	-	9	-	31	-	1	7
Miniopterus australis / Vespadelus pumilus	2	13	-	-	6	-	12	-	2	2
Miniopterus australis / Vespadelus pumilus / Vespadelus troughtoni	-	21	-	1	13	-	6	-	-	-

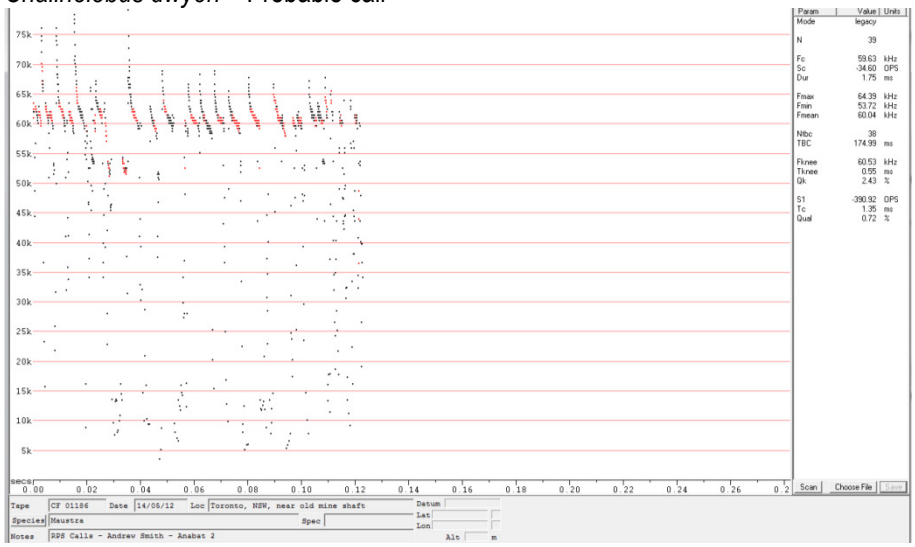
IDENTIFICATION	**Anabat 1 20120514 14/05/2012**	**Anabat 1 20120514 15/05/2012**	**Anabat 1 20120514 16/05/2012**	**Anabat 1 20120516 16/05/2012**	**Anabat 1 20120516 17/05/2012**	**Anabat 2 20120514 14/05/2012**	**Anabat 2 20120514 15/05/2012**	**Anabat 2 20120514 16/05/2012**	**Anabat 2 20120516 16/05/2012**	**Anabat 2 20120516 17/05/2012**
Miniopterus schreibersii oceanensis / Vespadelus darlingtoni / Vespadelus regulus	1	1	-	2	1	-	-	-	-	-
Miniopterus schreibersii oceanensis / Vespadelus vulturnus	-	1	-	1	-	1	6	3	5	13
Vespadelus pumilus / Vespadelus troughtoni	-	2	-	-	9	-	-	-	-	5
Vespadelus pumilus / Vespadelus vulturnus / Vespadelus troughtoni	-	7	-	-	-	-	4	-	-	34
UNKNOWN										
Unknown	3	9	2	4	12	2	24	-	11	8
'Noise' files	3	-	-	3	1	494	1437	1118	466	639
TOTAL	**14**	**70**	**2**	**25**	**59**	**513**	**1574**	**1123**	**517**	**723**
Time of calls recorded (does not necessarily translate to survey effort, simply when calls were recorded)	**9:50pm – 5:45am**	**Entire Night**	**5:00pm**	**Entire Night**	**Entire Night**	**10:30pm – 6:30am**	**Entire Night**	**Day – 6:00pm**	**Entire Night**	**Entire Night**

4.0 SAMPLE CALLS

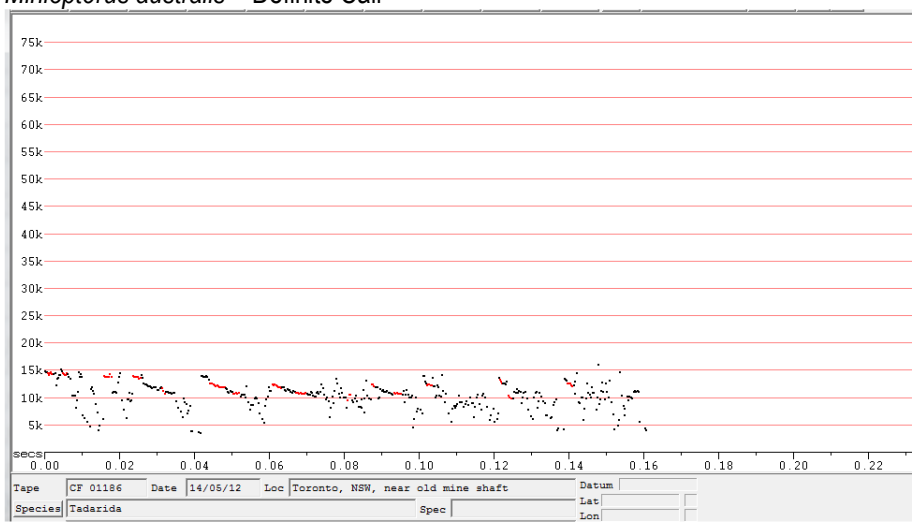
A sample of the calls actually identified from the site for each species is given below.



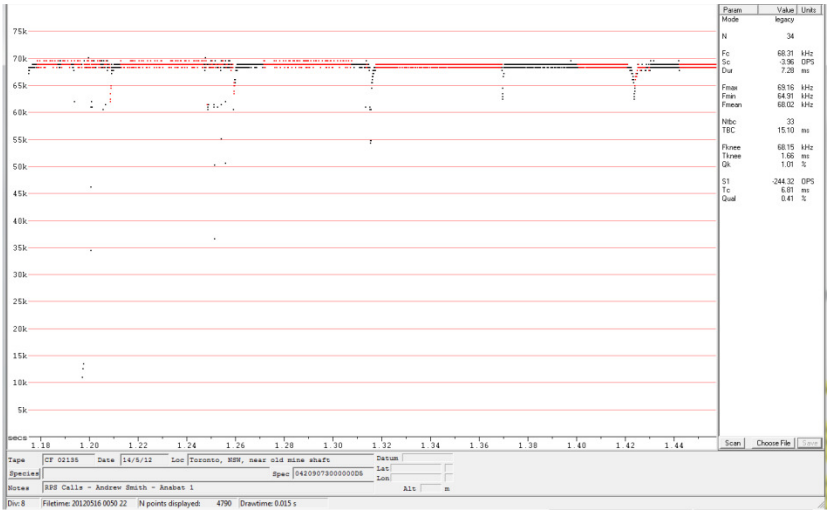
Chalinolobus dwyeri – Probable call



Miniopterus australis – Definite Call



Tadarida australis – Definite Call



Rhinolophus megaphyllus – Definite Call

5.0 REFERENCES

Adams, M., Reardon, T.R., Baverstock, P.R. and Watts, C.H.S. (1988). Electrophoretic resolution of species boundaries in Australian Microchiroptera. IV. The Molossidae (Chiroptera). *Australian Journal of Biological Sciences* 41: 315-326.

Australasian Bat Society Incorporated (undated) *Standards for reporting bat detector surveys*, http://batcall.csu.edu.au/abs/issues/ABS_Anabat_survey_standards.pdf

Churchill, S. (2008). *Australian Bats.* Second Edition Allen & Unwin; Crows Nest, NSW.

Hoye, G.A, Law, B.S. and Lumsden, L.F. (2008). Eastern Free-tailed Bat Mormopterus sp. Pp. 493-495 in *The Mammals of Australia*: Third Edition (S. van Dyck and R. Strahan, Eds.); New Holland; Sydney.

Law, B.S., Turbill, C. and Parnaby, H. (2008). Eastern Forest Bat Vespadelus pumilus. Pp. 567-568 in *The Mammals of Australia*: Third Edition (S. van Dyck & R. Strahan; Eds.); New Holland; Sydney.

Law, B.S., Reinhold, L. and Pennay, M. (2002). Geographic variation in the echolocation calls of Vespadelus spp. (Vespertilionidae) from New South Wale and Queensland, Australia. *Acta Chiropterologica* 4: 201-215.

Pennay, M., Law, B. and Reinhold, L. (2004). *Bat calls of New South Wales: Region based guide to the echolocation calls of Microchiropteran bats*. NSW Department of Environment and Conservation, Hurstville.

Reinhold, L., Law, B., Ford, G. and Pennay, M. (2001a). *Key to the bat calls of south-east Queensland and north-east New South Wales*. Queensland Department of Natural Resources and Mines, State Forests of New South Wales, University of Southern Queensland, and New South Wales National Parks and Wildlife Service, Australia.

Reinhold, L., Herr, A., Lumsden, L., Reardon, T., Corben, C., Law, B., Prevett, P., Ford, G., Conole, L., Kutt, A., Milne, D. and Hoye, G. (2001b). Geographic variation in the echolocation calls of Gould's wattled bat Chalinolobus gouldii. *Australian Zoologist* 31: 618-624.

Richards, G.C., Ford, G.I. and Pennay, M. (2008). Inland Free-tailed Bat Mormopterus sp. Pp. 494-495 in *The Mammals of Australia*: Third Edition (S. van Dyck and R. Strahan, Eds.); New Holland; Sydney.

Thomas, D.W., Bell, G.P. and Fenton, M.B. (1987). Variation in echolocation call frequencies recorded from North American vespertilionid bats: a cautionary note. *Journal of Mammalogy* 68: 842-847.

Van Dyck, S. and Strahan, R. (Eds.) (2008). *The Mammals of Australia: Third Edition*. New Holland; Sydney.

Appendix 7

Staff Qualifications

Curriculum Vitae

PAUL HILLIER

Senior Ecologist / Project Manager

Newcastle, NSW

Bachelor of Environmental Science (Environmental Management)

AREAS OF EXPERTISE:

Paul has broad range of Ecological Assessment reporting and project management experience from 10 years of professional ecological work both in Australia and abroad. Project experience has primarily included a range of flora and fauna assessment disciplines as required by a wide range of corporate and domestic client requirements. Paul has been employed both within the private and public sector, providing a strong knowledge and understanding of the role of both developers and government in legislation and planning.

Paul has the majority of his experience within the consultancy industry, primarily focussing on the preparation of Flora and Fauna Assessments, EPBC Act Referrals, EPBC Act Preliminary Documents Ecological Monitoring Reports, as well as Construction Environmental Management Plans and Compensatory Habitat Management Plans. Paul has extensive experience with flora and fauna survey methodologies, species identification and targeted threatened flora and fauna surveys. In addition, Paul holds a strong knowledge of Geographic Information Systems mapping and analyses.

SELECTED PROJECT EXPERIENCE:

- **Springvale Mine Extension Project (Centennial Coal)**
  Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for a proposed longwall coal mine extension at Springvale Mine on the Newnes Plateau, near Lithgow, NSW.
- **Angus Place Mine Extension Project (Centennial Coal)**
  Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for a proposed longwall coal mine extension at Angus Place Mine on the Newnes Plateau, near Lithgow, NSW.
- **Airly Mine Extension Project (Centennial Coal)**
  Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for an underground coal mine extension, using partial extraction mining methods, at Airly Mine, near Capertee, NSW. This project also required a presentation to be given to the local community.
- **Neubeck Coal Project (Centennial Coal)**
  Project management, ecological survey, advices, preparation of an EPBC Referral and preparation of an ecological report for an opencut coal mine at Blackmans Flat, near Lithgow, NSW.
- **Glasserton Pilot Wells, PEL 1, Gunnedah Basin (Santos)**
  Vegetation surveys and ecological assessment to support a Review of Environmental Factors for three coal seam gas pilot wells, near Gunedah, NSW.
- **White Rock Wind Farm, Glen Innes, NSW (Epuron)**
  Ecological surveys, advices and preparation of an ecological report to support an application for a 119 turbine wind farm at White Rock, near Glen Innes, NSW.

- **Subdivision and Urban Development at Hills Plain, Tamworth, NSW (Marloelle)**
  Detailed floristic surveys to determine the condition and extent of the EPBC Act Critically Endangered Ecological Community - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland). Project managed and prepared an EPBC Act Referral and Preliminary Documentation (following a controlled action decision). Preliminary Documentation included successful negotiation of both on-site and off-site offsets, using the EPBC Act environmental offsets policy, to compensate for unavoidable impacts to the derived grasslands component of Box-Gum Woodland.
- **Annual Ecological Monitoring, Wombo Mine (Peabody Energy)**
  Project managed and undertook a variety of monitoring surveys over both existing managed woodlands and mine rehabilitation areas. Monitoring survey techniques included, flora quadrats, riparian vegetation transects, fauna surveys and Ecosystem Function Analysis.

PREVIOUS EXPERIENCE:

Ecological Records Officer – West Yorkshire Ecology **2007-2009**
Duties included collection and collation of ecological records from across West Yorkshire, United Kingdom; Preparation of fee proposals for ecological services; GIS/ spatial analysis and database management; Database searches and reporting; Liaison with client, stakeholder groups, state and local governing bodies; Review of local planning applications and consequent consultations to local councils.

Ecologist – Harper Somers O'Sullivan **2004-2006**
Duties included flora and fauna surveying and survey design; overseeing and contribution to the preparation of complex ecological and environmental reports for both small and large projects; liaison with both the private sector and federal, state and local government department**.**

MEMBERSHIPS & ACHIEVEMENTS:

NSW Driver's Licence (Class C)

OH&S Induction Training (White Card)

Senior First Aid

Landscape Function Analysis Training

Snake and Spider Safety Awareness for Employees (SSSafe) Training

For Australian Wildlife Needing Aid (FAWNA), NSW Australia

Curriculum Vitae

ZIGGY ANDERSONS

Ecology Manager - Newcastle

Newcastle, NSW

Bachelor of Science Botany Major 2010

AREAS OF EXPERTISE:

Ziggy has a diverse range of experiences in the fields of Ecology and Natural Resource Management. He has worked in the rehabilitation, ecological assessment, environmental management and business development fields across NSW and Qld. Clients have included state government agencies, civil contractors but have predominantly been within the resource sector. Ziggy is experienced in the management of large resource projects including project inception, client liaison, project design, project management, liaising with regulatory agencies and business development.

Ziggy also has experience in ecological assessment methodologies and has a particular interest in ecosystem rehabilitation and plant ID and ecology.

SELECTED PROJECT EXPERIENCE:

Environment

- Flora and Fauna assessment project design
- Flora and fauna identification and habitat assessment
- Targeted threatened flora and fauna surveys
- Delineation and mapping of vegetation communities
- Endangered Ecological Community (EEC) assessment
- Experience with GPS/GIS for project design and mapping
- Conducting Field Surveys for Flora, Fauna and Habitat Identification
- Report Preparation including Fauna and Flora Assessments
- Ecological Monitoring and Reporting
- Vegetation Management Plan Reporting
- Understanding of environmental legislation

Projects

- Black Hill Flora and Fauna Impact Assessment (Diocese of Maitland).
- Centennial Coal Offset Assessment (Newstan, Coal Logistics, Mandalong South, Clarence, Neubeck Expansions. Awaba and Airly Offset Sites).
- Escott Zeolite Mine Flora and Fauna Assessment and Rehabilitation Management Plan.
- Mandalong South Powerline Relocation Flora and Fauna Impact Assessment
- Huntlee Conservation Management Plan
- Huntlee *Persoonia pauciflora* Population Management Plan
- Huntlee Flora and Fauna Management Plan

- Windmill Hill Offset Management Plan
- Kurri Kurri Rising Main Flora and Fauna Impact Assessment
- Bulga Mine Annual Fauna Monitoring
- Carnley Ave (Blackbutt Reserve) Ecological Constraints Assessment
- Beltana (Bulga) Underground Mine Bat Impact Assessment and Monitoring
- Centennial Angus Place Impact Monitoring

PREVIOUS EXPERIENCE:

Mackay Regional Manager – Kleinfelder Ecobiological (2012)
Ziggy was employed to establish a regional office in Mackay to service the Central and Northern Qld regions. During his employment he was responsible for the whole gamut of activities involved in ecological consultancy including; business development, client liaison, project management, negotiations with regulatory bodies, ecological assessments, report development and review, budgeting, workflow and business management.

Ecological Consultant (Business Owner) – Evergreen Vegetation Consultants (2010-2011)

Ziggy owned and operated his own ecological consultancy business with a significant two year contract with Callide Mine (AngloAmerican). Ziggy was responsible for developing and implementing Management Action Plans that related to an EPBC non-compliance as well as acting in a support role to the environmental department staff. During this period Ziggy was responsible for contractor management (quote review, contract development, contractor management), community liaison, incident investigation and management, reporting and liaising with regulatory agencies, advising senior leadership team on ecological matters etc.

Botanist and Bush Regenerator – Sustainable Resource Management Group (2009-2010)

Ziggy acted as the company's botanist and was part of the Bush Regeneration Team. The company had numerous contracts with the Hunter Valley CMA as well as Landcare groups within the Hunter and Mid North Coast region. He had a range of responsibilities including ecological assessments, report writing, quoting, project management, and team supervision.

VOLUNTEER WORK

- Callide Valley Landcare Chair (October 2009 to 2011)
- Callide Valley Landcare Treasurer (August to October 2009)
- Clean up Australia Day Coordinator, Bohnock, NSW (March 2007)
- Self initiated weed management and revegetation of Charley's Island/ Farquhar Pk, Manning River NSW (2007-2008)

MEMBERSHIPS & ACHIEVEMENTS:

- Drivers Licence (C, MR (Motorcycle), and RMDL (Boat))
- RTD02 ChemCert Chemical Accreditation AQF III
- HLTFA301B Apply First Aid Certificate
- 91476NSW Course in Sustainable Private Native Forestry
    - Follow environmental care procedures
    - Operator core knowledge and skills
    - Protect coastal & tableland native forest
    - Apply biodiversity conservation principles

  - Apply silviculture principles
- Qld Black Coal Generic Induction (Surface)
- S1, S2, S3 Supervisor Training (Qld)
- G2 Risk Assessment Training (Qld)
- HLTFA301C - Apply First Aid
- Standard 11 Generic Induction Refresher (Qld)
- RIIVEH201A – Operate Light Vehicle
- RIIVEH305A – Operate and Maintain a Four-Wheel Drive Vehicle
- Qld BioCondition v2.1 Training

Curriculum Vitae

LAUREN VANDERWYK

Ecologist

Newcastle, NSW

Bachelor of Science, University of Newcastle

AREAS OF EXPERTISE:

During the six years Lauren has been working as an Ecologist, she has gained a broad range of ecological field experience and experience in Ecological Assessment and management reporting in accordance with relevant State and Commonwealth government legislative frameworks. In addition, Lauren has developed numerous Bushfire Threat Assessments and Bushfire Attack Level certificates informed by field surveys and desktop assessments in accordance with Planning for Bushfire Purposes (2006). Her experience within the consulting industry has primarily included a wide range of flora and fauna assessment disciplines as required by a wide range of public and private clients including Centennial Coal, Santos and NSW Roads and Maritime Services. Lauren's knowledge of the Central Coast, Hunter, Greater Lithgow and Liverpool Plains regions has expanded extensively since the commencement of her career.

SELECTED PROJECT EXPERIENCE:

Environment

- Flora and fauna identification and habitat assessment
- Targeted threatened flora and fauna surveys
- Delineation and mapping of vegetation communities
- Endangered Ecological Community (EEC) assessment
- Conducting Field Surveys for Flora, Fauna and Habitat Identification
- Report Preparation including Fauna & Flora Assessments
- Ecological Monitoring and Reporting
- Bushfire Threat Assessment & Management reporting
- Understanding of environmental and bushfire legislation

Ecology

- Northern Beaches Hospital Connectivity and Network Enhancements Project (SMEC) – Preparation of a flora and fauna memorandum for two sites proposed to be developed for the Project. Project tasks included preliminary desktop assessment, interpretation of legislative requirements, targeted field surveys, and assessment of fauna habitat quality and value to threatened species.
- Bulga Mine Annual Fauna Monitoring – Lauren has been involved in an annual monitoring program that spans two operations and involves seasonal bird surveys, habitat assessments and the full spectrum of fauna monitoring methodologies targeting threatened species as well as comprising an overall species list, and providing technical input and annual report writing
- Angus Place Longwalls 900 and 910 Flora and Fauna Monitoring (Centennial Coal Angus Place) – Pre and postmining baseline surveys were undertaken by Lauren including flora and fauna species diversity surveys, vegetation condition assessments and nest box erection. Monitoring of multiple sites provides a comparable data set to display any notable changes as a result of longwall mining within this mining lease area. Swamp vegetation monitoring was a separate component of this project which required a memorandum to

comment on overall swamp health and potential impacts as a result of surrounding mining activities. This project is ongoing.

- Pacific Highway Upgrade-Oxley Highway to Kempsey (NSW Roads and Maritime Services)

  Implementation of the Microchiropteran Bat Management Plan prepared for the 37km upgrade of the Pacific Highway between the Oxley Highway and Kempsey on the NSW Mid-north coast. For this project Lauren was involved in the installation of 158 bat roost boxes and the provision of GIS data to inform future monitoring activities.
- Neubeck Open Cut Coal Mine (Centennial Coal) – Flora and fauna field surveys over a three year period and the production of the Flora and Fauna Assessment as part of an overiding Environmental Impact Statement were undertaken for the proposed Neubeck open cut coal mine
- Airly Coal Mine Flora and Fauna Surveys (Centennial Coal) – A range of flora and fauna surveys were undertaken to inform both the Airly Baseline Survey Report and the Airly Flora and Fauna Report
- Lidsdale Siding Biodiversity Management Plan (Centennial Ivanhoe)– Ecological assessments primarliy undertaken for Lidsdale Siding Flora and Fauna Report informed the production of the Lidsdale Siding Biodiversity Management Plan, both of which Lauren was involved in. The BMP outlined areas of ecological importance and ecological issues on site with associated management actions
- Coal Seam Gas Exploration (Santos)- On site supervisor for coal seam gas exploration and clearing activities in the Gunnedah region. Lauren ensured that all contractors and staff on site complied with the Review of Environmental Factors with environmental protection a prioirty during clearing on site

PREVIOUS EXPERIENCE:

Environmental Scientist - Ecobiological (2011)
Primary roles included bush regeneration and the identification of a wide range of native and non-native plant species for rehabilitation of various sites throughout the Hunter and Central Coast regions. Some ecological surveys and Ecological Assessment reporting was carried out during Lauren's time with Ecobiological

Trainee Ecologist - Pygmy Possum Ecological Consulting (2008-2010)
Undertaking ecological field surveys was the primary role at Pygmy Possum Ecological Consulting. Fauna surveys were carried out across the Central Coast, Lake Macquarie and into the Hunter region. Basic reporting and data entry were undertaken throughout Lauren's time with Pygmy Possum Ecological Consulting

VOLUNTEER EXPERIENCE:

- Bush regeneration at Trig Shepards Hill, Bar Beach with Newcastle Landcare (2013);
- Regent Honeyeater habitat restoration in the Capertee region with Birdlife Australia (2012);
- Amphibian (*Litoria citropa*) acoustic research in the Watagan Mountains, NSW with Carl Gerhardt (2012);
- Biodiversity research for independent researchers and Australian Geographic in East Kimberley (2011);
- Amphibian (*Litoria subglandulosa* and *Mixophyes balbus*) research at the New England Tablelands with Marion Anstis, Simon Clulow and Carl Gerhardt (two separate occasions 2010);
- Bandicoot Research in Manly with the Australian Wildlife Conservancy (2010);
- Microbat dietary surveys and tracking at Empire Bay with Leroy Gonsalves (2010);
- Green and Golden Bell frog research at the Sydney Olympic Park (2010);
- Bush-stone Curlew surveys at Empire Bay on the Central Coast undertaking call play back methods (2010).
- Bush regeneration at Wamberal Lagoon Nature Reserve with National Parks and Wildlife Services primarily restoring Littoral Rainforest (EEC) (2007-2010); and

- Fauna research including pit trapping, Elliot trapping, triangulation (for amphibians) and spotlighting for the Watagans fauna database (2007).

MEMBERSHIPS & ACHIEVEMENTS:

- NSW Driver's Licence (Class C)
- OH&S Induction Training (White Card)
- 4WD course
- ChemCert II certification
- Landscape Function Analysis Training
- Member of the Ecological Society of Australia (ESA)
- Member of Birdlife Australia
- Member of the Australian Mammal Society (AMS)

CONFERENCES:

- Australasian Raptor Conference, Adelaide SA (Attendee) 2013
- National Koala Conference, Port Macquarie NSW (Attendee) 2013
- Society for Conservation Biology Conference - Oceania, Darwin NT (Attendee) 2012

Curriculum Vitae

ARNE BISHOP

Senior Ecologist

Newcastle, NSW

Bachelor of Environmental Science, University of Canberra, 2009

Bachelor of Landscape Architecture, University of Canberra, 2009

Cert IV Horticulture (Landscape) Canberra Institute of Technology, 2003

Cert II Australian Land Conservation and Restoration, Conservation Volunteers Australia, 2001

NSW Driver's Licence (Class C)

AREAS OF EXPERTISE:

Arne began paid employment in environmental management as a part time field assistant for Alison Rowell Environmental Consultancy in 1999. This role included working on flora and fauna surveys, and habitat/vegetation assessment and mapping. The knowledge and experience Arne gained from this role progressed and developed into a sub-consultancy role with full time employment over spring- summer every year until 2010.

In 2001, Arne completed a six month environmental traineeship with Green Corps. This course involved learning about environmental issues and how best to manage them in a practical sense. Arne performed duties such as: pest and weed identification and control; bush regeneration; and natural area restoration.

Arne has also completed several contracts as an environmental consultant for Eco Logical Australia, assisting with threatened species identification and monitoring on a range of projects.

Arne has been employed full-time with RPS at their Newcastle office since January 2011; he quickly progressed from a Field Ecologist role to an Ecologist position in the first 8 months of employment. Arne is currently employed with RPS as a senior ecologist.

All of these above roles have been focused on collating and interpreting scientific information in order to produce recommendations on and resolutions to environmental issues. All aspects of field surveys and reporting associated with these roles have been conducted in accordance with relevant Local, State and Commonwealth government legislative frameworks.

SELECTED PROJECT EXPERIENCE

- **Gunnedah Basin (Santos)**
  Conducted multiple projects over approximately two years. These projects included; ecological works for Santos within the Gunnedah Basin covering gas exploration and provision of infrastructure, including, gas pipelines and access tracks. Works included field survey, preparation of advice, impact assessments, EPBC referrals, preparation and implementation of well lease rehabilitation plans, liaison and negotiations with regulators and agencies.
- **Bulga Mine Annual Fauna Monitoring (Glencore)**
  Conducted and project managed an annual monitoring program for the past four years. The program spans two operations and involves seasonal bird surveys, habitat assessments, and the full spectrum of fauna monitoring methodologies, provides technical input and document review.
- **Airly Coal Mine Flora and Fauna Surveys and Assessment (Centennial Coal)**
  A range of flora and fauna surveys were undertaken to inform both the Airly Baseline Survey Report and the Airly Flora and Fauna Report. Project tasks included; review of specialist reports, interpretation of legislative requirements, targeted field survey, assessment of fauna habitat quality and value to threatened species, identification of project impacts and measures to avoid or mitigate potential impacts.
- **Angus Place and Springvale Extension Projects (Centennial Coal)**

Ecological surveys were undertaken over a period of 1.5 years to aid in the production of a Flora and Fauna Report for both the Angus Place and Springvale underground mines. The project role included flora and fauna field surveys.

- **Mandalong Mine Extension Project (Centennial Coal)**
  Project tasks included preliminary desktop assessment, interpretation of legislative requirements, targeted field survey, assessment of fauna habitat quality and value to threatened species, identification of project impacts and measures to avoid or mitigate potential impacts.
- **Mandalong South Powerline Relocation - Flora and Fauna Impact Assessment (Centennial Coal)**
  Conducted targeted threatened seasonal threatened species surveys, client liaison and report development.
- **Beltana Underground Mine Bat Impact Assessment and Monitoring (Glencore)**
  Conducted extensive fieldwork to identify potential habitat, assessed habitat using night vision technology and developed report.
- **Subdivision and Urban Development at Hills Plain, Tamworth, NSW (Marloelle)**
  Conducted detailed floristic surveys to determine the condition and extent of the EPBC Act Critically Endangered Ecological Community - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland (Box-Gum Woodland).

PREVIOUS EXPERIENCE:

Part-time field assistant/consultant – Alison Rowell **1999 - 2010**
This role included working on flora and fauna surveys, and habitat/vegetation assessment and mapping. The knowledge and experience I have gained from this role has progressed and developed into a sub-consultancy role with full time employment over spring- summer every year.

Environmental consultancy work - Eco Logical Australia **2008 - 10**
Arne completed several contracts as an environmental consultant for Eco Logical Australia, assisting with threatened species identification and monitoring on a range of projects.

Green Corps Traineeship - Conservation Volunteers Australian (CVA) **2001**
Arne received accredited practical and theoretical training in; First Aid (Level 2, St Johns); Occupational Health and Safety and Environmental Concepts. This training contributed to Certificate II in Australian Land Conservation and Restoration.

MEMBERSHIPS & ACHIEVEMENTS:

Award of Excellence for first place in Conservation Biology and Genetics - University of Canberra.

Landscape Functional Analysis Training

NSW Driver's Licence (Class C)

OH&S Induction Training (White Card)

First Aid Certification

Four Wheel Drive Training and Certification - Out of Town Four Wheel Drive.

Snake and Spider Safety Awareness for Employees (SSSafe) Training

Royal Zoological Society NSW - Membership

Ecological Consultants Association - Membership

Birds Australia membership

Curriculum Vitae

ANDREW SMITH

Ecologist

Newcastle, NSW

Ph.D. (Avian Population Ecology), Bachelor of Science in Environmental Biology (Sub-major: Wildlife Ecology)

NSW Driver's Licence (Class C), 4WD Training

White Card (OH&S Induction Training)

Senior First Aid

Waterways Authority Boating Licence

AREAS OF EXPERTISE:

Andrew has over 10 years experience in Environmental Science with a wide range of industry groups. His skills include project design, data collection, statistical analysis and presentation of scientific data (both written and oral communication). He has produced a large number of ecological reports for the private sector and as peer-reviewed scientific publications. As well as conducting many targeted Swift Parrot and Regent Honeyeater survey throughout the Hunter Valley, Andrew also voluntarily coordinates the Birdlife Australian community surveys of the Mudgee-Wollar Important Bird Area. Also, Andrew used his knowledge of Australian birds to create migration route maps along south-eastern Australia for a large number of bush birds. Currently, Andrew is voluntarily working with staff at Birdlife Australia to produce a Population Viability Analysis for the Powerful Owl population within the Sydney region, a community survey based project which he cofounded.

SELECTED PROJECT EXPERIENCE:

ENVIRONMENT

- Flora and fauna identification and habitat assessment;
- Targeted threatened flora and fauna surveys (e.g. targetting breeding sites for the threatened Regent Parrot at Hattah-Kulkyne National Park during 2012);
- Delineation and mapping of vegetation communities;
- Endangered Ecological Community (EEC) assessment;
- Experience with GPS/GIS for project design and mapping;
- Conducting Field Surveys for Flora, Fauna and Habitat Identification;
- Report Preparation including Fauna and Flora Assessments;
- Ecological Monitoring and Reporting;
- BioBanking data collection, credit calculating and reporting;
- Vegetation Management Plan reporting; and
- Understanding of environmental legislation.

RPS

Curriculum Vitae

- CONTINUED -

PREVIOUS EXPERIENCE:

Research Officer – Birds Australia **(2010)**

Andrew was employed on the Great Eastern Ranges Initiative project: movements and landscape connectivity. The project was funded of the Department of Environment, Climate Change and Water, NSW. Primarily, he mapped the movements and migration routes of several bird species along south-eastern Australia, including the Swift Parrot, Regent Honeyeater, Flame Robin and Scarlet Robin.

Scientific Officer – Department of Industry and Investment **(2009)**

Andrew was employed under Dr Rod Kavanagh to perform over 100 bird surveys over a large area on the mid-north coast of NSW. This work was performed to help develop a broad scale biological diversity monitoring strategy.

Ph.D Candidate – Australian White Ibis: University of Technology, Sydney **(2005–2009)**

Andrew investigated the population ecology of the Australia White Ibis (*Threskiornis molucca*) in the urban environment. Andrew compiled detailed information on the breeding, feeding, movement and population dynamics of ibis which is critical for the longer term sustainable management of this species.

Technical Officer – University of Technology, Sydney **(2007–2009)**

Andrew was employed to help run the practical components for a number of environmental subjects: Wildlife Ecology, Animal Behaviour and Physiology, and Catchment Ecosystems. His role mainly involved teaching students a wide range of wildlife surveying techniques.

MEMBERSHIPS & ACHIEVEMENTS:

- Ecological Consultants Association of NSW (ECA);
- NSW, Royal Zoological Society (RZS);
- Birdlife Australia;
- Australia Bird Study Association;
- A Class Bird Banding Licence;
- Snakes and Spider Saftey Awareness (SSSafe) Training; and
- Landscape Functional Analysis Training.

PEER-REVIEWED PUBLICATION:

- Smith, A.C.M., and Munro, U. (2008). Cannibalism in the Australian Pelican *Pelecanus conspicillatus* and Australian White Ibis *Threskiornis molucca*. *Waterbirds* **31**, 632–635.
- Smith, A.C.M., and Munro, U. (2010). Seasonal population dynamics of the Australian White Ibis (*Threskiornis molucca*) in the urban environment. *Emu* **110**, 132–136.
- Smith, A.C.M., and Munro, U. (2011). Local and regional movements of the Australian White Ibis (*Threskiornis molucca*) in eastern Australia. *Corella* **35**, 89–94.
- Smith, A.C.M., Figueira, W., and Munro, U. (2013). Modelling urban populations of the Australian White Ibis (*Threskiornis molucca*) to inform management. *Population Ecology*. In press.
- Smith, A.C.M., Kikillus, K.H., Ross, G. and Munro, U. (2013). Breeding of the Australian White Ibis *Threskiornis molucca* in the urban environment. *Corella*. In Press.
- Thomas, C.A., Lidums, E., Smith, A.C.M. and Munro, U. (2013). Seasonal abundance shifts by the Australian White Ibis Threskiornis molucca across parts of eastern Australia in 2007: a survey using questionnaires. *Corella*. In Press.

Appendix 8

Cardno (2013) Aquatic Ecology Impact Assessment

Cardno Ecology Lab

Shaping the Future

Marine and Freshwater Studies



Newstan Colliery

Aquatic Ecology Impact Assessment for the Northern Coal Logistics Project

Job Number: EL1112084

Prepared for Northern Coal Services

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Cover Image: LT Creek above the Newstan Colliery rail loading facility. Photographer Max Best, Cardno Ecology Lab

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Executive Summary

Cardno Ecology Lab was engaged by Centennial Northern Coal Services Pty Limited (Northern Coal Services) to conduct an aquatic ecology impact assessment to support a development application for the expansion of the coal handling, storage and distribution facilities on site at the Newstan Colliery as part of the Northern Coal Logistics Project (the Project).

As part of the Project, Northern Coal Services proposes to increase the current coal stockpile areas across the upper north arm of LT Creek and install automated coal conveyance and train loading facilities. In order to remove the risk of coal stored in the additional stockpiles from entering LT Creek and being transported downstream, Northern Coal Services propose to pipe a reach of the north arm of LT Creek from the downstream side of By-wash Dam in the upper catchment to the south of the rail loading facility.

This report includes a desktop review, field investigation and aquatic ecology impact assessment for the piping of a section of LT Creek. An additional impact assessment report on changes relating to surface water quality and flow is being prepared by GHD (L. Hammersly, 2013, *letter comm.* 10 April). Field investigations were completed in July 2012 at four sites along LT Creek within, upstream and downstream of the construction zone. Field investigation included assessment of water quality, aquatic habitat, macrophytes, macroinvertebrates and fish. No threatened or endangered flora or fauna were observed during the investigation.

The condition of the existing aquatic ecosystem within and downstream of the proposed development area was identified as moderately degraded based on the interpretation of flora, fauna, water quality and habitat data collected in this and previous investigations. Despite the degraded condition, LT Creek provides valuable aquatic habitat for resident organisms and is part of an interconnected ecosystem stretching from ephemeral creeks in the upper catchment through to the Lake Macquarie estuary.

Key potential impacts identified for the proposed development include: removal of aquatic and terrestrial habitat; increased sediment and water quality issues during construction; direct and indirect impacts on aquatic flora and fauna; increase in flood risk and; further restriction of fish passage through an already restricted creek. Further degradation of this ecosystem can be minimised by implementing effective controls to minimise impacts on water quality, hydrology and the aquatic habitat.

Recommendations were made to assist with the mitigation of potential impacts including: update and implementation of water and sediment management plans; design of infrastructure based on appropriate hydrological modelling; monitoring and control of sediment; improvement of aquatic habitat upstream and/or downstream of the pipeline; implementation of an ongoing aquatic ecology monitoring program.

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Glossary

AUSRIVAS	Australian River Assessment System
AWS	Automated Weather Station
DPI	Department of Primary Industries
DSEWPAC	Department of Sustainability, Environment, Water, Population and Communities
EC	Electrical Conductivity
EP&A Act	Environmental Planning and Assessment Act (1979)
EPL	Environmental Protection Licence
EPT	Ephemeroptera, Plecoptera, Trichoptera
ISQG	Interim Sediment Quality Guidelines
LDP	Licenced Discharge Point
NCLP	Northern Coal Logistic Project
NCS	Northern Coal Services
NES	National Environmental Significance
POEO Act	Protection of the Environment Operations Act
RCE	Riparian, Channel and Environment
SIGNAL2	Stream Invertebrate Grade Number Average Level version 2
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WMP	Water Management Plan
WTP	Water Treatment Plant

1 Introduction

Cardno (NSW/ACT) Pty Ltd trading as Cardno Ecology Lab was engaged by Centennial's Northern Coal Services Pty Limited (Northern Coal Services) to conduct an aquatic ecology impact assessment to support a development application for the expansion of the coal handling, storage and distribution facilities on site at the Newstan Colliery (located near the township of Fassifern) as part of the Northern Coal Logistics Project (the Project).

Northern Coal Services is seeking approval for the Project under Part 4 Division 4.1 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), and part of the proposal includes the redevelopment of the Newstan Colliery Surface Site. In order to remove the risk of coal stored in the additional stockpiles from entering LT Creek and being transported downstream, Northern Coal Services are proposing to pipe the length of the north arm of LT Creek from the downstream side of the By-wash Dam to the south toward the rail loading facility (Figure 1-1).

This report outlines findings of desktop and field based assessments completed and provides an assessment of potential impacts on the aquatic ecosystem associated with the proposed piping of LT Creek only.

1.1 Scope of Work

The field assessment component of this study focused specifically on the section of LT Creek where the majority of direct impact is expected to occur, which runs between the Main By-wash Dam weir and the rail loading facility. Consideration has also been given to the aquatic environment upstream and downstream of this section, where impacts may also occur. The estuary of the waterway has been considered in less detail than the supra-tidal aquatic environment, which is the focus of this report.

1.2 Aims

The specific component of the proposed development that relates to the aquatic ecosystem is the piping of a section of the upper north arm of LT Creek. The aim of the study and the focus of this report is therefore the assessment of potential impacts on the aquatic ecosystem in relation to this proposed development activity.

The specific aims of the study are to:

- Undertake background research and compile existing information on the aquatic habitats, biota and fisheries of LT Creek;
- Identify legislative requirements and guidelines that are relevant to the effects of the proposed works on aquatic ecology;
- Review current listings of species identified on Schedules to the Threatened *Species Conservation Act 1995* (TSC Act) and the *Fisheries Management Act 1994* (FM Act), and the *Environment Protection and Biodiversity Act 1999* (EPBC Act) and assess the likely presence of protected aquatic species, including a list of such species, populations, communities and processes;
- Assess the relevance of processes as defined in the TSC Act, considering communities, populations and processes that are listed on the relevant TSC Act Schedules;
- Consider potential impacts in relation to Commonwealth requirements and international agreements, including the EPBC Act , wetlands policies and migratory bird agreements;
- Undertake field studies to describe the aquatic habitat provided by, and aquatic species utilising, LT Creek, including the collection of data on water quality, aquatic macroinvertebrates, habitat quality, aquatic macrophytes and fish;
- Assess the potential impact of the proposed works on the aquatic ecology of LT creek and provide recommendations to avoid, minimise and / or mitigate identified potential impacts;
- Identify any permits that may be required; and
- Make recommendations on any further work and further monitoring, if required.

1.3 Background

In 1999 the Newstan Colliery Surface Site, as part of Newstan Colliery, received Development Consent DA 73-11-98 following the submission of the Newstan Colliery Life Extension Area Environmental Assessment (Umwelt 1998). This

development Consent allowed, among other things, the development of coal stockpile areas and the piping of approximately 150 m of LT Creek North Arm between the By-wash Dam and the rail loop and approximately 175 m of LT Creek North Arm within the rail loop. As part of the current Project, Northern Coal Services are planning to extend the approved piping in 2 sections of the creek (approximate addition of 300 m of pipeline in total) to remove the risk of coal entering the creek and being transported downstream from the proposed expansion of the overlying coal stockpile area and associated works. The proposed piping would link the currently approved pipeline sections to create a continuous length of piping approximately 625 m along the north arm of LT Creek as it traverses through the Newstan Colliery Surface Site.

The excavation and disturbance associated with installing the pipelines in the existing channel of the north arm of LT Creek has the potential to result in significant downstream sedimentation. On this basis, it is proposed to install lengths of piping adjacent to the existing creek channel and subsequent diversion of flow through this pipeline. Figure 1-1 shows the two sections of LT Creek North Arm where piping has previously been approved under Development Consent DA 73-11-98 and the two remaining sections of the Creek where Northern Coal Services is seeking approval to extend the pipeline.

1.3.1 Licenced Discharge Points

Newstan Colliery's Environmental Protection Licence (EPL 395) permits the discharge of water from the Newstan Colliery Surface Site through two licenced discharge points on the north arm of LT Creek. Licenced Discharge Point 001 (LDP001) is located at the upper end of the catchment upstream of the By-wash Dam and is licensed to discharge up to 11 ML per day under normal weather conditions. Licenced Discharge Point 002 (LDP002) is located to the south on the downstream side of the Newstan Colliery Surface Site on the Final Pollution Control Dam. LDP002 is only permitted to discharge into LT Creek if the storage capacity of the dam is exceeded during rainfall events. Figure 1-1 shows the locations of the licenced discharge points.

An increase in the volume of water discharged into LT Creek via LDP001 is being sort from the current 11 ML per day limit to 14.5 ML per day. Design of the proposed pipeline through LT Creek will sufficiently accommodate this increase in discharge and will be designed for a 1:100 year storm event (J. Wearne 2013 pers. comm., 11 March).

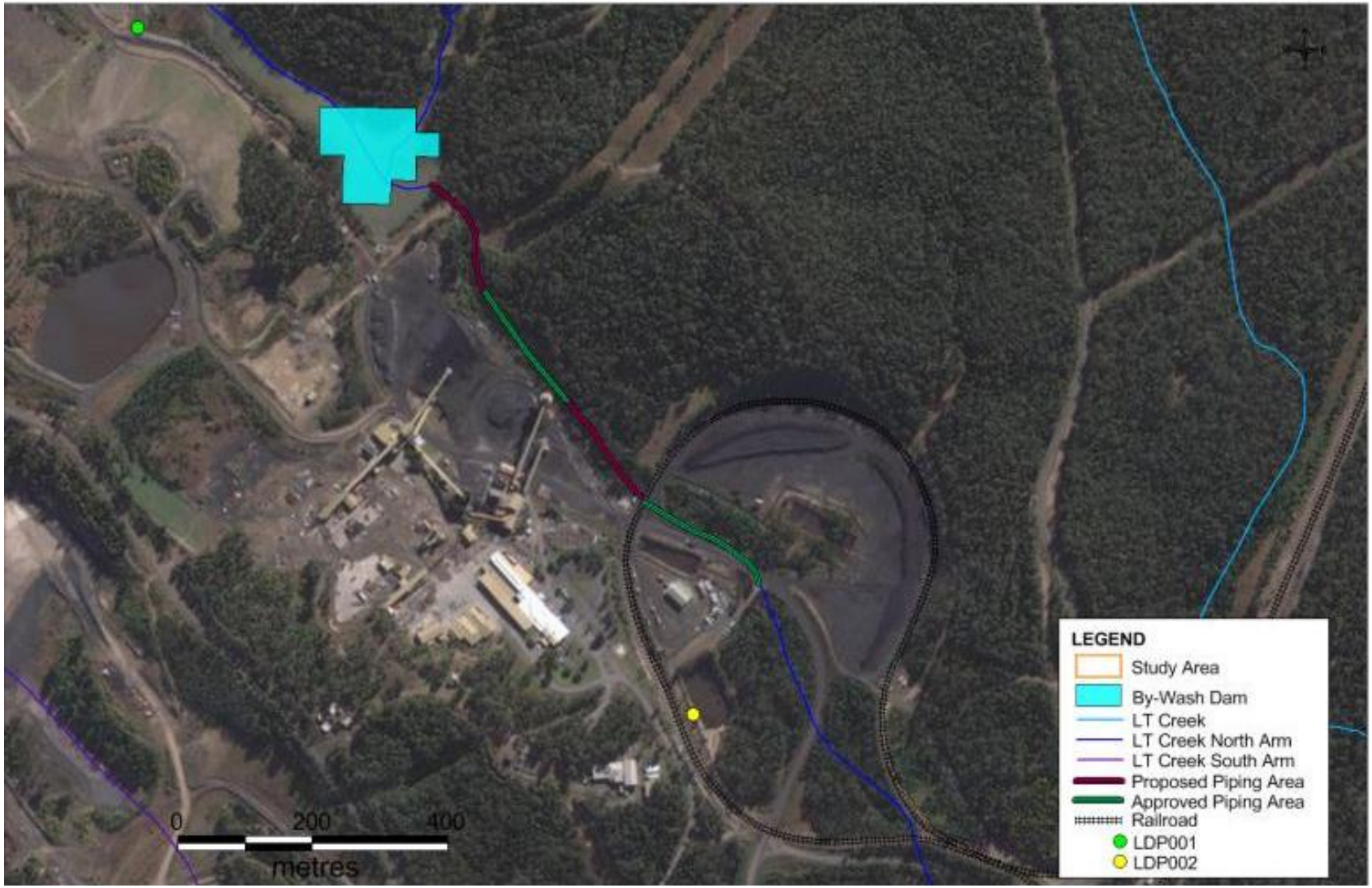


Figure 1-1: Location of the proposed works and Licenced Discharge Points (LDPs) along LT Creek

1.3.2 LT Creek

LT Creek is a tributary of Lake Macquarie draining a catchment area of some 7.5km^2, extending north/north-west of the township of Fassifern (Figure 1-2). The catchment is drained by LT Creek and a number of unnamed tributaries, discharging to Fennel Bay, a semi-closed embayment of the broader Lake Macquarie waterway (BMT WBM 2011).

The Newstan Colliery Surface Site lies within the upper catchment of LT Creek and consists of a North Arm and a South Arm that converge within the residential / commercial area of Fassifern (Figure 1-2). The upper catchment of LT Creek North Arm also consists of bushland associated with the Rhondda Colliery owned by Coal and Allied. A power easement and rail corridor runs through the LT Creek catchment downstream of Newstan Colliery. LT Creek was originally an ephemeral system, but the North Arm has been receiving water from the underground mine water for a number of years (GHD 2009).

LT Creek is considered to be a highly valued asset to the local community, particularly the lower estuary where it is interconnected with Lake Macquarie. A 2010 survey of the local community and subsequent report prepared by Lake Macquarie City Council (LMCC), found that residents were most concerned about the water pollution within LT Creek and the sediment deposition into the estuary (LMCC 2010).

Northern Coal Services are in the process of upgrading water treatment at the Newstan Colliery Surface Site by installing a water treatment plant for the LDP001 discharge point. On completion, all water from LDP001 will be treated at the plant prior to discharge. Previously, treatment has involved passive settlement within the By-wash Dam. The planned new water treatment mechanisms combine previous processes with coagulation/flocculation, settlement and filtration in a separate plant. The operation and maintenance of this facility and the existing settlement basins will be an important factor in the protection of the aquatic environment.

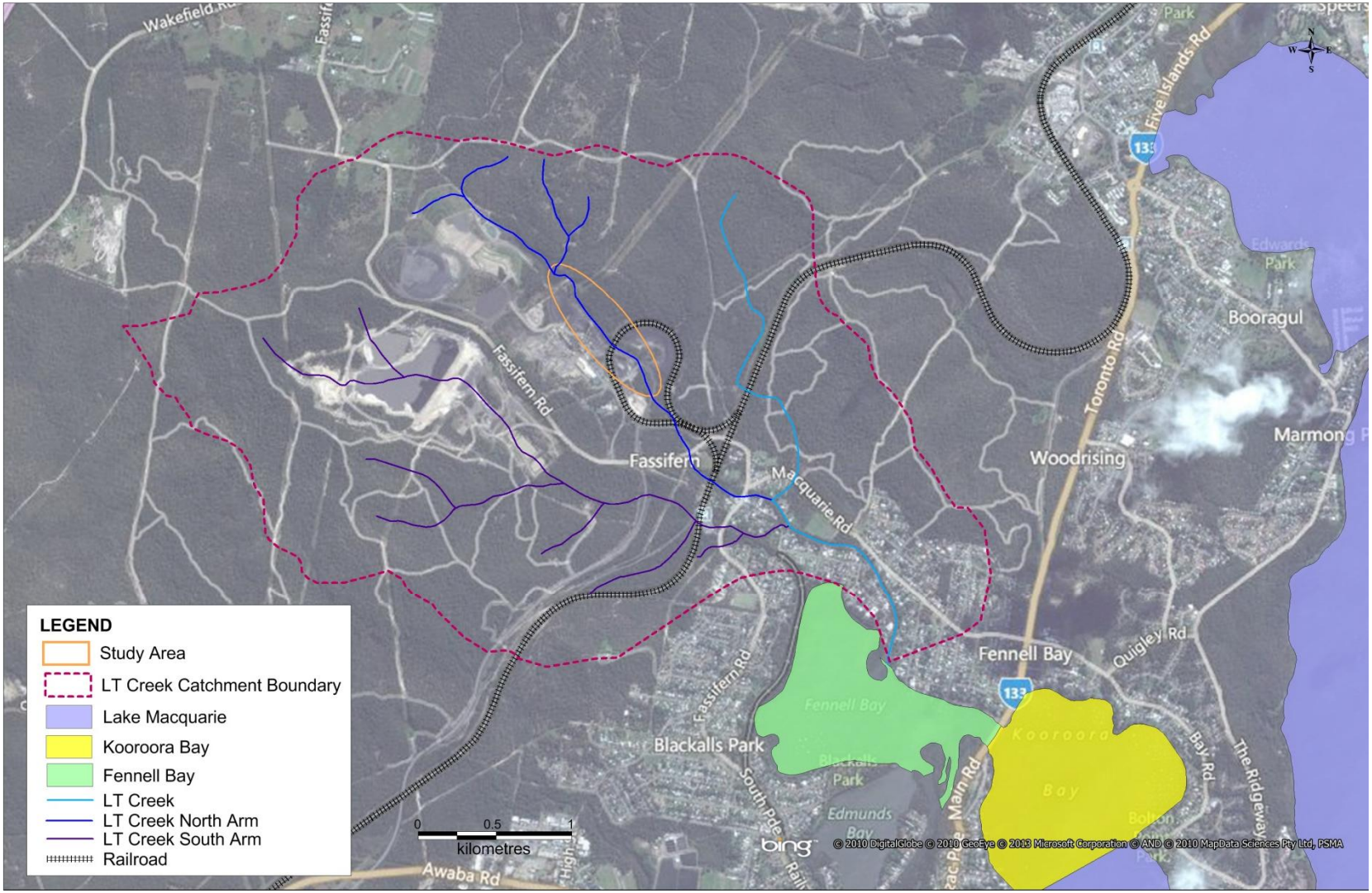


Figure 1-2: LT Creek Catchment boundary and watercourses

2 Legislative Context

2.1 Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

The EPBC Act is administered by the Commonwealth Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC). The aims of the Act are to:

- Provide for the protection of the environment, especially those aspects of the environment that are matters of National Environmental Significance (NES);
- Promote ecologically sustainable development through conservation and ecologically sustainable use of natural resources;
- Promote conservation of biodiversity;
- Provide the protection and conservation of heritage.

In the aquatic environment, the Act lists the following matters of NES relevant to this study:

- Nationally threatened species, ecological communities, critical habitats and Key Threatening Processes (KTP);
- Migratory species;
- Ramsar wetlands of national significance.

Under the EPBC Act, any action that will have, or is likely to have a significant impact on a matter of NES must be referred to the Australian Government Minister for a decision on whether assessment and approval is required under the EPBC Act. To assist proponents in determining whether an action is likely to have a significant impact on a matter of NES, DSEWPAC's reference Matters of National Environmental Significance, Significant Impact Guidelines 1.1 (DEWHA 2009) is available.

The EPBC Act also provides for the identification and listing of KTPs. A KTP may be identified and listed if it threatens or may threaten the survival, abundance or evolutionary development of a native species or ecological community.

To comply with EPBC Act, a survey of the study area needs to be conducted targeting any matters of NES (nationally threatened species, ecological communities, critical habitats, migratory species, Ramsar wetlands). If any of these items are identified within, or are relevant to the study area of this Project, these will need to be assessed under the EPBC Act.

2.2 The Environmental Planning and Assessment Act 1979 (EP&A Act)

The EP&A Act is the principal piece of legislation overseeing the assessment and determination of development proposals in NSW. It also establishes the framework under which environmental planning instruments (e.g. State Environmental Planning Policies and Local Environmental Plans) which guide planning decisions are prepared.

The EP&A Act contains several pathways under which development can be assessed and determined.

The Northern Coal Logistics Projects is considered State significant development and, as such, Northern Coal Services is seeking approval under Division 4.1 of Part 4 of the EP&A Act

Under the EP&A Act, any development that will have a significant impact on the environment requires preparation of an environmental impact assessment. This aquatic ecology impact assessment has been prepared to support of the wider Environmental Impact Statement (EIS) for The Project.

As the project is being assessed as a State significant development, preparation of a Species Impact Statement is not required as outlined in Section 78A(8) of the EP&A Act.

2.3 Threatened Species Conservation Act 1995 (TSC Act)

In NSW, the TSC Act, administered by the Office of Environment and Heritage (OEH), formerly the Department for Environment Climate Change and Water (DECCW) includes provisions to declare threatened species, populations, ecological communities and KTPs. Species populations and communities identified as 'endangered' are listed in Schedule 1 of the TSC Act. Species populations and communities identified as 'critically endangered' are listed in Schedule 1A of the TSC Act and species populations and communities identified as 'vulnerable' are listed in Schedule 2 of the TSC Act.

Marine birds, mammals and reptiles are included in Schedules of the TSC Act whereas all fish and marine vegetation and some aquatic invertebrates are listed under the FM Act (see below). In addition, the TSC Act provides for the identification and listing of habitat that is critical to the survival of an endangered species, population or ecological community.

Any organisms found within the study area that are listed in the TSC Act will require specific assessment under this legislation to assess any potential impact by the development.

2.4 Fisheries Management Act 1994 (FM Act)

The FM Act seeks to conserve fish stocks, key fish habitats and threatened species, populations and ecological communities of fish and marine vegetation. Species populations and communities identified as 'endangered' are listed in Schedule 4 of the FM Act. Species populations and communities identified as 'critically endangered' are listed in Schedule 4A of the FM Act and species populations and communities identified as 'vulnerable' are listed in Schedule 5 of the FM Act. The FM Act also lists KTPs that may threaten the survival of those species, populations and ecological communities.

Section 19 of the FM Act allows for the declaration of specified species as protected fish, although not currently declining, these fish must be protected so they do not become threatened in future. Provisions for the protection of aquatic habitats and aquatic reserves are included under Part 7 of the Act. In addition, Division 3 of the FM Act provides for the identification of habitat that is critical to the survival of an endangered species, populations or ecological communities.

Section 218 of the FM Act outlines legislative obligations for fishways to be provided in construction of dams and weirs. The Minister may, by order in writing, require a person (other than a public authority) who constructs, alters or modifies a dam, weir or reservoir on a waterway to carry out, within the period specified in the order, such works as may be so specified to enable fish to pass through or over the dam, weir or reservoir. A person (other than a public authority) must not construct, alter or modify a dam, weir or reservoir on a waterway unless the person ensures that the Minister is given notice in writing of the proposed works at least 28 days before the commencement of the works.

3 Methodology

3.1 Sampling Sites

An initial visit to the study area was made to gain an appreciation of the aquatic habitat, water management practices and proposed development within the site. Four sampling sites were then selected to represent the length of the section of LT Creek (North Arm) below LDP001 and within the area of potential impact. All sites covered a length of approximately 100 m of the creek bank. Site locations, descriptions and GPS coordinates are provided in Table 3-1 and the sampling locations are illustrated in Figure 3-1.

Table 3-1: Site Locations and Descriptions

Site Name	Sampling Site Code	Description	Easting (UTM 56H)	Northing (UTM 56H)
LT Creek 1	LTC 1	Directly above the weir of the Main By-Wash Dam	6350722	0366683
LT Creek 2	LTC 2	Proposed upper piped section downstream of weir	6350567	0366717
LT Creek 3	LTC 3	Proposed lower piped section upstream of railway line	6350342	0366911
LT Creek 4	LTC 4	Below the lower piped section, downstream of the Haul Road	6349999	0367157

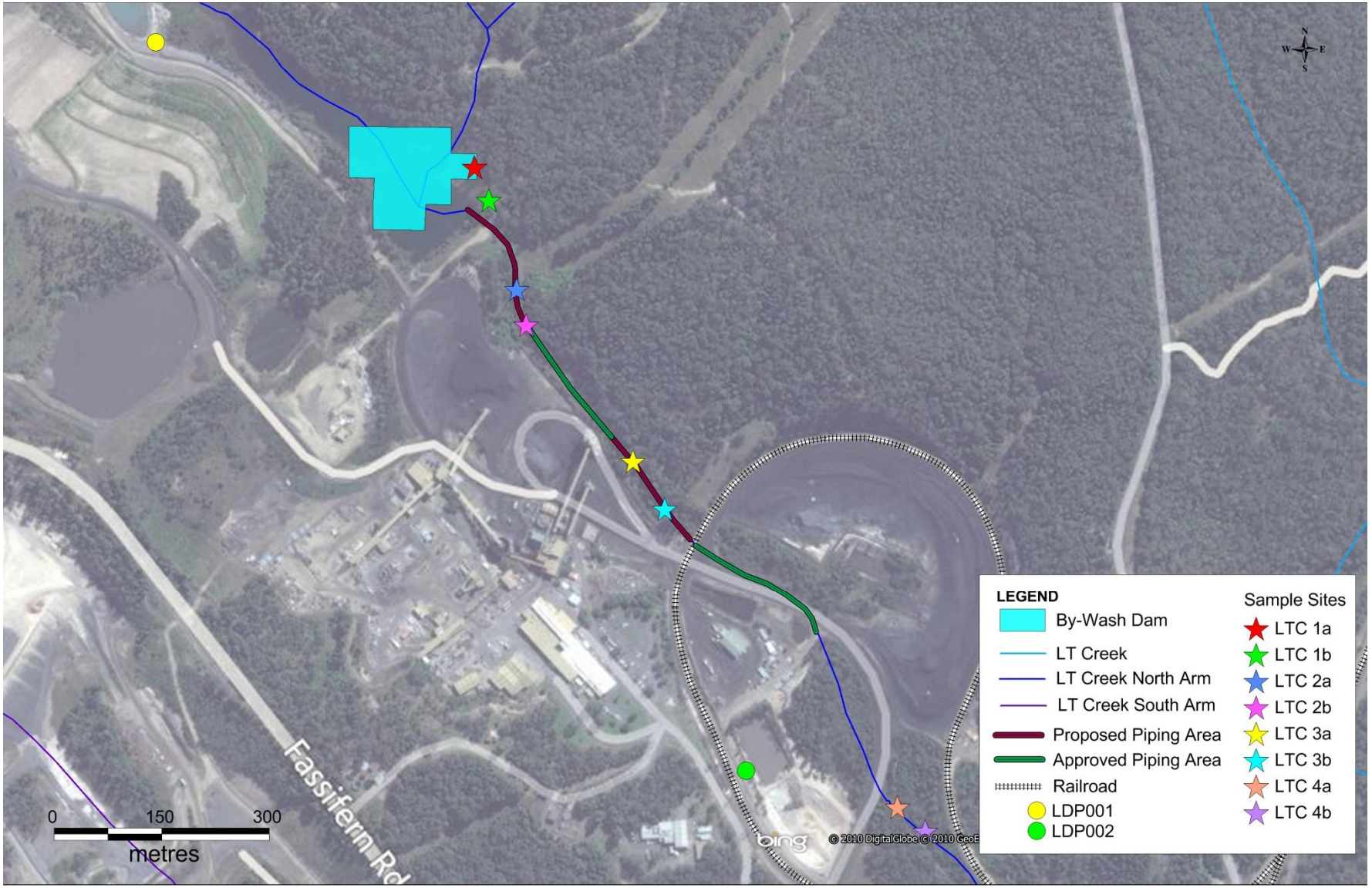


Figure 3-1: Locations of sampling sites

3.2 Sampling Methodology

3.2.1 Aquatic Habitat Assessment

The condition of the aquatic habitat at each site was assessed using a modified version of the Riparian, Channel and Environmental (RCE) Inventory Method (Chessman *et al.* 1997). This assessment involves evaluation and scoring of the characteristics of the adjacent land, the condition of riverbanks, channel and bed of the watercourse, and degree of disturbance evident at each site (Appendix 1). The maximum score (52) indicates a stream with little or no obvious physical disruption and the lowest score (13) indicates a heavily channelled stream without any riparian vegetation. This methodology developed by Peterson (1992), was modified for Australian conditions by Chessman *et al.* (1997) by combining some of the descriptors, modifying some of the associated categories and simplifying the classifications from 1 to 4.

3.2.2 Water Quality

Water quality was measured *in situ* with a YeoKal 611 water quality probe and meter that was calibrated prior to sampling. This was done before aquatic fauna were sampled to avoid disturbance to the waterway. The following variables were recorded:

- Temperature (°C);
- Electrical Conductivity (EC) (µs/cm);
- pH (pH units);
- Dissolved Oxygen (DO) (mg/L and % saturation);
- Oxidation Reduction Potential (ORP) (mV); and,
- Turbidity (NTU).

Two replicate readings of each variable were taken in accordance with Australian Guidelines (ANZECC/ARMCANZ 2000). Six replicate readings were taken for turbidity as this measure tends to be more variable.

3.2.3 Aquatic Macroinvertebrates

Two replicate samples of aquatic macroinvertebrates associated with edge habitats were collected at each site using the AUSRIVAS rapid assessment methodology (RAM) (Turak *et al.* 2004). Riffle habitat was not sampled, because this habitat was not adequately represented at any of the stretches of creek surveyed. Samples were collected with dip nets (250 µm mesh) over a period of 3-5 minutes from a 10 m length of habitat along the creek. The dip net was used to agitate and scoop up material from vegetated river edge sub-habitats including trailing vegetation, submerged macrophytes, rocky substrate, large wordy debris and detritus. Where habitat was discontinuous, patches of habitat with a total length of 10 m were sampled. Each RAM sample was rinsed from the net onto a white sorting tray from which animals were picked using forceps and pipettes. Each tray was picked for a minimum period of forty minutes, after which they were picked at ten minute intervals for either a total of one hour or until no new specimens had been found. Care was taken to collect cryptic and fast moving animals in addition to those that were conspicuous or slow. The animals collected at each site were placed into a labelled jar containing 70% alcohol.

In the laboratory, each sample was sorted under a binocular microscope (at 40 X magnification), macroinvertebrates were extracted and identified to family level using standard references and up to ten animals of each family counted, in accordance with the latest AUSRIVAS protocol (Turak *et al.* 2004). Identifications were confirmed using standard references. After confirmation of sample identifications, samples were stored in 70% alcohol in containers appropriate for long-term storage.

The AUSRIVAS model was not used to interpret the macroinvertebrate data collected. This was due to the sampling being conducted well outside the sampling seasons specified by the model. Additionally, high carbonate alkalinity (as opposed to pH) was recorded and this generally results in outputs 'outside the experience of the model'.

The revised SIGNAL2 biotic index (Stream Invertebrate Grade Number Average Level) developed by Chessman (2003) was used to determine the "environmental quality" of sites on the basis of the presence or absence of families of macroinvertebrates. This method assigns grade numbers to each macroinvertebrate family or taxa found, based largely on their responses to chemical pollutants. The sum of all grade numbers for that habitat was divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index. The SIGNAL2 index therefore uses the average sensitivity of macroinvertebrate families to present a snapshot of biotic integrity at a site.

The SIGNAL2 outputs were plotted to display the number of macroinvertebrate taxa and the SIGNAL2 index on separate axis to provide a graphical representation of these data. This diagram is referred to as a SIGNAL2 bi-plot by Chessman (2003) and is usually separated into quadrants representing the level of biological impairment at each sample site (Figure 3-2).

Definition of the biological impairment using these two values (number of taxa and SIGNAL2 index) is somewhat arbitrary and depends on factors such as geographical location and the condition of the aquatic habitat. In general, SIGNAL2 values greater than 6, between 5 and 6, 4 and 5 and less than 4 indicate that the quality of the water is clean, mildly, moderately or severely degraded, respectively. Taxa richness values greater than 20, between 15 and 20, 10 and 15 and less than 10 generally indicate a rich assemblage, moderately degraded, severely degraded and depauperate community respectively. For the purpose of this study, bi-plot boundaries were set at 20 for the number of taxa represented and 4.5 for the SIGNAL2 index to produce a region of 'high environmental quality' quadrat above these two values.

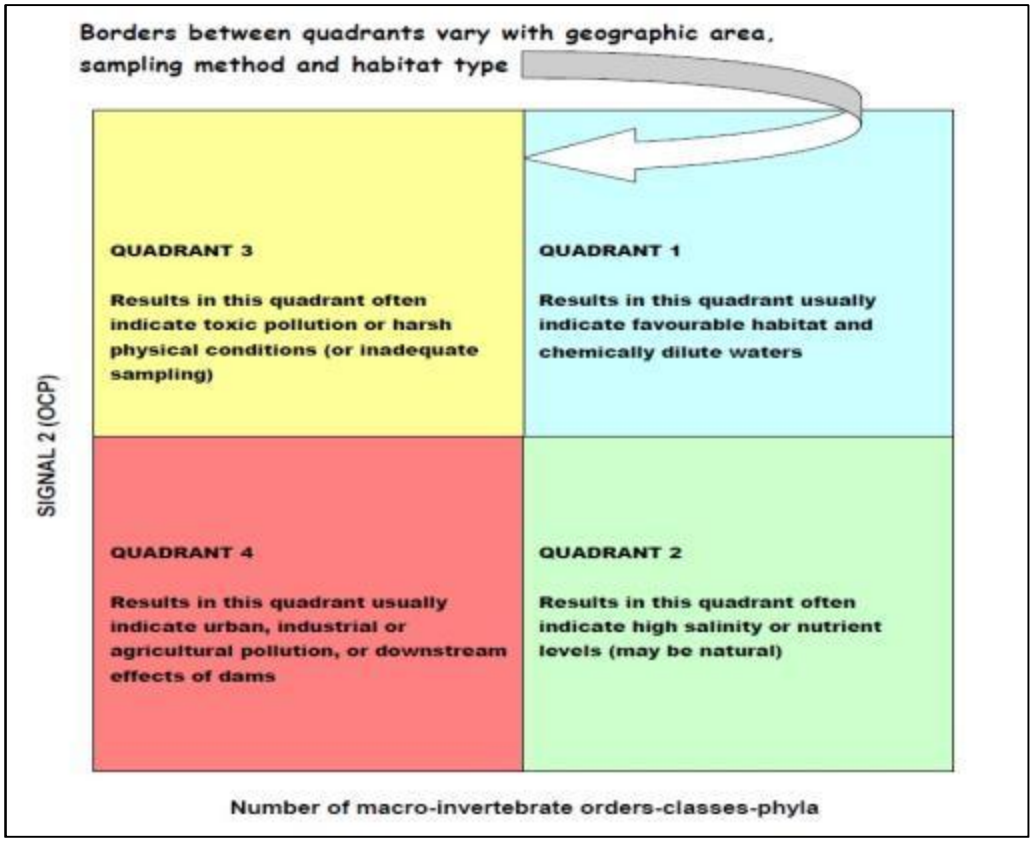


Figure 3-2: SIGNAL2 quadrat descriptions from Chessman (2003).

3.2.4 Fish

At each site, four collapsible bait traps were deployed overnight in discrete locations on the creek bed, amongst vegetation and near submerged logs or within dense vegetation. The traps used were 350 mm long and 200 mm wide, and were constructed of 3 mm wide mesh, with an entrance that tapers in to 15 mm.

Seine netting (using a small 4 m long net with 1 m drop and mesh size 5 mm) was attempted in the shallow margin of the Main By-wash Dam although was unsuccessful due to the sediment and macrophyte density, which prevented acceptable retrieval and therefore catch.

Backpack electrofishing is a non-destructive technique that is restricted to depths of approximately 1 m (hip height) and water bodies with low to moderate salinity. Backpack electrofishing was not used in LT Creek due to high electrical conductivity, which renders the electric pulses generated by the electrofisher ineffective.

All fish caught were placed into a tub containing creek water, identified, counted, checked for abnormalities and then released as quickly as practicably possible. The numbers of each species of fish captured at each site were recorded on data sheets. Non-native species were humanely disposed of, as per DPI guidelines. All fish captured and their fates were reported to the DPI and the Director General's Ethics Committee as per the conditions of our permit to sample fish.

3.2.5 Aquatic Macrophytes

Submerged, emergent and riparian aquatic macrophytes occurring in-stream and within 1m of the wetted bank edge were surveyed at each of the survey sites. This was completed by walking the length of the site along the creek line and identifying and recording all plants within this zone. Most of the plant identifications were completed in the field by an experienced aquatic ecologist. Where identifications were not made in the field, specimens were collected and preserved in a plant press or wet bag (for succulent species) for later identification in the laboratory or by an expert botanist at the Royal Botanic Gardens Herbarium in Sydney. Due to the time of year of the survey, numerous plants were not flowering and were therefore difficult to identify to species level. Where this was not possible, identification was made to the lowest level of taxonomic resolution possible and subsequent checks of the literature were made to eliminate any threatened or endangered species from the identification.

3.3 Assumptions and Constraints

LT Creek was visually surveyed during an initial site visit on 12 June 2012, between the By-wash Dam weir and the railway crossing downstream. This initial assessment provided a broad description of the aquatic habitat along this section of the creek, around the newly proposed pipe sections. The aquatic habitat along this stretch of the creek was assessed as relatively homogenous, and two study sites were subsequently selected to represent this reach in the detailed field investigation. It is assumed that the two sites selected adequately represent the aquatic ecosystem within this area of the creek. The area in between the two selected sites was not visited during the detailed investigation and is assumed to contain similar aquatic species to those areas assessed.

The field survey completed covered the aquatic and riparian environment within 1m of the creek and did not examine the terrestrial margins of this zone. Riparian zone flora and fauna located away from the creek and the terrestrial environment were not included in the survey.

A targeted search for frogs was completed by RPS (A. Smith 2012 email comm., 5 October) but no searches were undertaken for waterbirds during this investigation. Comments on the presence or absence of waterbirds have therefore been based on available habitat and known distributions.

3.4 Literature Review

A review of available information on the aquatic ecosystem of LT Creek and the proposed Project was undertaken for this assessment. The key documents reviewed are:

- BMT WBM (2011). *LT Creek Flood Study - Final Report*. Prepared for Lake Macquarie City Council.
- Centennial Coal (2009). *Revised Water Management Plan*.
- Centennial Coal (2012). *Newstan Colliery Extension of Mining Project Briefing Paper*.

- GHD (2009). *Centennial Coal – Newstan: Surface Water Quality Baseline Study*. Prepared for Centennial Newstan Pty Ltd.
- GHD (2011). *Centennial Newstan: Report for LT Creek Ecotox Study - Ecotoxicological Assessment and Trigger Values*. Prepared for Centennial Newstan Pty Ltd.
- GHD (2012). *Centennial Newstan: Downstream Assessment of LT Creek Report*. Prepared for Centennial Newstan Pty Ltd.
- GHD (2012). *Centennial Newstan: Report for Treated Discharge Water Ecotoxicology*. Prepared for Centennial Newstan Pty Ltd.
- Umwelt (2009). *LT Creek Catchment Water Quality Management Plan*. Prepared on behalf of Lake Macquarie City Council.

3.5 Database Searches

A search of the Bionet Atlas of NSW Wildlife database was conducted for threatened flora and fauna species recorded since 2000 in a 5km by 5km search area surrounding the site on 6 July 2012. The EPBC Database (Protected Matters Search Tool) was also searched on 4 August 2012 with a 1km search buffer around the study area. The results of the searches are discussed in Section 4.2.1.

4 Existing Environment

4.1 Physical Setting

LT Creek is located on the western side of Lake Macquarie, draining to the northern side of Fennel Bay (Figure 1-2) with a catchment area of approximately 7.5km^2. Alternate layers of sandstone, coarse pebbly conglomerate and fine grained claystone underlie the ridges and slopes in the catchment. Small cliffs, steep rock slopes and flatter benches form on different rock types. The topography of the catchment area generally consisted of rolling low hills with short side slopes and numerous closely spaced drainage lines, on predominately coarse-grained sediments of the Narrabeen Group and Newcastle Coal Measures. Slope gradients were generally 10 – 25 per cent and local relief was between 20 m and 110 m Australian Height Datum (AHD) (Centennial Coal 2012).

Severe sheet, rill and gully erosion of dispersible soils has occurred in the LT Creek catchment where groundcover vegetation and catchment hydrology have been disturbed by land uses such as mining, urban and infrastructure (power easements, rail and road). Together with runoff from the Newstan Colliery that may be contaminated with fine coal particles as well as sand and clay from the local bedrock and soils, this catchment erosion has resulted in very high sediment concentrations in LT Creek during rainfall events (Umwelt 2009).

4.2 Aquatic Habitat

Detailed descriptions of the aquatic habitat observed during the field investigation on 9 and 10 July 2012 are provided below. Also described are the locations and sub-habitat characteristics at the location of each of the macroinvertebrate sampling points.

4.2.1 LT Creek (North Arm)

At the time of the site inspection (9-10 July 2012), the hydrology and water quality of the North Arm of LT Creek was dominated by the discharge of water from Newstan Colliery's LDP001. Water management structures including dams, weirs, culverts, flow diffusers and a largely modified and unnatural channel form are the most prominent features of the creek.

The channel width ranged from around 1m in the steeper narrow sections (and piped areas around the rail loading facility) to over 100m at the earthen wall of the By-wash Dam. At the time of the inspection, water depth in the thalweg ranged from around 0.5m along the flowing channel to greater than 1m (unmeasured) within the By-wash Dam. Sediment accumulation within the main channel (and assumedly within the By-wash Dam) was severe, with depths of greater than 0.5m recorded in the flowing channel despite moderate flow velocity. The water was brackish in the supra-tidal creek channel, which has been the norm for several decades due to mine water discharges (Stuart C. Gray 2012 pers. comm. 27 September).

The in-stream habitat consisted of some large woody debris and large levels of detritus mixed in amongst a thick bed of blanketing silt substrate. In-stream submerged and emergent macrophytes (including dense macroalgae) were moderately abundant along most of the creek and By-wash Dam. Riparian zone macrophytes were also abundant with some trailing vegetation also present. Erosion controls were in place in the form of modified bank structures. Erosion was observed in some areas where erosion controls were not in place.

4.2.1.1 LT Creek 1 – Directly above the By-wash Dam

This site was located directly upstream of the By-wash Dam (Plate 1) at the south-eastern edge of stored water. The riparian vegetation at this site was dominated by a canopy of *Angophora costata* with a shrub layer of *Melaleuca sp. Acacia sp., Dodonea sp.*, and other native shrubs. A sparse cover of native and exotic grasses was also present. The banks were steep and unnatural around the weir channel becoming gentler around the main stored water area. The eastern banks of the dam were generally less disturbed than the western banks, where mining activity and related vegetation disturbance was more evident

Macroinvertebrate sample #1 (LTC 1a) was collected around the eastern bank of the By-wash Dam, around 50 m upstream of the main high flow weir (Plate 2). The dam was close to 100m wide at this point and greater than 0.5m deep around the sampled edge. The water here was still and slightly turbid with an exclusively silt and detritus substrate

that produced large quantities of anoxic gas when disturbed. A dense cover of emergent aquatic macrophytes was present around the sample area (predominantly *Triglochin microtuberosum*, *Bacopa monnieri* and *Schoenoplectus validus*) and large areas of *Typha orientalis* were dominant elsewhere around the periphery of the dam.

Macroinvertebrate sample #2 (LTC 1b) was collected in the channel directly upstream of the main high flow weir (Plate 1). The channel was approximately 3 m wide and reached over 1 m deep in the middle of the channel, close to the weir. The water here was flowing slowly and was slightly turbid. The substratum was predominantly silt with a small amount of sand and gravel which produced moderate quantities of anoxic gas when disturbed. A concrete bank existed on the eastern edge and a submerged concrete structure was present perpendicular to the bank within the channel. Emergent macrophytes present included *Baumea articulata*, *Typha orientalis* and *Bacopa monnieri*, while the submerged macro-algae *Chara* sp. was relatively dense close to the weir.

4.2.1.2 LT Creek 2 – Proposed upper piped section

This site was located approximately 50m downstream of the By-wash Dam Weir, where access was amenable. The riparian vegetation at this site was dominated by a canopy of *Eucalyptus sp.* and a small number of *Syncarpia glomulifera*, with *Glochidion ferdinandi* and various *Melaleuca sp*. dominant closer to and within the creek. Shrubs in the riparian zone included *Dodonaea sp*. and smaller specimens of *Melaleuca sp*. and *Glochidion ferdinandi*. Various ferns, vines and grasses were present in the understorey. The eastern bank was of a gentle slope close to the access road and the western bank was relatively steep and unnaturally covered with riprap to prevent erosion.

Macroinvertebrate sample #1 (LTC 2a) was collected around a series of small, heavily silted pools upstream of the GPS location recorded (Plate 3). The creek here was approximately 6m wide and 0.25 - 0.5m deep. The substratum consisted entirely of silt and detritus and the channel was braided by loose sediment that produced anoxic gas when disturbed. The flow velocity was moderate and the water relatively clear, with few snags or woody debris present. A small riffle like section was present upstream (Plate 4), although this was too small and silty to warrant sampling. Herbaceous emergent macrophytes present included the noxious weed *Ageratina adenophora*, the native sedge *Schoenoplectus validus and Typha orientalis*. Submerged macrophytes present around the pools included *Potamogeton sp*. and the macro-algae *Nitella sp*.

Macroinvertebrate sample #2 (LTC 2b) was collected downstream of the GPS position in moderately sized, heavily silted pools, similar to those upstream. The creek became swampier and was up to 12m wide and around 0.3m deep. The substratum again consisted entirely of loose, anoxic, gaseous silt and detritus. The flow velocity was moderate in the main line of flow and low to still in the wider offline areas. *Melaleuca sp*. and *Glochidion ferdinandi* were dominant shrubs within the channel and *Triglochin sp.*, *Gahnia clarkei, Typha orientalis* and *Ageratina adenophora* were present in the understorey.

4.2.1.3 LT Creek 3 – Proposed lower piped section

This site was located directly upstream of the rail line and loading facility (Plate 5). The riparian vegetation at this site was similar to that of the site directly upstream with *Eucalyptus sp.*, *Glochidion ferdinandi* and *Melaleuca sp*. dominant. Some *Pittosporum undulatum* were also present in the canopy and a large bed of *Nephrolepis cordifolia* was present on the eastern bank. The banks were slightly steeper than further upstream and both sides were unnaturally covered with riprap to prevent erosion, some pieces of which had made their way into the channel. The in-stream habitat was also of a similar character to that described for the LT Creek 2 site.

Macroinvertebrate sample #1 (LTC 3a) was collected at the upstream end of the site below a concrete weir (Plate 6). The creek was reduced to around 1 - 2m wide at this point and close to 1m deep, including a very deep layer of loose, silty, anoxic sediment (approximately 0.5m). A reasonable amount of large woody debris was present in the creek at this point and the flow velocity was moderate. A dense bed of emergent *Schoenoplectus validus* and *Typha orientalis* was present above the weir with far fewer plants present below it.

Macroinvertebrate sample #2 (LTC 3b) was collected upstream of the culvert below the railway line (Plate 5). Here the creek was around 2m wide and the water around 0.5 m deep with loose, silty, anoxic sediment again around 0.5m deep. Some emergent macrophytes were present along the banks and included *Gahnia clarkei, Typha orientalis* and *Ageratina adenophora*. Some submerged *Potamogeton sp*. was observed in the channel close to the culvert.

4.2.1.4 LT Creek 4 – Downstream of the Newstan-Eraring Private Haul Road

This site was located downstream of the rail loading facility and private haul road. The riparian vegetation and in-stream habitat at this site were separated into two relatively distinct zones. The area within 30 m of the culvert and flow diffusion structure was swampy and dominated by a canopy of *Melaleuca sp.* and an understorey of *Gahnia clarkei*. Below this, the channel became deep and appeared to have been either artificially cut out or severely eroded and was dominated by *Typha orientalis*.

Macroinvertebrate sample #1 (LTC 4a) was collected closest to the culvert in the upper swampy zone described (Plate 7). The creek was approximately 15m wide and relatively shallow (approximately 0.4m), around half of this depth being loose silty anoxic sediment. A bed of *Typha orientalis* grew closest to the culvert. Downstream some large woody debris was present, mostly in the form of exposed *Melaleuca styphelioides* tree roots. The water velocity was slow and pooling in some areas due to the wideness and spreading nature of the waterway. *Gahnia clarkei*, *Lantana camara* and *Ageratina adenophora* were the dominant plants amongst the Melaleuca canopy.

Macroinvertebrate sample #2 (LTC 4b) was collected downstream of the swampy area described above, in a relatively deep channel below a series of small waterfalls (Plate 7) (around 10 cm drop) that transected the creek in an approximately north-south direction. The channel was relatively deep (> 1m in the centre) with very deep, loose, anoxic sediment taking up around half of this depth. The banks of the channel were heavily eroded and appeared to have been unnaturally cut in the past, or scoured out by high flows. The upstream end of the channel was a small pool (Plate 7), relatively devoid of vegetation, before dense bed of *Typha orientalis* and other emergent macrophytes (*Schoenoplectus validus*) and weeds (*Cortaderia selloana*) covered the channel entirely (Plate 8).

4.2.2 Threatened Species

A desktop study and site inspection (9-10 July 2012) were conducted to establish the existing environment with respect to riparian flora and fauna at the site. Ecological databases searched during the desktop study included:

- EPBC Database (with a 1km radial buffer around the proposed piping of LT Creek works);
- NSW FM Act list of threatened, endangered and protected fish species in NSW;
- NSW NPWS Wildlife Atlas (with a 5km x 5km buffer around the proposed piping of LT Creek works); and
- OEH Critical Habitat Register.

Note that these databases are indicative records of flora and fauna species recorded in the locality only and are not the result of a systematic flora and fauna survey.

4.2.2.1 Flora

A search of the Bionet NSW Wildlife Database and the EPBC Protected Matters Search tool identified a total of 30 types of flora species that could occur or have previously occurred within 5km of the works site that are protected under the TSC Act and/or the EPBC Act. No Endangered Ecological Communities (EECs) were identified as having potential to be located within 1km of the study area according to the EPBC Database. The protected, threatened and endangered flora species are listed in Table 4-1 and their locations illustrated in Figure 4-1.

Table 4-1: Threatened Flora Species within 5km of the Study Area

Scientific Name	Common Name	Classification	
		EPBC Act	TSC Act
Acianthus fornicatus	Pixie Caps	-	P
Acacia bynoeana	*Bynoe's Wattle*	V	E
Angophora inopina	Charmhaven Apple	V	V
Archontophoenix cunninghamiana	Bangalow Palm	-	P
Banksia spinulosa	Hairpin Banksia	-	P
Banksia spinulosa var. collina		-	P
Boronia polygalifolia	Dwarf Boronia	-	P
Caladenia catenata	White Caladenia	-	P

Scientific Name	Common Name	Classification	
		EPBC Act	TSC Act
Caladenia spp.		-	P
Callistemon linearifolius	Netted Bottle Brush	-	V
Calochilus paludosus	Red Beard Orchid	-	P
Cymbidium suave	Snake Orchid	-	P
Dicksonia antarctica	Soft Treefern	-	P
Doryanthes excelsa	Gymea Lily	-	P
Gahnia sieberiana	Red-fruit Saw-sedge	-	P
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V
Kunzea ambigua	Tick Bush	-	P
Livistona australis	Cabbage Palm	-	P
Macrozamia communis	Burrawang	-	P
Maundia triglochinoides		-	V
Melaleuca biconvexa	Biconvex Paperbark	V	V
Persoonia levis	Broad-leaved Geebung	-	P
Persoonia linearis	Narrow-leaved Geebung	-	P
Prasophyllum spp.		-	P
Pterostylis spp.	Greenhood	-	P
Syzygium paniculatum	Magenta Lilly Pilly	V	V
Tetratheca juncea	Black-eyed Susan	V	V
Xanthorrhoea latifolia		-	P
Xanthorrhoea latifolia subsp. latifolia		-	P
Xanthorrhoea spp.		-	P

P = Protected; V = Vulnerable; E = Endangered

4.2.2.2 Fauna

A search of the Bionet NSW Wildlife Database and the EPBC Protected Matters Search tool identified 16 types of protected, threatened and endangered fauna species and 3 types of migratory marine birds that could occur or have previously occurred within 5km of the works site that are protected under the TSC Act and/or the EPBC Act. These species are listed in Table 4-2 and their locations illustrated in Figure 4-1.

Table 4-2: Threatened Aquatic Fauna Species and Migratory Marine Birds within 5km of the Study Area

Scientific Name	Common Name	Classification		
		EPBC Act	TSC Act	FM Act
Epinephelus daemelii	Black Rockcod, Black Cod, Saddled Rockcod	V	-	V
Mixophyes balbus	Stuttering Frog	V	-	-
Mixophyes iteratus	Giant Barred Frog	E	E	-
Crinia signifera	Common Eastern Froglet	-	P	-
Limnodynastes peronii	Brown-striped Frog	-	P	-
Limnodynastes tasmaniensis	Spotted Grass Frog	-	P	-
Litoria aurea	Green and Golden Bell Frog	V	E	-
Litoria chloris	Red-eyed Tree Frog	-	P	-
Litoria fallax	Eastern Dwarf Tree Frog	-	P	-
Litoria latopalmata	Broad-palmed Frog	-	P	-
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	V	V	-
Litoria peronii	Peron's Tree Frog	-	P	-
Litoria tyleri	Tyler's Tree Frog	-	P	-
Litoria verreauxii	Verreaux's Frog	-	P	-
Pseudophryne coriacea	Red-backed Toadlet	-	P	-
Uperoleia fusca	Dusky Toadlet	-	P	-

Scientific Name	Common Name	Classification		
		EPBC Act	TSC Act	FM Act
Apus pacificus	Fork-tailed Swift	M	-	-
Ardea alba	Great Egret, White Egret	M	-	-
Ardea ibis	Cattle Egret	M	-	-

V = Vulnerable; E = Endangered; M = Migratory

4.2.2.3 Aquatic Species

Most of the protected flora and some of the protected fauna are terrestrial organisms and are therefore not associated with the aquatic environment that is under investigation in this assessment. An assessment of the likelihood of each of these organisms occurring in close proximity to LT Creek is provided in Appendix 9 based on habitat present and environmental requirements of the organisms.

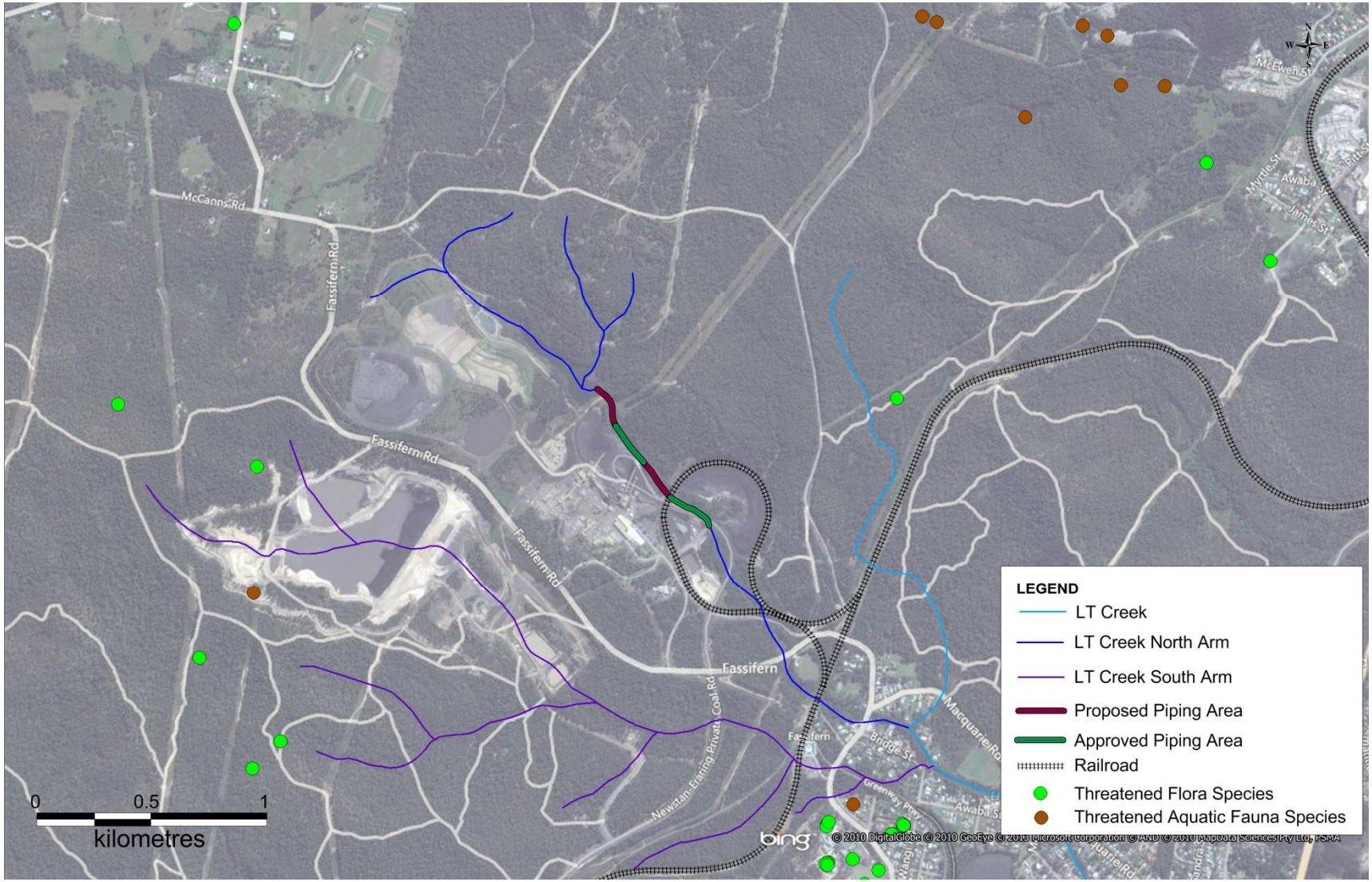


Figure 4-1: Threatened species (listed under the TSC Act) recorded around the LT Creek study area (5km x 5km search area) since 2000.

4.3 Water Management and Monitoring

Water in the LT Creek North Arm is dominated by the discharge from mining operations during dry weather conditions and by rainfall runoff during certain rainfall events. As previously noted, Newstan Colliery's EPL 395 permits the discharge of water from the Newstan Colliery Surface Site via two Licenced Discharge Points , which are identified in Figure 1-1. The figure in Appendix 4, taken from the Northern Coal Logistics Water Balance (GHD 2013), illustrates water movement around the Newstan Colliery Surface Site.

GHD (2011) have described water quality data collected from:

- WMP01 (LT Creek North Arm upstream of LDP001);
- WMP09 (LT Creek South Arm in the upper catchment);
- LDP001 (at the LDP001 discharge point); and
- WMP03 (within the By-wash Dam).

Robust background water quality data was only available from the sampling site WMP09 on the South Arm of LT Creek. Background data for WMP01 was incomplete the due to the ephemeral nature of creek upstream of the By-wash Dam and high salinity measurements between January 2002 and March 2013 that were not deemed suitable background information and were therefore excluded. Data collected from WMP03 (Appendix 2), being the most spatially representative site sampled, were used to describe water quality of LT Creek North Arm within the current area of investigation. The location of sampling points WMP01, WMP09, LDP001 and WMP03 are illustrated in Figure 4-2.

4.3.1 Licenced Discharge Points

The current conditions of the licence contain both concentration and volume limits as specified in the Environmental Protection Licence (Appendix 11).

4.3.1.1 LDP001

LDP001 at the Newstan Colliery Surface Site is located in the upper storage of the By-wash Dam and is licenced to discharge up to 11 ML per day under normal weather conditions. If water quality indicates additional settling time is required to reduce suspended solids, water can be pumped through LDP001 to discharge into Graunches Dam, which has a temporary storage capacity of approximately 9 ML (Cells 1 and 2) before controlled overflow into the By-wash Dams. An increase of 3.5 ML per day to 14.5 ML per day is currently being sort for this discharge point as part of this Project.

4.3.1.2 LDP002

LDP002 is located downstream of the Newstan Colliery Surface Site at the Final Pollution Control Dam (FPCD). A recent upgrade of the FPCD increased the storage capacity from 18 ML to around 50 ML. LDP002 is only permitted to discharge into LT Creek if the storage capacity of the FPCD is exceeded during rainfall events.

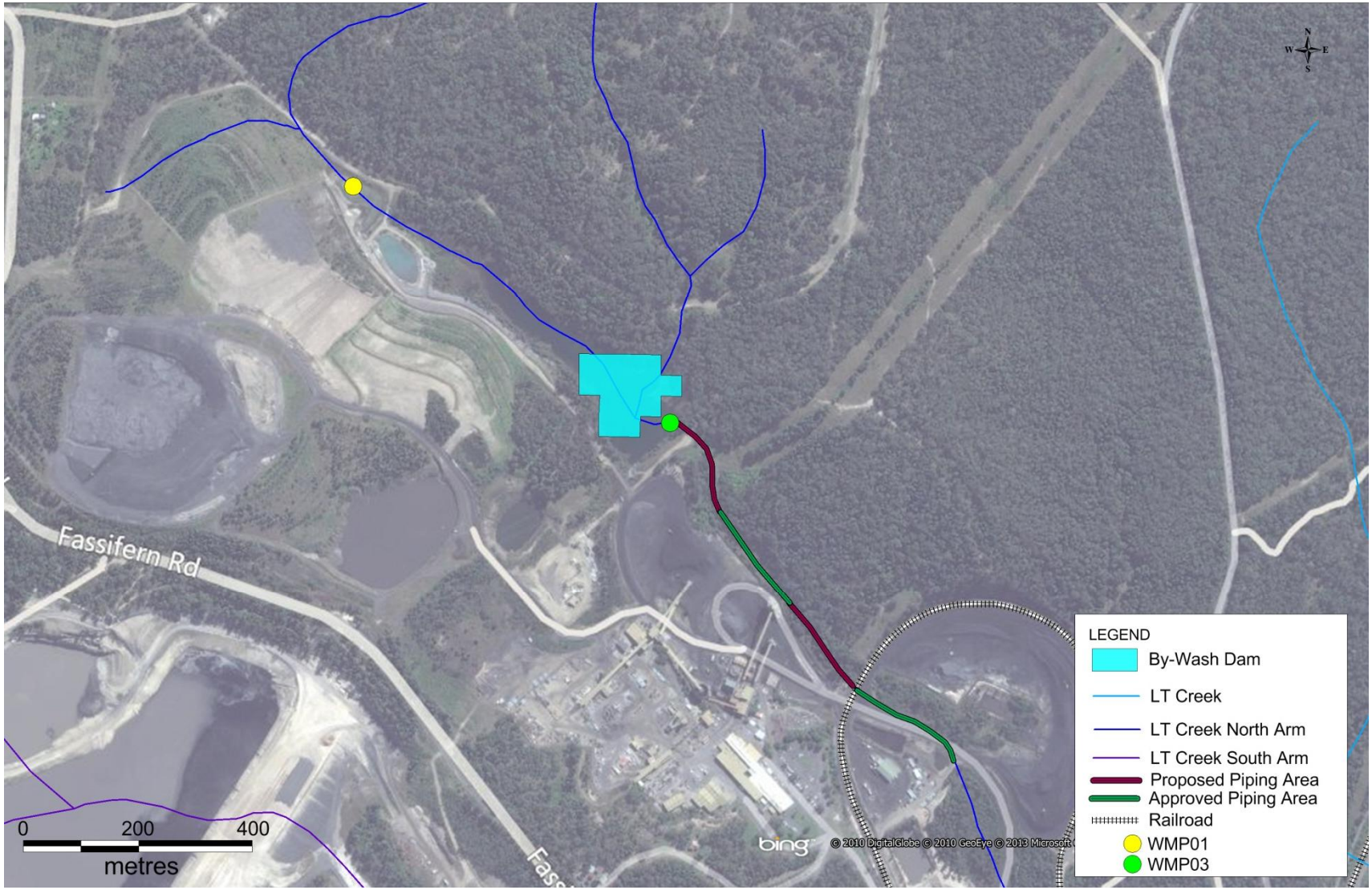


Figure 4-2: GHD (2009) Water Sampling Locations WMP01 and WMP03.

4.3.2 Overview of Water Quality Within LT Creek

GHD (2011) derived site specific trigger values for LT Creek based on background water quality data. Sites selected as appropriate background sites for LT Creek were:

- WMP01 (LT Creek North Arm); and
- WMP09 (LT Creek South Arm).

The 50th percentile concentrations reported at the WMP3 site were compared with the adopted trigger values (either the site specific trigger value or the default ANZECC and ARMCANZ (2000) value) in Appendix 3.

The elevated electrical conductivity is indicative of a high concentration of dissolved ionic constituents, which can be seen from the analysis of water samples from the WMP03 site undertaken for the ecotoxicology investigation conducted by GHD (2011). From the sample taken from WMP03 in May 2011, high bicarbonate (590 mg/L), chloride (437 mg/L), sulphate (128 mg/L) and sodium (599 mg/L) ions were detected (GHD 2011).

Arsenic (0.028 mg/L) and selenium (0.11 mg/L) concentrations were detected above the site specific trigger values for the sample collected in the GHD (2011) investigation, although arsenic concentrations were very low (maximum of 0.003) in the historical dataset summarised by GHD (2009). The ecotoxicology assessment conducted by GHD (2011) for the untreated mine water discharge indicated toxicity effects for some of the organisms tested, with the cladocera and larval fish taxa being most affected.

A subsequent ecotoxicology assessment was conducted using 'treated' mine water discharge and resulted in considerably reduced toxicity (GHD 2012b). The water used for this subsequent ecotoxicology assessment is understood to have been treated using the chemical coagulation/flocculation, settlement and filtration method outlined in Hunter Water (2011). Water quality test results from the water treatment trial were not available from the Hunter Water (2011) report, although the treatment method is likely to have resulted in the removal of total solids and other suspended contaminants. Conditions of the EPL (Appendix 11) also require Northern Coal Services to undertake a detailed sampling regime of the treated mine water following the commissioning of the water treatment plant.

Total contaminant load downstream of the discharge in relation to the aquatic ecosystem have been considered in the surface water assessment report currently being prepared by GHD (L. Hammersly, 2013, *letter comm.* 10 April), in addition to the specific contaminant concentration. If total water volume increases, total mass of contaminants is increased proportionally given unchanged concentration. This increased mass of contaminants, particularly for total and dissolved solids, increases the potential impact on the receiving environment and ecosystem, in terms of potential sedimentation and overall contribution to the stream and estuary. This would be most evident during high flow events such as significant rainfall and is also relevant in relation to increased licenced discharges.

4.4 Sediment

High concentrations of suspended solids have been recorded in LT Creek, particularly after heavy rainfall, and this has been attributed to elevated erosion in the upper catchment, contaminants from mine water discharge and poor historical sediment control within the Newstan Colliery (Umwelt 2009). Significant settling and accumulation of this suspended material has been recorded along the freshwater section of LT Creek, within the estuarine channel and within Fennell Bay. Sediment is evidently mobilised after heavy rainfall, when high volumes of catchment runoff increase vertical mixing and longitudinal velocities within the settlement basins and along the creek. A large increase in the total load of contaminants would be expected during these high flow events.

One of the dominant mechanisms influencing sediment accumulation and transport is settlement within storages and along the creek line, and re-suspension and transport of this material under high flow conditions. Chemical precipitation is also likely to be a significant mechanism in the accumulation of sediment along the creek. This is due to the high ionic concentrations in the mine discharge and moderate historical fluctuations in pH (GHD 2009).

Water management, especially the management of suspended sediment, has therefore been a major issue for the Newstan Colliery and has subsequently been addressed in ongoing optimisation of water management as outlined in the Newstan Colliery Water Management Plan (WMP) (Centennial Coal, 2009). The WMP outlines measures taken to

optimise clean water runoff and to minimise dirty water discharge through the optimised recirculation and treatment mechanisms. Current and proposed water treatment mechanisms are outlined in Section 4.5.

GHD (2012a) reported that all metal concentrations in LT Creek surface and deep sediment samples were below ANZECC/ARMCANZ (2000) low interim sediment quality guidelines (ISQG), with the exception of lead. Copper concentrations were somewhat elevated in the deep sediments being approximately four times higher than the surface sediments, although did not exceed the ISQG in LT Creek North Arm. Due to the high total organic carbon (TOC) and small sediment particle size, lead present in sediments may be bound tightly to the sediment and would be unlikely to be bioavailable. Relatively neutral water pH in historical measurements would not promote the mobilisation and bioavailability of lead. The surface sediment samples showed a decrease in metal concentration with distance from the mine discharge point, with metals decreasing by an average of 90% at a WMP03 sampling site and many metals below detection limit at this site GHD (2012a).

4.5 Water Treatment

The majority of water treatment is currently undertaken through passive methods, mainly through settlement in sedimentation basins. Appendix 4 illustrates the flow pathways through storage and settlement basins before discharge. Improvements to Graunches Dam (receiving water from LDP001) will improve passive treatment from LDP001, while a recent upgrade to the storage (18 ML to 50 ML) of the Final Pollution Dam will increase the capacity of this basin to retain and treat runoff.

Active treatment processes are also employed in the treatment of water within the site. Treatment of water with a high risk of hydrocarbon contamination is separated and treated using an oil/water separator, with the retained oil removed from the site. Additionally, a Sewage Treatment Plan (STP) is operated on the site, which discharges treated water into a sewage maturation pond for further passive treatment.

Northern Coal Services are in the process of upgrading water treatment, specifically installing a new Water Treatment Plant (WTP) at the Newstan Colliery Surface Site to improve the quality of water being discharged into LT Creek via LDP001. All water discharged from LDP001 would be treated at the new WTP (J. Wearne 2013 pers. comm., 1 May). The new WTP will utilise the chemical coagulation/flocculation, settlement and filtration method outlined by Hunter Water (2011). This treatment process is likely to significantly improve the removal of total solids, including suspended contaminants bound to particulates. Commissioning this WTP is expected to significantly improve treatment of the discharge water (Hunter Water 2011) and may benefit the aquatic ecosystem through reduced toxicity of aquatic organisms (GHD 2012b) if specific contaminant concentrations are reduced.

5 Field Survey Results and Discussion

Results of the field survey completed on 9 and 10 July 2012 are outlined below. Conditions at the time of the sampling were fine to overcast. Light rainfall was recorded at the Bureau of Meteorology's (BoM) Lake Macquarie Automated Weather Station (AWS) at Cooranbong in the week prior to the survey (2, 11 and 3 mm on 5, 6 and 7 July 2012 respectively) and heavy rainfall was recorded around a month prior (17, 55 and 13 mm on 11, 12 and 13 June 2012 respectively). A plot of the rainfall in the period preceding sampling is provided in Appendix 5. Ambient daily minimum and maximum temperature measurements in the month prior to sampling ranged from -0.4 °C on 25 June to 21.2 °C on 15 June.

5.1 Aquatic Habitat

Detailed descriptions of the aquatic habitat during the field investigation have been provided in Section 4.2 along with specific information on each of the macroinvertebrate sapling locations. Habitat assessment based on the Riparian, Channel and Environmental Inventory (RCE) scores for each of the aquatic ecology sampling sites on LT Creek are provided in Table 5-1. These values provide a numeric interpretation of the written descriptions.

Table 5-1 - Habitat Description Scores using the Modified RCE Inventory Method

Designation		LT Creek 1	LT Creek 2	LT Creek 3	LT Creek 4
1	Land use pattern beyond the immediate riparian zone	3	3	3	3
2	Width of riparian strip of woody vegetation	4	3	3	4
3	Completeness of riparian strip of woody vegetation	2	2	2	3
4	Vegetation of riparian zone within 10m of channel	4	3	3	3
5	Stream bank structure	3	3	3	3
6	Bank undercutting	4	3	3	2
7	Channel form	1	3	3	3
8	Riffle/pool sequence	1	1	1	1
9	Retention devices in stream	1	2	2	2
10	Channel sediment accumulations	1	1	1	1
11	Stream bottom	1	1	1	1
12	Stream detritus	2	2	2	2
13	Aquatic vegetation	1	1	1	1
Total		28	28	28	29

The RCE index used provides a simplified description of the aquatic habitat and does not fully represent complex nature of the aquatic habitat, for example the change in habitat structure in response to elevated flow. The score also has equal weightings for each of the indices and therefore, certain elements and differences in the habitat of each site may to be masked. The scores should therefore be used as a generalised assessment only.

All sites along LT Creek scored similarly for the total RCE index, this being in the poor to average habitat quality range. Site 1 on LT Creek was within the impoundment of the By-wash Dam and as such, scored differently in several indices to the sites further downstream, although the total score remained comparable.

5.2 Water Quality

A summary of the in-situ physicochemical water quality measurements collected at the time of the survey are provided in Appendix 6.

The in-situ physico-chemical measurements collected during the survey (Appendix 6) concur with the historical data for LT Creek in GHD (2009) (Appendix 2 and 3), this being moderately degraded. The main observations from the data collected are that electrical conductivities are in the brackish range (average between 1994 – 2254 µS/cm at LT Creek Site 3 and Site 1 respectively), high alkalinity measurements (all greater than 500 ppm) and alkaline pH, becoming increasingly so moving downstream (averages of 7.9, 8.1, 8.1 and 8.3 units at LT Creek Site 1, 2, 3, and 4 respectively).

5.3 Aquatic Macroinvertebrates

5.3.1 LT Creek

A total of 35 distinct macroinvertebrate taxa were recorded from the eight samples collected in LT Creek (Appendix 7). The minimum number of taxa represented in an individual sample was seven in the LTC 2a and the maximum was 24 in the LTC 1b sample. SIGNAL2 indexes ranged from 3.4 in the LTC 1a and LTC 1b samples (15 and 23 SIGNAL2 taxa represented respectively) to 4.6 at the LTC 4a sample (12 SIGNAL2 taxa represented). Note that the number of SIGNAL2 taxa can be less than the total number of taxa, as some groups of organisms do not have SIGNAL2 scores assigned.

Four families belonging to the generally more pollution sensitive orders (EPT) of Ephemeroptera (Mayflies), Plecoptera (Stoneflies) and Trichoptera (Caddis flies) were observed across all sites in LT Creek. These were (SIGNAL2 scores in brackets) the Ephemeroptera Caenidae (4), Trichoptera Hydroptilidae (4), Ecnomidae (4), and Leptoceridae (6). These taxa are all relatively common EPT families and are less sensitive than others within the group. No Plecoptera were observed, with these organisms more common in relatively undisturbed, oxygenated riffle zones. Other families observed in LT Creek with relatively high SIGNAL2 scores were the freshwater mites, Hydracarina (6), the Alderfly family, Corydalidae (7) and the Beetle family, Scirtidae (6).

5.3.2 SIGNAL2 interpretation

A graphical representation of the SIGNAL2 outputs using a biplot with boundaries set at 4.5 for the SIGNAL2 index and 20 for the number of SIGNAL2 taxa represented is provided in Figure 5-1. Most of the sites fell into quadrant 4, indicating water pollution issues or the downstream effects of dams. The sample from LTC 4a is close to, or within quadrant 3 (indicative of harsh pollution or physical conditions) and the sample from LTC 1b was within quadrant 2 (indicating elevated salinity or nutrient levels). As would be expected, no samples fell within quadrant 1 (favourable habitat and chemically dilute water), although sample LTC 4b was closest to this zone in the figure.

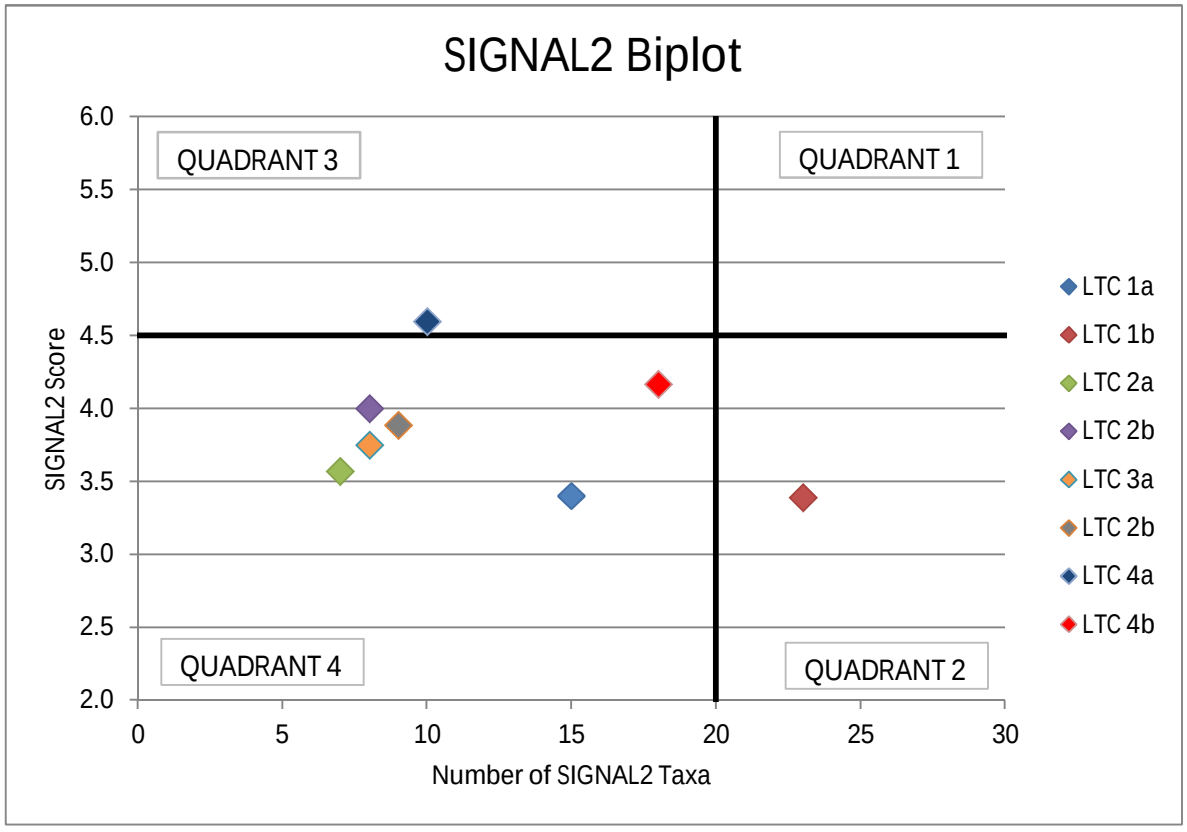


Figure 5-1: SIGNAL2 bi-plot for samples collected from LT Creek and the unnamed Creek

SIGNAL2 values for each taxa were derived from ecotoxicology investigations, and are therefore relevant to water quality sensitivity. Considering that water quality at the time of sampling was similar across the LT Creek sites, other factors, such as habitat characteristics and hydrological effects are likely to be largely influential in the results obtained.

The macroinvertebrate results from LT Creek samples are indicative of a degraded ecosystem, with many pollution tolerant taxa identified. Overall, the macroinvertebrate samples collected from the LT Creek site 1 (above the By-wash Dam) produced better results in terms of taxa diversity than those downstream. This may have been due to more stable conditions at this location above the dam, with those further downstream being more likely to experience high velocity flows and associated water quality disruption following rainfall, as was the case around a month prior to sampling. Different habitat conditions at this site, such as a greater abundance of macrophytes, may also have contributed to increased taxa diversity.

5.4 Aquatic Macrophytes

A list of the macrophyte species recorded along LT Creek during the field investigation is provided in Appendix 8.

Thirty two macrophyte species were recorded across the four LT Creek sites of which the majority were considered emergent (11) and submerged (2) herbaceous fully aquatic macrophytes, macro-algae (2) and hydrophilic trees/shrubs (4). The remaining plants were grasses (6), herbs (2), ferns (3) and vines (2) that were considered more terrestrial, water loving species. The dominant canopy species were *Melaleuca decora* and *Glochidion ferdinandi*, with *Schoenoplectus validus*, *Gahnia clarkei*, and *Ageratina adenophora* being dominant in the understorey. *Potomogeton* spp., *Triglochin* spp. and *Bacopa monnieri* were the most common in-stream macrophytes observed.

Three of the plants recorded are listed as noxious weeds under the NSW Noxious Weeds Act (1993); Crofton's Weed (*Ageratina adenophora*), Pampas Grass (*Cortaderia selloana*) and Lantana (*Lantana camara*). Four plants were not able to be fully identified due being in an early stage of development or due to lack of floristic structures. No plants listed as threatened or endangered were found at the LT Creek sites during the survey. Those that were not fully identified were confirmed as not resembling threatened species within the taxonomic group to which they were identified.

5.5 Fish

Three species of fish were found within LT Creek (Table 5-2); Firetail Gudgeon (*Hypseleotris galii*), Striped Gudgeon (*Gobiomorphus australis*) and Common Jollytail (*Galaxias maculatus*). All three were found in three traps only at site 4, below the proposed piped area. The three out of four bait traps that captured fish at this site were located within the deeper downstream channel area described in the habitat description for LTC 4b above. This area was the deepest area of the site and was below the major existing piped area below the rail loading facility. No fish were captured elsewhere in the upper sections of the creek or in the By-wash Dam.

Table 5-2 - Number of fish and mobile invertebrate species captured in bait traps deployed at each location

Common Name	Scientific Name	LTC 1	LTC 2	LTC 3	LTC 4
Firetail Gudgeon	Hypseleotris galii	0	0	0	3
Striped Gudgeon	Gobiomorphus australis	0	0	0	4
Common Jollytail	Galaxias maculatus	0	0	0	9

*Denotes a noxious species under the NSW Fisheries Management Act 1994

Fish were only found downstream of the railway loading and Newstan-Eraring private haul road already approved to be piped. This indicates that there are already significant barriers in place for fish movement, including the culverts themselves and the flow diffusion area below the railway and haul road. It is therefore possible that the proposed piping of the creek upstream of this will have little additional impact to fish movement compared to what already exists. A significant blockage to fish passage is the large By-wash Dam weir further upstream.

The current investigation is limited in temporal scope and triggers such as rainfall may stimulate fish movement upstream of the existing structures, if navigable. Different species of fish are triggered to migrate by a variety of environmental cues, such as decreased electrical conductivity following rainfall. As the discharge water has a high conductivity, impediments to fish migration cues may already be in place, as well as the more obvious physical barriers.

The fact that no fish were caught upstream during this investigation does not mean that none are present. Some species of fish and certainly larger fish in general, are unlikely to have been captured with the methods used. Freshwater eels and carp are examples of common fish that could potentially be present in the dam that would not have been captured using the baited traps. Additionally, fish migration events may be triggered by environmental cues that were not present around the time of sampling and may result in fish attempting migration further up the creek at some time in the future.

6 Assessment of Impacts

The assessment of impacts has been considered in two phases; construction and operation. For the assessment of operational impacts, the final development is assumed to have been constructed as outlined in the plan provided in Appendix 10. These plans indicate that the existing creek line and riparian zone between the By-wash Dam and the rail loading facility would be covered by the expansion of stockpiles and related conveyance systems. The creek would be piped parallel to its existing route, with approval having already been granted for piping of around a third of its length around the middle of the section between the By-wash Dam and railway loop and another section within the railway loop. No specific plans have been developed for the construction activities at this stage and this assessment has therefore assumed that construction will be completed with appropriate environmental management considerations.

The increase in discharge from LDP001 has not been assessed in this report although all water discharged here would be treated at the new water treatment plant as previously described.

6.1 Construction Phase

6.1.1 Aquatic Habitat Loss

During construction, all functional in-stream and riparian habitat within the proposed development site boundary would be removed. Concrete channels and smooth pipelines do not provide habitat for aquatic flora and fauna and enclosed pipelines prevent light reaching the water. The piped section would therefore serve only to conduct water downstream. The impact on the aquatic flora and fauna in this section of the creek would be significant in that would alter key aspects of the aquatic habitat.

The length of flowing freshwater habitat between the By-wash Dam weir and the point where tidal influence begins (the main northern railway line near Fassifern) is around 1500 m. This reach represents the bulk of relatively undisturbed freshwater riverine habitat along the north arm of LT Creek (different habitat characteristics are present above the By-wash Dam). Assuming an average stream width of 5 m and an additional 1 m on either bank of lower riparian vegetation, the area of aquatic habitat along this reach would be 10500 m^2. Existing culverts under roads and railways account for approximately 195 m of this reach (length reduced to 1305 m), bringing the current estimated aquatic habitat area to around 9135 m^2. This estimate does not consider the two sections of LT Creek already approved for piping.

Approval has already been granted for piping of approximately 150 m of the creek between the By-wash Dam and the rail loading facility, and another 175 m of the creek within the rail loading loop (325 m in total and approximately 25% of the aquatic habitat in this reach) (Appendix 10). The proposed pipeline, would add a further 300 m of pipeline to that already approved. The proposed pipeline would also link already approved sections creating a 625 m continuous section of piping along the creek. Using the assumption of a 7 m aquatic habitat width, the total aquatic habitat lost to construct the already approved pipeline is 2275 m^2. A further 2100 m^2 of aquatic habitat would then be lost to construct the new pipeline. This equates to approximately 48% (4375 m^2) of remaining aquatic habitat (9135 m^2) being lost in the construction of all pipeline sections. This represents a significant loss of aquatic habitat within the LT Creek catchment and subsequently a significant impact on resident aquatic flora and fauna in the construction zone.

Riparian zone macrophytes are important habitat for terrestrial and littoral organisms as well as being an integral part of the in-stream habitat, providing habitat structure in the form of woody debris, as well as providing food and shelter in various forms of organic matter. The estimation of riparian habitat loss above is a broad brush approach that accounts for macrophytes in the lower riparian zone only and does not account for land clearing away from the creek. Although potential impacts on terrestrial ecology are covered in a separate report, both aquatic and terrestrial ecosystems are intrinsically linked through a plethora of physicochemical and biological interactions and therefore should not be considered in isolation.

Runoff following rain may result in erosion in areas of earthworks, unprotected spoil or cleared land during construction and this could increase sediment transported into LT Creek and the estuary. Although already a historical issue in the degradation of the aquatic habitat, increased sediment loads resulting from uncontrolled sediment would exacerbate this problem in the receiving environment. This increase in sediment would result in loss of habitat through a reduction in depth of available pools, which serve as refuge areas for aquatic biota, and the smothering of habitat features such as aquatic macrophyte beds, woody debris, riffles and spawning grounds in the estuary.

6.1.2 Water Quality and Flow

During construction, the hydrology within the pipeline area would be changed from the natural turbulent flow pathway to a more laminar flow through the pipeline. Not considering the increase in flow volume from LDP001, this change in hydrology would increase longitudinal water velocity and reduce residence time. Increased water velocity may result in scouring of the bed and increased bank erosion at the outlet of the pipeline if not adequately managed. The lack of substrata and structures available for periphytic growth within the pipeline (such as woody debris and macrophytes) may decrease water treatment enacted by filtration, sorption and ion exchange processes. Decreased residence time within the piped area may also result in reduction in passive settlement through this reach.

As indicated above, ineffective sediment management during construction could result in material entering the creek and smothering habitat. In this scenario, water quality impacts would also be observed in the form of increased suspended solids and turbidity. This would result in a decline in light penetration and a subsequent reduction in primary productivity. This may affect submerged macrophytes, photosynthetic algae and other organisms for which these plant and algae groups provide food or habitat. Increased turbidity and subsequent reduced primary productivity may also impact oxygenation of water provided by photosynthesis in submerged macrophytes and algae. This could also have carry on effects on sediment redox reactions and microbial metabolic processes. Oxygenation of water would also be reduced due to the removal of turbulent flow and light induced photosynthesis in the piped waterway, having similar potential impacts on fauna to those described above and more obvious potential impacts on oxygen respiring organisms.

If released into the water column during construction, nutrient enrichment would increase the risk of algae blooms, while other contaminants may induce toxicity effects on aquatic fauna. Contaminants related to construction activities (oil or chemicals spillage for machinery or construction processes) may be washed into the creek unless adequate control measures are implemented. Depending on the product and quantity involved, this could be toxic to aquatic fauna if allowed to enter the creek. Risk management and appropriate housekeeping would be required to mitigate potential harm.

Additionally, mobilisation of sediments may lead to an increase in nutrients and other contaminants associated with solids. Sediment mobilisation during the construction phase is most likely to occur during periods of rainfall. The likelihood and scale of impacts associated with an increased sediment load would depend on the amount of sediment mobilised into the water and over what period it occurs. Given the conditions at the worksite (i.e. steeply sloping banks, proximity of earthworks to the waterway, potential for high rainfall), a detailed sediment and erosion control plan would be required to ensure that risks of increased sedimentation are adequately addressed.

6.1.3 Aquatic Ecology

In-stream and riparian fauna species will not inhabit an area without adequate aquatic habitat and amenable environmental conditions. As outlined above, suitable habitat conditions will be removed within the construction zone for most aquatic fauna. Upstream of the construction zone, impacts are expected to be negligible assuming that water is not held back within the By-wash Dam. If this was to occur, it may result in riparian vegetation dieback and drowning of terrestrial fauna.

Downstream of the construction zone, impacts on aquatic fauna may include habitat change, potential water quality degradation and changes to the creek hydrology. Excess water and high velocities may result in unfavourable conditions, whereas a lack of water would desiccate habitat. Interrupting water flow, if required during construction, would result in impacts due to the drying of habitat and potential stranding of organisms. Potential water quality degradation as a result of the construction activities has been outlined above and this evidently has the potential to impact on aquatic fauna through toxicity. Any potential toxicity would be dependent on the type of contaminant and its concentration.

Numerous species of threatened and endangered frogs are known to occur in the vicinity of the Newstan Colliery and populations of these organisms may be impacted by construction activities. A targeted frog survey was completed by RPS Australia on the 3rd and 4th of October 2012 using call identification and spotlighting to determine frog species were residing along LT Creek (A. Smith 2012 *email comm.*,5 October). This investigation detected four frogs, these being the Common Eastern Froglet (*Crinia signifera*), Eastern Dwarf Tree Frog (*Litoria fallax*), Broad Palmed Frog (*Litoria latopalmata*) and Peron's Tree Frog (*Litoria peroni*). None of these species are listed under state or federal threatened species legislation. Habitat and water quality constraints along LT Creek are likely to be the cause of limited frog

observations. Some endangered frogs listed as occurring in the vicinity are unlikely to be present along LT Creek for this reason (e.g. Red-crowned Toadlet) (A. White 2012 *pers. comm.* 2 August).

When flow through the creek is redirected through the pipeline, any larger mobile organisms (fish, turtles, frogs) that are present along the creek may naturally move downstream to the outlet area where water is more plentiful. Smaller organisms such as macroinvertebrates are likely to become stranded when flow ceases and may perish. Some adult insects with the ability to fly (e.g. beetles) are likely to migrate elsewhere if the creek dries sufficiently.

6.2 Operation Phase

6.2.1 Aquatic Habitat

No additional impacts on aquatic habitat within the piped section of the creek are expected during the operation phase. Impacts downstream of the pipeline outlet are expected to be minimal compared to construction impacts. Unless appropriate controls/mitigation measures are installed, some increase in erosion and bed scouring downstream of the pipeline outlet may accompany the increase in flow velocity and this may reduce and degrade aquatic habitat downstream of the pipeline. GHD have identified this issue in their surface water impact assessment report and support the construction of stabilisation structures downstream of the discharge point around the Fassifern Archery Club (L. Hammersly, 2013, *letter comm.* 10 April). The pipeline discharge area is relatively well vegetated and this likely to decrease the likelihood of major erosion and scouring. Longer term benefits to the aquatic habitat may be observed with improved treatment of water discharging into LT Creek via LDP001 and reduced volume of coal particles entering the creek from the stockpile areas, although the extent of this benefit is unknown.

6.2.2 Water Quality and Flow

The potential impact of large flood events may be exacerbated by the proposed pipeline if not adequately assessed and managed. This is outside the scope of work for this report, although potential impacts on the aquatic habitat and surrounding environment may be serious if the pipeline flow increased flooding risk. In the event of flood waters washing through stockpile areas due to flow constriction within the pipeline, adverse impacts on the aquatic ecosystem would occur. In relation to the large flood event of 2007, which was modelled by BMT WBM (2011), a rough approximation of the average flow in the 24 hour peak flow period was 10m^3/sec (864 ML/day), with a maximum peak instantaneous flow of 28 m^3/sec. These are very large potential flows compared with the base flow volumes normally being discharged from LDP001 and indicate the potentially serious implications of flood events on the creek, particularly if water flow is restricted through pipelines. Although there is a risk of negative impacts, Northern Coal Services will design the proposed pipeline to accommodate a 1:100 year rainfall event to ensure this risk is mitigated, as outlined previously.

Large volumes of sediment currently exist in the By-wash Dam and have the potential to be mobilised after heavy rainfall along with material mobilised through erosion within the upper catchment. Any sediment washing over the By-wash Dam during high flow events is likely to be transported effectively through the pipeline, but may become concentrated around the outlet point, pools or estuary downstream, where water velocity is reduced and settling rate increased. Potential sediment mobilisation is likely to be an infrequent occurrence, but may increase through time if sediment influx from the catchment increases and siltation of the By-wash dam increases.

Improvements in water quality are expected to result from operation of the new WTP and maintenance of Graunches Dam around the LDP001. Additionally, the increase in the Final Pollution Control Dam at the LDP002 will improve water quality through increased retention. Water quality within LT Creek will vary over time dependant on factors including flow rate, storage and treatment processes in operation. Although not examined in detail in this report, it is expected that the aquatic ecosystem downstream of the pipeline would benefit from improvements in water quality resulting from improvements to water management and treatment on site.

6.2.3 Aquatic Ecology

Impacts on the aquatic ecosystem following construction are expected to be minor compared with those produced during the construction phase. Macroinvertebrate, water quality and habitat data collected within and downstream of the area of the proposed piping indicated that the aquatic ecosystem is relatively degraded and under stress. Changes to the composition of macroinvertebrate, macrophyte and other groups of aquatic organisms may be observed through water quality changes, habitat changes and/or flow alteration as a result of the pipeline. If realised, improved water quality at

the licenced discharge points is likely to provide an overall benefit to aquatic organisms downstream of the pipeline discharge.

Restricted fish passage following construction of the pipeline has been raised as a potential impact. Barriers to fish movement can be physical (e.g. dams and weirs) or indirect (e.g. interruption of continuous habitat, water quality and light) or a combination of these, the latter often being harder to detect (Koehn 1999). Fish migration for spawning can be triggered by various environmental cues such as season and reduced conductivity after rainfall (Mallen-Cooper 1999). These cues vary between species and are often poorly understood. In reference to vertical slot fishways, Mallen-Cooper (1996) noted that some species only migrated upstream during daylight and if their ascent of the fishway was not completed in daylight, fish moved back down the fishway. This observation may be relevant to the construction of extended pipelines with little light penetration.

Physical barriers to fish migration already exist within LT Creek and include the flow dissipation structure below the rail facility and the By-wash Dam Weir. Indirect barriers also exist, including culverts below the railway line and roads downstream of the proposed piped area. Additionally any fish movement triggered by conductivity changes may already be disrupted due to the consistently brackish water quality of the mine water discharge.

Fish catch data collected during this investigation did not indicate that fish had moved upstream beyond the rail loading facility. It is expected that, although fish passage may be further restricted due to the piping of the creek, this is unlikely to have any further impact than the barriers already in place within the creek. The By-wash-Dam appears to be the most physically restrictive barrier in place for fish movement and is unlikely to allow in-stream fish passage past this point for most species (eels may have bypassed this barrier overland and other species may have been historically released or stocked in the dam).

6.3 Summary of Potential Impacts

The condition of the existing aquatic ecosystem within and downstream of the proposed development area was identified as moderately degraded based on the interpretation of flora, fauna, water quality and habitat data collected in this and previous investigations. Key findings included:

- Aquatic habitat alteration through the presence of deep sediment deposits, unnaturally high flow and unnatural bank and channel form;
- The presence of numerous exotic and invasive macrophytes, some of which are listed as noxious species;
- A macroinvertebrate community assemblage with fewer taxa represented than would be expected in an otherwise undisturbed system;
- A lack of any fish found in the upper catchment and the presence of numerous barriers to fish passage.

The works and activities proposed under this project would take place within an aquatic ecosystem that can be summarised as moderately degraded and under stress, largely, but not entirely due to current and historical land use and water management. Despite the already degraded condition, LT Creek provides valuable aquatic habitat for resident organisms and is part of an interconnected ecosystem stretching from ephemeral creeks in the upper catchment through to the Lake Macquarie estuary.

Further degradation of this ecosystem can be minimised by implementing effective controls to minimise impacts on water quality, hydrology and the aquatic habitat. Key potential impacts identified for the proposed development include:

- Removal of approximately 2100 m^2 of aquatic habitat in addition to the 2275 m^2 of habitat already approved for removal during the construction phase;
- Removal of terrestrial habitat adjacent to the creek line to clear land for stockpiles;
- Potential increased sediment and other contaminants entering the creek during construction activities and subsequent transport of this material downstream to the estuary resulting in habitat simplification and aesthetic issues. However, this risk will be significantly reduced during operational activities;
- Potential erosion and bank scouring downstream of the pipeline outlet due to increased water velocity;
- Increased sediment accumulation at the outlet point of the proposed pipeline;
- Drying of aquatic habitat and stranding of organisms in the event of water retention and diversion through the pipeline during construction;
- Further restriction of fish passage through the already highly modified and restricted creek line.

Potential benefits arising from the development may include:

- Decrease in the volume of coal particles being washed into the creek from the stockpile area;
- Improvements to the aquatic ecology through a targeted weed management programme of the sections of LT Creek immediately upstream and downstream of the proposed piped sections; and
- Potential improvements in water quality provided by an active WTP and other improved water management actions.

7 Recommendations

7.1 Aquatic Habitat

While mitigation of impacts caused by the loss in aquatic habitat along the length of the pipeline will be difficult to achieve, improvement of aquatic habitat elsewhere in the catchment will be implemented by Northern Coal Services through bush regeneration and weed control. Northern Coal Services will commit to improving aquatic habitat by undertaking bush regeneration works and weed control upstream and immediately downstream of the construction zone. Beneficial actions may include weed removal, re-planting with native species and improving bank structure and stability in problem areas. Weed removal would optimally start in the upper catchment to minimise rapid weed re-colonisation from seeds dispersed by water.

7.2 Water Quality and Flow

A construction management plan for the development site would be formulated to assist in mitigating any potential negative consequences and would be adhered to during the construction. Appropriate erosion control and water management practices during construction would be implemented through this plan. Erosion control measures are likely to include the construction of sediment control fences and work being undertaken only during appropriate weather conditions.

Capture and treatment of contaminated runoff from new development and stockpile areas would need to be incorporated into management plans to prevent contaminated discharge directly to the creek from newly disturbed areas. The existing water management plan for the site should therefore be updated to reflect changes in site water management post construction of the pipeline.

Hydrological modelling for the construction of the pipeline and related structures will be undertaken to ensure that this infrastructure is appropriate for purpose and does not increase the risk of flooding. Baffles will be incorporated within the piped section near the discharge point which would serve to reduce scouring around the outlet. This would further decrease the potential for sediment to reach the estuary.

7.3 Aquatic Ecology

Effective hydrological and water quality management are required to reduce impacts on the aquatic ecosystem, which may occur as a result of the construction and operation of the Project. Steps are being taken at the Newstan Colliery to improve hydrological management and to improve water quality include increased pollution control dam storage and construction of a new water treatment facility. These actions will help to mitigate impacts on the aquatic ecosystem resulting from the proposed Project construction area. Ongoing environmental monitoring coupled with diligent and active management will be required throughout and following the construction process to ensure that harm to the aquatic ecosystem is minimised. Northern Coal Services will prepare a construction Management Plan that will incorporate erosion and sediment control measures for this purpose. These actions will assist to mitigate harm to the aquatic ecosystem and provide potential benefits to aquatic habitat downstream of the newly piped sections, following the completion of construction.

All action taken to minimise the loss and degradation of aquatic and terrestrial habitat will be beneficial to the remaining aquatic ecosystem within and around the construction zone. Minimising aquatic habitat degradation downstream of the construction area will also be required through proactive management of construction activities, including sediment control, and ongoing diligence in water management practices, both during and post-construction. Targeted bush regeneration and weed management will assist with protection and rehabilitation of riparian habitat for organisms displaced by the construction.

No threatened or endangered aquatic flora or fauna were identified as occurring within this investigation or through the subsequent targeted searches for amphibians. Loss of aquatic flora and fauna from the construction work is therefore not anticipated to directly impact on organisms with legislative protection. Losses of individuals are expected to be common species along with a reduction of available creek habitat.

An ongoing aquatic ecology monitoring program using quantitative or semi-quantitative measurement techniques and a robust experimental design should be developed to help understand how the aquatic ecosystem responds to changes over time. This monitoring program should include the establishment of replicate sites for sampling aquatic flora and fauna in 'impact' and 'control' locations through standardised sampling methods, conducted routinely on an annual or bi-annual basis.

8 Acknowledgements

This report was written by Max Best and Caroline Bathje, who also completed the field investigation. The laboratory work was completed by Rad Nair and Max Best. The report was reviewed by Peggy O'Donnell. Cardno Ecology Lab would like to thank James Wearne for assistance with the field logistics and literature compilation.

9 References

ANZECC and ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy No. 4*. Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand, October 2000.

BMT WBM (2011). *LT Creek Flood Study - Final Report*. Prepared for Lake Macquarie City Council.

Centennial Coal (2009). *Revised Water Management Plan*.

Centennial Coal (2012). *Newstan Colliery Extension of Mining Project Briefing Paper*.

Chessman, B.C Growns, J.E and Kotlash, A.R. (1997). Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales *in* Marine and Freshwater Research, 48, pp. 159-172.

EPA (2011) Environmental Protection Licence 395 for Newstan Colliery

GHD (2009). *Centennial Coal – Newstan: Surface Water Quality Baseline Study*. Prepared for Centennial Newstan Pty Ltd.

GHD (2011). *Centennial Newstan: Report for LT Creek Ecotox Study - Ecotoxicological Assessment and Trigger Values*. Prepared for Centennial Newstan Pty Ltd.

GHD (2012a). *Centennial Newstan: Downstream Assessment of LT Creek Report*. Prepared for Centennial Newstan Pty Ltd.

GHD (2012b). *Centennial Newstan: Report for Treated Discharge Water Ecotoxicology*. Prepared for Centennial Newstan Pty Ltd.

Turak, E., Waddell, N. and Johnstone, G. (2004). *New South Wales (NSW) Australian River Assessment System (AUSRIVAS). Sampling and Processing Manual*. Environmental Protection Authority. pp. 45.

Peterson, R. C. Jr. (1992) The RCE: A riparian, channel and environmental inventory for small streams in the agricultural landscape. Freshwater Biology 27, pp. 295-306.

Chessman (2003). *SIGNAL 2.iv A Scoring System of Macroinvertebrates (Water Bugs) in Australian Rivers – User Manual, Monitoring River Health Initiative Technical Report No. 31*. Department of the Environment Heritage

Chessman, B. C., Growns, J. E. and Kotlash, A. R. (1997) Objective derivation of macroinvertebrate family sensitivity grade numbers for the SIGNAL biotic index: Application to the Hunter River system, New South Wales. Marine & Freshwater Research 48, pp. 159-172.

LMCC (2010) *LT Creek Sustainable Neighbourhood Community Attitudes Survey*. Available at: http://www.sustainableneighbourhoods.org.au/uploads/6/7/0/6/6706950/lt_creek_survey_report_august_2010.pdf

Koehn, J. D. (1999) Environmental determinants, barriers and human interference to the movement of fish, in: Handcock, D. A., Smith, D. C. and Koehn, J.D. Fish Movement and Migration, Australian Society for Fish Biology Workshop Proceedings. Bendigo, Victoria, 28-29 September 1999.

Mallen-Cooper, M. (1999) Taking the mystery out of migration. in: Handcock, D. A., Smith, D. C. and Koehn, J.D. Fish Movement and Migration, Australian Society for Fish Biology Workshop Proceedings. Bendigo, Victoria, 28-29 September 1999.

Mallen-Cooper, M. (1996), Fishways and Freshwater Fish Migration in South Eastern Australia. Thesis submitted to UTS. Accessed July 2012 Google Scholar < http://epress.lib.uts.edu.au/dspace/handle/2100/548 >

Umwelt (1998) Newstan Colliery Life Extension Project Environmental Impact Assessment.

Umwelt (2009). *LT Creek Catchment Water Quality Management Plan*. Prepared on behalf of Lake Macquarie City Council.

10 Plates



Plate 1: LT Creek Site 1 (LTC 1b) looking upstream from the Main By-wash Dam weir



Plate 2: LT Creek Site 1 (LTC 1a) looking east from the south eastern corner of the Main By-wash Dam storage.



Plate 3: LT Creek Site 2 (LTC 1a) looking downstream from near the centre of the site



Plate 4: LT Creek Site 2 looking at the small riffle area near the top of the site



Plate 5: LT Creek Site 3 (LTC 3b) looking upstream from near the railway line culvert



Plate 6: LT Creek Site 3 (LTC 3a) looking upstream from the old weir near the top of the site



Plate 7: LT Creek Site 4 looking upstream from the deep channel (LTC 4b) into the Melaleuca swamp



Plate 8: LT Creek Site 4 looking downstream through the deeply incised channel

11 Appendices

Appendix 1: Riparian, Channel and Environment (RCE) scores modified from Chessman (1997)

	Descriptor and category	Value		Descriptor and category	Value
1	Land use pattern beyond the immediate riparian zone		8	Riffle / pool sequence	
	Undisturbed native vegetation	4		Frequent alternation of riffles and pools	4
	Mixed native vegetation and pasture/exotics	3		Long pools with infrequent short riffles	3
	Mainly pasture, crops or pine plantation	2		Natural channel without riffle / pool sequence	2
	Urban	1		Artificial channel; no riffle / pool sequence	1
2	Width of riparian strip of woody vegetation		9	Retention devices in stream	
	More than 30 m	4		Many large boulders and/or debris dams	4
	Between 5 and 30 m	3		Rocks / logs present; limited damming effect	3
	Less than 5 m	2		Rocks / logs present, but unstable, no damming	2
	No woody vegetation	1		Stream with few or no rocks / logs	1
3	Completeness of riparian strip of woody vegetation		10	Channel sediment accumulations	
	Riparian strip without breaks in vegetation	4		Little or no accumulation of loose sediments	4
	Breaks at intervals of more than 50 m	3		Some gravel bars but little sand or silt	3
	Breaks at intervals of 10 - 50 m	2		Bars of sand and silt common	2
	Breaks at intervals of less than 10 m	1		Braiding by loose sediment	1
4	Vegetation of riparian zone within 10 m of channel		11	Stream bottom	
	Native tree and shrub species	4		Mainly clean stones with obvious interstices	4
	Mixed native and exotic trees and shrubs	3		Mainly stones with some cover of algae / silt	3
	Exotic trees and shrubs	2		Bottom heavily silted but stable	2
	Exotic grasses / weeds only	1		Bottom mainly loose and mobile sediment	1
5	Stream bank structure		12	Stream detritus	
	Banks fully stabilised by trees, shrubs etc	4		Mainly unsilted wood, bark, leaves	4
	Banks firm but held mainly by grass and herbs	3		Some wood, leaves etc. with much fine detritus	3
	Banks loose, partly held by sparse grass etc	2		Mainly fine detritus mixed with sediment	2
	Banks unstable, mainly loose sand or soil	1		Little or no organic detritus	1
6	Bank undercutting		13	Aquatic vegetation	
	None, or restricted by tree roots	4		Little or no macrophyte or algal growth	4
	Only on curves and at constrictions	3		Substantial algal growth; few macrophytes	3
	Frequent along all parts of stream	2		Substantial macrophyte growth; little algae	2
	Severe, bank collapses common	1		Substantial macrophyte and algal growth	1
7	Channel form			**TOTAL**	
	Deep: width / depth ratio less than 7:1	4			
	Medium: width / depth ratio 8:1 to 15:1	3			
	Shallow: width / depth ratio greater than 15:1	2			
	Artificial: concrete or excavated channel	1			

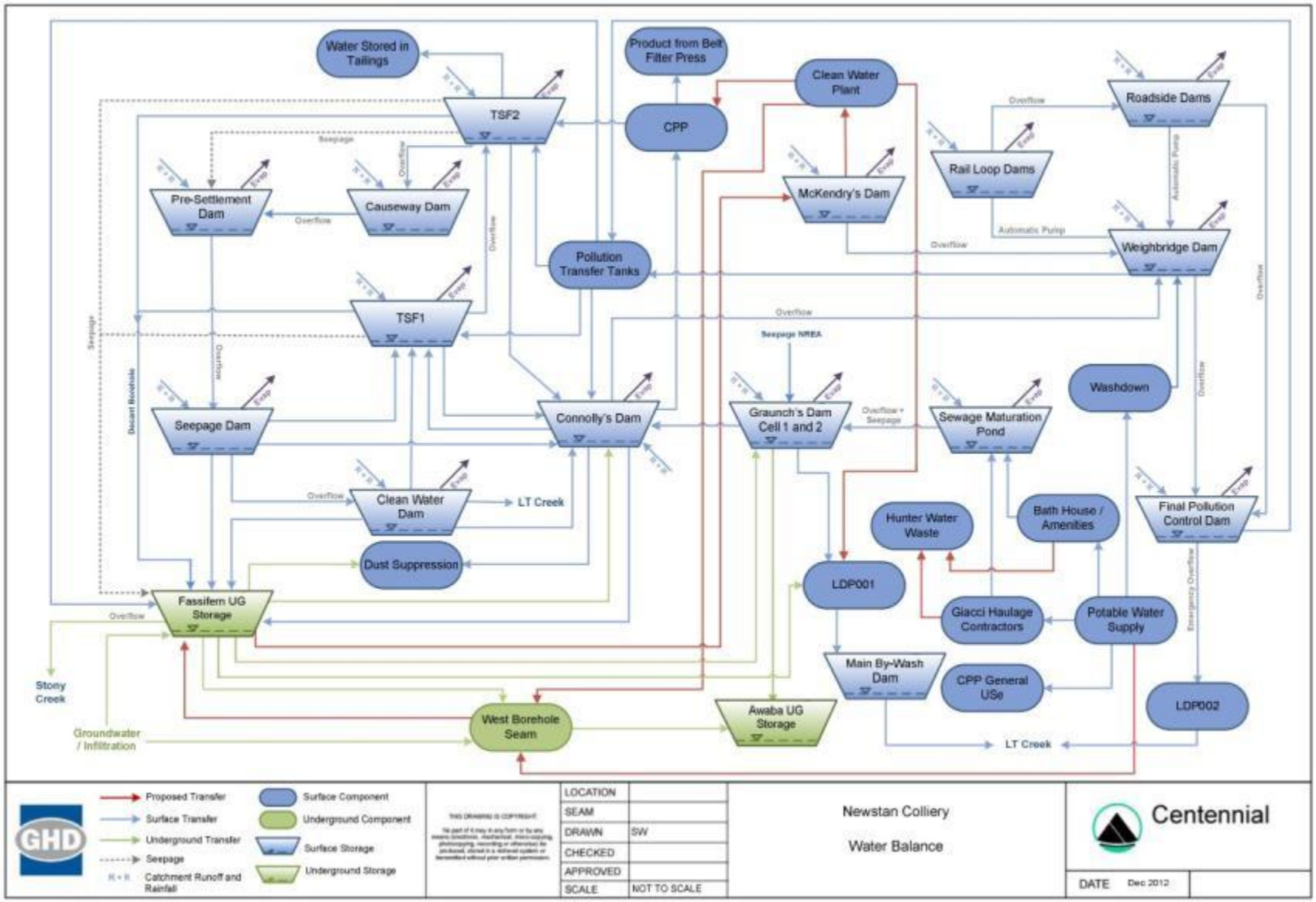
Appendix 2: Statistical Summary of water quality at the LDP001 and WMP03 sites between January 2009 and February 2011 derived from GHD (2009)

Analyte	Units	Ambient (50th%) Statistical Summary LDP001	Ambient (50th%) Statistical Summary WMP03	Trigger Value		Comments
				ANZECC (2000)	SSTV Derived for LT Creek	
pH		7.7	8.3	6.5-8.0	6.5-8.5(1)	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.2
Turbidity	NTU	3	-	6 – 50	50	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.3
Oil & Grease	mg/L	2	2	-	10	EPL395
EC	µS/cm	2430	2535	125 – 2200	2200	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.3
TSS	mg/L	5	5	6 - 50	50	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 8.2.12
Ammonia as N	mg/L			0.9	0.9	ANZECC & ARMCANZ Freshwater Trigger Value for 95% Species Protection
Total Nitrogen as N	mg/L			0.5	0.5	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.2
Total Phosphorous	mg/L	0.1	-	0.05	0.05	ANZECC & ARMCANZ Lowland River – South-east Australia: Table 3.3.2
Aluminium	mg/L	0.3	0.2	0.055	0.68	80th percentile of upstream WMP09
Arsenic	mg/L	0.01	0.01	0.024	0.024	95% ANZECC (2000) Trigger Value: Table 3.4.1
Boron	mg/L	0.01	0.01	0.37	0.37	95% ANZECC (2000) Trigger Value: Table 3.4.1
Cadmium	mg/L	0.001	0.001	0.0002	0.00054	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Chromium	mg/L	0.22	0.22	0.001	0.0025	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Copper	mg/L	0.0001	-	0.0014	0.0035	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Iron	mg/L	0.001	-	-	0.30	Canadian Guideline as recommended by ANZECC (2000) Ch.8.3.7.1
Lead	mg/L	0.001	0.001	0.0034	0.0136	95% ANZECC (2000)

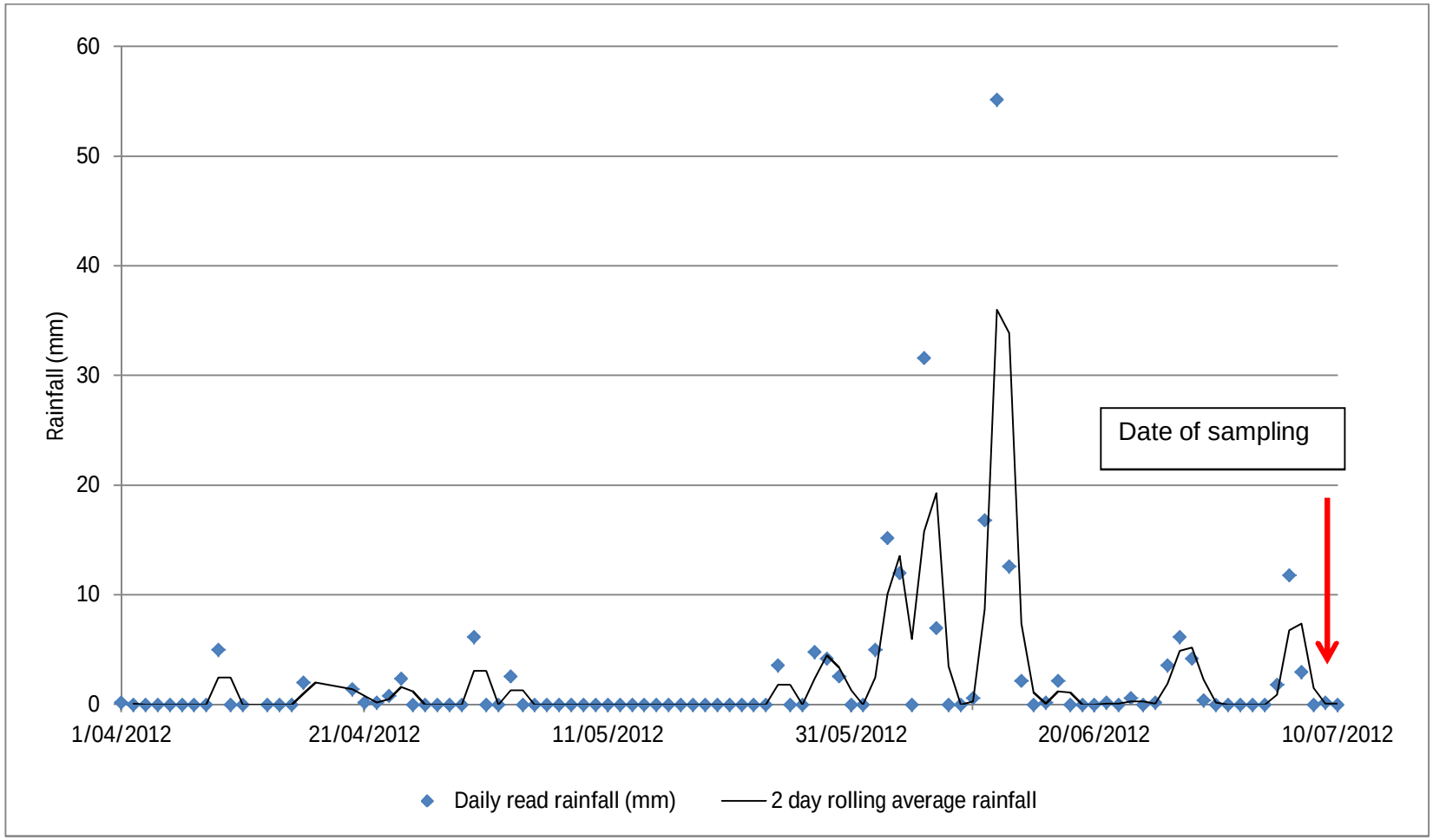
Analyte	Units	Ambient (50th%) Statistical Summary LDP001	Ambient (50th%) Statistical Summary WMP03	Trigger Value		Comments
				ANZECC (2000)	SSTV Derived for LT Creek	
						Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Manganese	mg/L	0.05	0.05	1.9	1.9	95% ANZECC (2000) Trigger Value: Table 3.4.1
Mercury	mg/L	0.006	0.002	0.0006	0.0006	95% ANZECC (2000) Trigger Value: Table 3.4.1
Nickel	mg/L	0.126	0.004	0.011	0.0275	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4
Selenium	mg/L	0.0001	-	0.011	0.03	Site specific ecotoxicological testing July 2011
Silver	mg/L	0.0165	-	0.00005	0.00005	95% ANZECC (2000) Trigger Value: Table 3.4.1
Zinc	mg/L	0.01	-	0.008	0.02	95% ANZECC (2000) Trigger Value modified for moderate hardness: Tables 3.4.1 & 3.4.4

Summary by S Grey 2012, *email comm.* 20 Sept

Appendix 4: Water movement around the Centennial Newstan Colliery (GHD, 20130)



Appendix 5: Rainfall data for the three months prior to sampling taken from the Lake Macquarie AWS (BOM, 2012)



Appendix 6: Mean water quality data for sites sampled on 9 and 10 July 2011

Variable	Units	DTV	LT Creek 1		LT Creek 2		LT Creek 3		LT Creek 4		UN Creek 1		UN Creek 2	
			Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Temperature	˚C		13.5	0.2	15.3	0.0	14.0	0.5	12.8	0.0	10.5	0.1	18.1	0.0
Conductivity	µS/cm	125-2200	2254	190	2130	2	1994	129	2114	0	157	1	4096	35
pH	units	6.5-8	7.9	0.0	8.1	0.0	8.1	0.0	8.3	0.0	7.0	0.2	7.3	0.0
DO	% Sat	85-110	74.3	0.8	88.0	0.5	91.4	2.2	82.9	0.1	56.6	0.3	67.6	1.4
DO	mg/L	-	7.7	0.0	8.8	0.1	9.3	0.1	8.7	0.0	6.5	0.2	6.4	0.2
Turbidity	NTU	6-50	13.7	2.8	11.2	0.4	15.0	0.1	6.8	0.1	63.6	5.5	35.6	1.9
Alkalinity	ppm	-	> 500	-	> 500	-	> 500	-	> 500	-	20	-	> 500	-

(SE = Standard Error, n = 2, except for turbidity where n =6). Default Trigger Values (DTV) taken from ANZECC/ARMCANZ (2000) guidelines for slightly disturbed lowland rivers in southeast Australia. Grey shading indicates value outside of DTV.

Appendix 7: Aquatic macroinvertebrates collected at each of the two replicate samples at sites on LT Creek (LTC) and the Unnamed Creek (UNC).

Order or Family	LTC 1a	LTC 1b	LTC 2a	LTC 2b	LTC 3a	LTC 3b	LTC 4a	LTC 4b
Aeshnidae	1	6			1		1	1
Araneae				1		2	7	1
Atyidae								
Baetidae								
Caenidae	1	2					4	5
Ceratopogonidae	1	1		1				1
Chironominae	10	9	1	10	5	4	5	10
Tanypodinae	10	3		10	6	1	6	10
Coenagrionidae	4	9	1	2				
Corydalidae							1	
Culicidae								
Dytiscidae	1	1						
Ecnomidae	1	3	1					1
Empididae								1
Entomobryidae		1					2	
Gelastocoridae					1			1
Gerridae		1					1	4
Gyrinidae		1						
Haliplidae	2	1						
Hemicorduliidae	2	3	5	2	1	2	1	1
Hydracarina		3					1	
Hydrobiidae	5				1	2		3
Hydrometridae								2
Hydrophilidae								
Hydroptilidae								6
Leptoceridae	2	1						5
Megapodagrionidae								1
Nepidae		1	1					
Notonectidae		2						
Ostracoda		1						
Parastacidae								
Planorbidae	2	1	1					
Pleidae	4	2						
Pyralidae						2		
Scirtidae		1	1	1		3	1	4
Simuliidae						1		
Spongillidae								
Stratiomyidae		2			1	1		2
Tabanidae	1	1						
Tipulidae				1				
Veliidae		3		2	3	1	2	3
No. taxa	15	24	7	9	8	10	12	19
No. SIGNAL2 taxa	15	23	7	8	8	9	10	18
No. EPT Taxa	3	3	1	0	0	0	1	4
SIGNAL2 Index	3.4	3.4	3.6	4.0	3.8	3.9	4.6	4.2

Appendix 8: Macrophytes collected at each of the sample sites on LT Creek (LTC) and the Unnamed Creek (UNC).

Common Name	Scientific Name	LTC 1	LTC 2	LTC 3	LTC 4	UNC 1	UNC 2	Native / Introduced
Acacia longifolia	Coastal Wattle						x	N
Ageratina adenophora	Crofton's Weed	x	x	x	x		x	I *
Alternanthera denticulata	Lesser Joyweed					x		N
Bacopa monnieri	Bacopa	x	x	x				N
Baumea articulata	Jointed Twig-rush	x						N
Bidens pilosa	Cobblers Pegs			x				I
Carex appressa	Tall Sedge			x	x			N
Cassytha glabella	Slender Devils Twine		x	x	x			N
Chara sp.	Chara	x			x			N
Chloris gayana	Rhodes Grass			x	x			I
Christella dentata	Binung			x				N
Cortaderia selloana	Pampas Grass				x			I *
Cyperus eragrostis	Umbrella Sedge					x		I
Dianella sp.	Flax Lilly					x		N
Doodia caudata	Small Rasp Fern						x	N
Echinochloa colona	Awnless Barnyard Grass			x				N
Eucalyptus robusta	Swamp Mahogany					x		N
Gahnia clarkei	Tall Saw-edge	x	x	x	x	x		N
Glochidion ferdinandi	Cheese Tree		x	x	x		x	N
Isolepis prolifera	Proliferating Isolepis					x		I
Juncus usitatus	Common Rush					x	x	N
Lantana camara	Lantana		x	x	x		x	I *
Leptospermum sp.	Tea Tree					x		N
Ligustrum sinense	Small Leafed Privet						x	I *
Melaleuca decora	Paperbark	x	x	x	x	x		N
Melaleuca styphelioides	Prickly Paperbark		x		x			N
Nephrolepis cordifolia	Fishbone Fern			x				N
Nitella sp.	Nitella		x					N
Paspalum urvillei	Vasey Grass	x		x				I
Persicaria decipiens	Slender Knotweed					x		N
Phragmites australis	Common Reed						x	N
Potamogeton ochreatus	Blunt Pondweed		x					N
Potamogeton pectinatus	Sago Pondweed	x	x	x			x	N
Pteridium esculentum	Bracken Fern				x			N
Pteris tremula	Tender Brake						x	N
Ranunculus repens	Creeping Buttercup					x		N
Rubus fruticosus	Blackberry						x	I *
Schoenoplectus validus	River Clubrush	x	x	x	x			N
Setaria gracilis	Slender Pigeon Grass	x			x			N
Setaria sphacelata	Giant Pigeon Grass				x	x	x	I
Triglochin Microtuberosa	Small Water Ribbons	x	x	x	x			N
Triglochin procerum	Water Ribbons		x					N
Typha orientalis	Cumbungi	x	x	x	x		x	N
Unidentified Fern	Cyanthea sp.						x	N
Unidentified Forb	Xanthorrhoea sp.					x		N

Unidentified Grass	Oplismenus sp.					x		N
Unidentified Grass	Paspalum sp.						x	N or I
Unidentified Macrophyte	Cyperaceae				x			N or I
Unidentified Myrtaceae	Melaleuca/Leptospermum					x		N
Unidentified Myrtaceae	Melaleuca/Callistemon		x					N
Unidentified Sedge	Cyperus sp.	x	x					N or I
Unidentified Sedge	Juncus sp.			x	x	x		N or I
Verbena bonariensis	Purpletop						x	I

* Denotes a species listed as a Noxious Weed under the NSW Noxious Weeds Act (1993)

Appendix 9: Protected species recorded on the Bionet Database within 5km of the Works Site and their likelihood of occurrence within the LT Creek aquatic environment

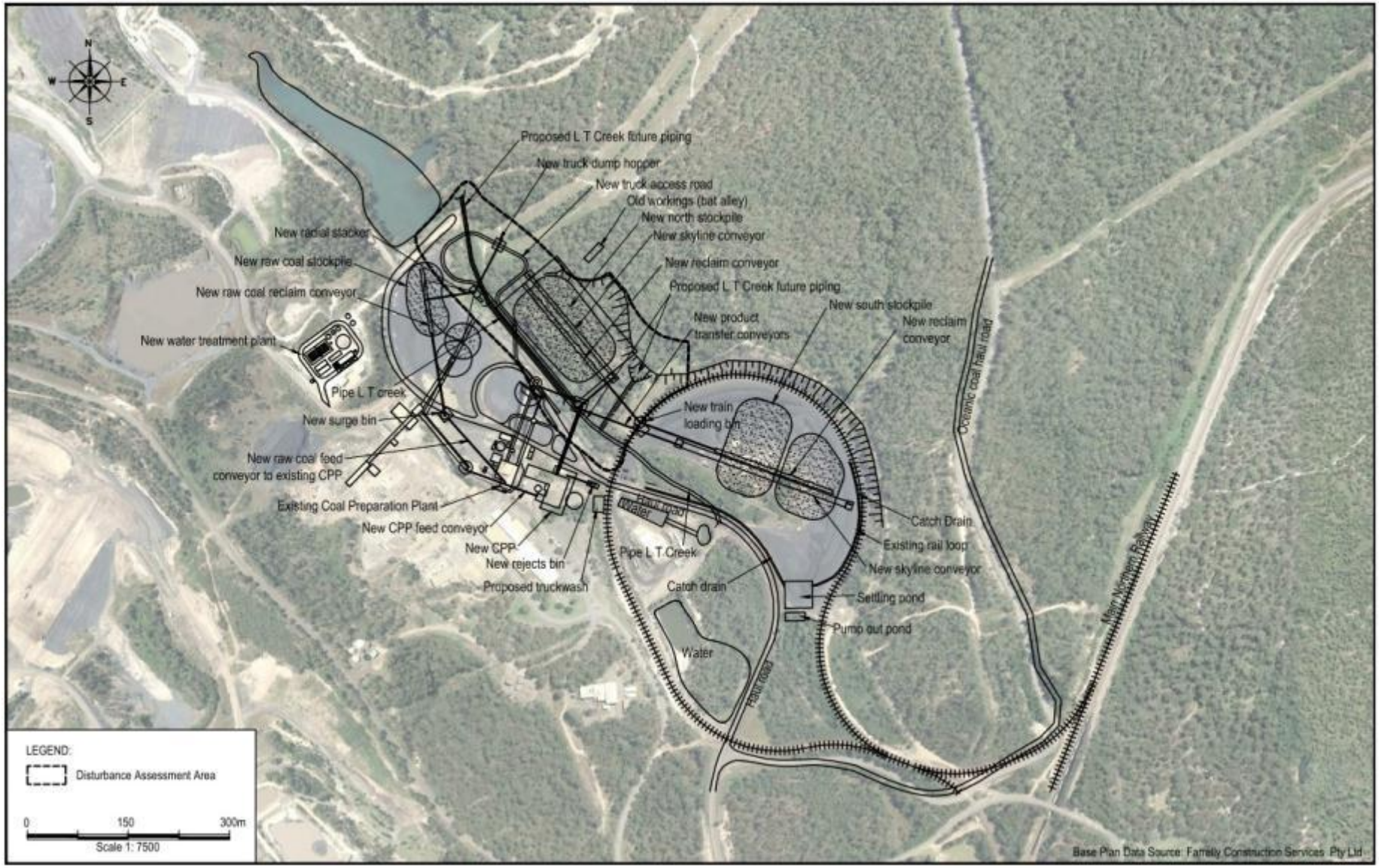
Scientific Name	Common Name	Likelihood of Occurrence
Acianthus fornicatus	Pixie Caps	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Acacia bynoeana	*Bynoe's Wattle*	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Angophora inopina	Charmhaven Apple	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm, however this species distribution range includes Lake Macquarie and have been recorded south of the study area in Toronto (Centennial Coal, 2006). (Terrestrial)
Archontophoenix cunninghamiana	Bangalow Palm	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat may be present in the study area. (Terrestrial)
Banksia spinulosa	Hairpin Banksia	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Banksia spinulosa var. collina		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Boronia polygalifolia	Dwarf Boronia	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Caladenia catenata	White Caladenia	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Caladenia spp.		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Callistemon linearifolius	Netted Bottle Brush	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Calochilus paludosus	Red Beard Orchid	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Cymbidium suave	Snake Orchid	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Dicksonia antarctica	Soft Treefern	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat may be present in the study area. (Terrestrial)
Doryanthes excelsa	Gymea Lily	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Gahnia sieberiana	Red-fruit Saw-sedge	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat is present in the study area. (Semi-Aquatic species)

Scientific Name	Common Name	Likelihood of Occurrence
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	Possible – No sightings have been recorded within the vicinity of LT Creek North Arm, however GSS Environmental (2011) recorded species within the Newstan Mine property south of LT Creek North Arm. (Terrestrial)
Kunzea ambigua	Tick Bush	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Livistona australis	Cabbage Palm	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Macrozamia communis	Burrawang	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Maundia triglochinoides		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat is present in the study area. (Aquatic Macrophyte)
Melaleuca biconvexa	Biconvex Paperbark	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat is present in the study area. (Semi-Aquatic species)
Persoonia levis	Broad-leaved Geebung	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Persoonia linearis	Narrow-leaved Geebung	Low Probability – Common Plant. No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Prasophyllum spp.		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Pterostylis spp.	Greenhood	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Syzygium paniculatum	Magenta Lilly Pilly	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat may be present in the study area. (Terrestrial)
Tetratheca juncea	Black-eyed Susan	Moderate probability – No sightings have been recorded within the vicinity of LT Creek North Arm, however GSS Environmental (2011) recorded several near the study area. (Terrestrial)
Xanthorrhoea latifolia		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Xanthorrhoea latifolia subsp. latifolia		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Xanthorrhoea spp.		Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Terrestrial)
Epinephelus daemelii	Black Rockcod, Black Cod, Saddled Rockcod	Low Probability – No sightings have been recorded within the vicinity of LT Creek North Arm. Suitable habitat was not found in the study area. (Marine/estuarine species)

Scientific Name	Common Name	Likelihood of Occurrence
Mixophyes balbus	Stuttering Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Mixophyes iteratus	Giant Barred Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Crinia signifera	Common Eastern Froglet	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Limnodynastes peronii	Brown-striped Frog	Moderate Probability –Common Frog, tolerant to pollution. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Limnodynastes tasmaniensis	Striped Grass Frog	Moderate Probability –Common Frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria aurea	Green and Golden Bell Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria chloris	Red-eyed Tree Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria fallax	Eastern Dwarf Tree Frog	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria latopalmata	Broad-palmed Frog	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria littlejohni	Littlejohn's Tree Frog, Heath Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria peronii	Peron's Tree Frog	Moderate Probability – Found during targeted survey. Common frog. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria tyleri	Tyler's Tree Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Litoria verreauxii	Verreaux's Frog	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Pseudophryne coriacea	Red-backed Toadlet	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)
Uperoleia fusca	Dusky Toadlet	Low Probability – Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Aquatic)

Scientific Name	Common Name	Likelihood of Occurrence
Apus pacificus	Fork-tailed Swift	Low Probability – Migratory species unlikely inhabit the study area. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Migratory bird)
Ardea alba	Great Egret, White Egret	Low Probability – Migratory species unlikely inhabit the study area. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Migratory bird)
Ardea ibis	Cattle Egret	Low Probability – Migratory species unlikely inhabit the study area. Suitable habitat is available in the study area, however no sightings have been recorded within the vicinity of LT Creek North Arm. (Migratory bird)

Appendix 10. Plans for the proposed Northern Coal Services Logistics Project (modified to highlight LT Creek)



Appendix 11. Environmental Protection Licence

Licence Number 395

Centennial Newstan Pty Ltd

Premises: 100 Miller Road, Fassifern NSW 2283

Centennial Coal

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