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# ACOL Extraction Plan

## Riparian and terrestrial ecology impacts

**Version: Final (1<sup>th</sup> December 2011)**

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## Executive Summary

This Technical Report lends support to an Extraction Plan being prepared for Ashton Coal Operations Pty. Limited (ACOL) for Longwalls 1-8 in the Upper Liddell Seam (ULD).

The aim of this report is to update and include new ecological findings where relevant to the above operations, specifically any threatened species or ecological communities that have the potential to be impacted by the extraction. Ecological findings made within the wider Ashton Coal operations that have no relevance to the impact area are not discussed.

Results of recent ecological survey in the impact area have identified an expansion of the local populations for two significant bird species, Grey-crowned Babbler (*Pomatostomus temporalis temporalis*) and Speckled Warbler (*Chthonicola sagittata*). Nesting and denning trees for Grey-crowned Babbler troops were recorded within the impact area, whilst at this stage, only foraging habitat for Speckled Warbler has been established. The following summarises the recommendations made to mitigate impacts on Grey-crowned Babbler and Speckled Warbler:

- Permanent marking of all nest and den trees within the impact area prior to the commencement of mining within ULD LW1;
- Fortnightly monitoring of all nest trees during active subsidence;
- Searches for new breeding sites within the impact area should commence immediately and continue for a minimum of 3 years, or until the completion of underground mining within the extraction area; Provision of engineering solutions for den or nest trees identified during the monitoring surveys that are at risk of damage, i.e. shoring up the tree and the ground with anchors and/or ground works;
- If a tree appears to be failing, apply for NPWS licence to relocate the nests; and
- Undertake relocation actions.

The findings of this assessment are consistent with the assessments and recommendations made in the Bowmans Creek Environmental Assessment (2009).

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# 1.0 Introduction

This Technical Report lends support to an Extraction Plan being prepared by Ashton Coal Operations Pty. Limited (ACOL) for Longwalls 1-8 in the Upper Liddell Seam (ULD).

The aim of this report is to update and include new ecological findings where relevant to the above operations, specifically any threatened species or ecological communities that have the potential to be impacted by the extraction.

A general description of the site locality and Application Area is provided in Section 1.1 of the Extraction Plan main document. An updated assessment of potential subsidence movements related to ULD LW1-8 has been prepared by SCT Operations Pty Ltd (SCT 2011). These subsidence predictions have been used as a basis for the updated assessment of impacts contained within this report. SCT's analysis and results are contained, in full, as an Appendix to the Extraction Plan.

## 1.1 Scope of Work

The Extraction Plan has been developed to comply with the relevant consent conditions for the Ashton Coal Project (ACP), in particular Development Consent Condition 3. 12 (e), which requires "...revised predictions of the potential subsidence effects, subsidence impacts, and environmental consequences of the proposed second workings incorporating any relevant information obtained since the consent". Accordingly the Scope of Works for the riparian and terrestrial ecology assessment report is to:

- Update the description of the existing ecological environment with the results of any additional monitoring undertaken since the preparation of the Bowmans Creek Diversion EA (Evans and Peck, 2009).
- Assess possible impacts that the revised subsidence predictions may have on riparian and terrestrial ecology within the ULD LW 1-8 Application Area; and
- Update subsidence management and monitoring measures where appropriate.

## 1.2 Methodology

The updated impact assessment (refer to **Section 4.0**) was undertaken based on results of recent ecology monitoring undertaken across the ULD LW 1-8 Application Area (refer to **Section 3.0**) and the revised subsidence predictions (SCT, 2011).

No additional surveys were required for the updated assessment of subsidence impacts. Flora and fauna monitoring surveys have been undertaken across ACP since 2005. The most recent surveys conducted in 2011 (PEA, *in prep*) included intensive quantitative methods and provide a detailed assessment of the ecological characteristics and significant ecological issues in the Application Area. It was therefore considered that sufficient data was available to support this assessment.

## 2.0 Existing Environment

For the purposes of this assessment, the impact area has been defined as terrestrial and/or riparian habitats that could potentially be directly or indirectly impacted by the secondary extraction of Longwalls 1-8 in the Upper Liddell Seam (ULD). This area includes mature and regenerating Eucalypt and Bull Oak woodlands, riparian corridors and planted corridors.

The comparison of the updated subsidence predictions with the results of recent ecological surveys has identified two significant species requiring additional consideration. The remaining ecological issues are either outside of the impact area or will remain sufficiently managed as part of existing ACOL management plans.

### 2.1 Grey-crowned Babbler

The recent surveys of the impact area identified one new sub-population made up of two (2) troops or 15 individual Grey-crowned Babblers (**Figure 1**). Systematic foot surveys of ACOL lands (2010-2011) also identified two (2) new breeding and five (5) nesting trees within the impact area. Home ranges for the troops have been mapped within **Figure 2** and include 77 hectares extending from Bowmans Creek across open areas east to the planted corridor and 89 hectares<sup>1</sup> extending from the central part of the impact area south towards the Hunter River. Overlap with existing territories was recorded, however this is common outside of the breeding season, and as such their respective territories may contract over spring.

During surveys individuals were recorded foraging and nest building daily within the impact area. Surveys of reserve areas and remnant habitats within ACOL operational lands confirmed the stability of the local population with troops being recorded within every remnant. There has been a steady increase in the size of the local population from a recorded 27 individuals in 2009 to a total of 42 individuals in 2011 (55% increase). The area of occupation has risen from 38 hectares in 2009 to 94 hectares in 2011 (~147% increase).

During this time underground mining has continued and mitigation measures have been implemented by ACOL to manage disturbance from impacts. The adequacy of the existing management and monitoring measures have been further addressed within **Section 5.0**.

### 2.2 Speckled Warbler

Recent surveys across the ACP confirmed the presence of two sub-populations of Speckled Warbler. Separate surveys on adjoining sites located an additional sub-population as mapped within **Figure 3**. Since 2009, three (3) new observations have been made of Speckled Warbler foraging within the impact area, with a maximum of four (4) birds being recorded at any one time. To date no evidence of breeding has been observed. One reasonable hypothesis for this is that individuals recorded have expanded their home-range from the core area into the outer limits of suitable habitat, an alternative hypothesis is that breeding habitat has not yet been located by surveys.

Updated subsidence predictions include increased surface deformation and cracking which may impact Speckled Warbler habitat and has been further addressed within **Section 4.0**:

The adequacy of the existing management and monitoring measures have been further addressed within **Section 5.0**.

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<sup>1</sup> Note that home ranges can often be larger than habitat for birds. This is due to birds crossing areas of open land to nearby habitat areas. These crossing areas are included within home ranges because they carry an energy cost and must be calculated in viability estimations. Moreover, all species have crossing thresholds.

## 3.0 Statutory Requirements

### 3.1 EPBC Act 1999

The Commonwealth Environment Protection & Biodiversity Conservation Act, 1999 (EPBC Act) provides for the approval of the Commonwealth Environment Minister for all actions that will or are likely to have a significant impact on a matter of national environmental significance. A Matters of National Environment Significance report compiled for the site identified one wetland of international significance, one threatened ecological community, seventeen threatened species and fourteen migratory species as having habitat in the regional area (<10km radius). Given that none of the listed species will be impacted by the extraction, no significant impacts on matters of national environmental significance were predicted during this assessment.

### 3.2 Threatened Species Act 1995

The TSC Act provides a framework for the listing and declaration of threatened species, populations, endangered ecological communities, key threatening processes and critical habitat. It also provides a framework for the preparation and implementation of recovery plans, threat abatement plans and licensing.

The compilation of threatened species data records, the review of recovery plans and threat abatement plans forms the basis of assessment under this Act (TSC Act 1995) via the 7-Part test. All species listed under the provisions of the Act recorded or found to have habitat on the site are submitted to the 7-Part test. This ecological assessment is based on several preceding ecological assessments prepared for the underground and Bowmans Creek Environmental Assessments. The aim of this document is to update current ecological findings with improved subsidence knowledge of the project. Therefore, only the significant ecological issues recorded on site that are likely to be impacted above and beyond those impacts already addressed in previous assessments are dealt with in this report and do not require updated 7 part test assessments..

### 3.3 Environmental Planning and Assessment Act 1979

The EP&A Act provides a framework for the assessment of development and activities which are likely to impact on threatened species, populations or ecological communities as listed pursuant to the TSC Act. It also requires that all relevant threat abatement plans and recovery plans are considered.

### 3.4 State Environmental Planning Policies (SEPP)

#### 3.4.1 SEPP 44 – Koala Habitat Protection

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) was introduced to protect potential and core koala habitat in NSW. Under SEPP 44, developers of land with koala habitat (as defined in the SEPP) have to consider the impact of their proposals on koalas, and in certain circumstances, prepare individual koala plans of management for their land.

Councils are encouraged to prepare shire wide koala plans of management and, once agreed to by the NSW Department of Infrastructure, Planning and Natural Resources (DIPNR), they could be used by developers to address koala issues – individual plans would no longer be required.

The Singleton Shire Local Government area does not have a Koala Plan of Management, therefore SEPP 44 applies. There are no local records for Koala and no habitat recorded on site during the various surveys, accordingly this SEPP will not be considered in this report.

### 3.5 Relative key threatening processes

In July 2005 the 'Alteration of habitat following subsidence due to longwall mining' was listed by the independent NSW Scientific Committee as a key threatening process under Schedule 3 of the Threatened Species Conservation Act 1995. The Scientific Committee recognised that subsidence due to longwall mining is the cause of habitat alteration, including cracks beneath a stream or other water bodies, and that subsidence may lead to "a temporary or permanent loss of water flows and could cause

permanent changes to riparian community structure and composition". The Committee also noted that, "Species and ecological communities that depend on aquatic and semi-aquatic habitats are particularly susceptible to the impacts of subsidence".

A total of four threat abatement strategies were identified to help tackle this key threatening process:

1. Establish management agreements with public authorities, CMAs and land managers/owners. Continue DECCW commitment to inter-agency committee for the review of Subsidence Management Plans with NSW Industry and Investment, NSW Land and Property Management Authority, NSW Planning and NSW Office of Water, to provide advice on the protection of biodiversity.
2. Prepare a statement of intent to establish links between existing regulation of clearing of native vegetation and identifying strategies for the protection of biodiversity.
3. Review and amend or adopt existing legislation and policies. Support the implementation of the Mining Act 1992 and associated subsidence management planning processes.
4. Determine impacts of longwall mining and subsidence on biodiversity with the aim to identifying priority threatened species, populations and endangered ecological communities impacted by this KTP.

## 4.0 Subsidence Impacts

SCT (2011) have prepared revised subsidence estimates for ULD LW 1-8 that incorporate the current mine design allowing for an offset longwall panel arrangement, consideration of relevant site-specific information obtained during secondary extraction in the PG Seam and current data and methods for the estimation of subsidence in multi-seam mining environments. These predictions as they relate to terrestrial and riparian ecology have been summarised below:

- Surface cracks associated with mining of the ULD Seam are expected to decrease in magnitude to the south as overburden increases. However in shallow parts on the LW1 large cracks of several hundred millimetres wide are expected. Generally in areas where both seams are mined cracks and surface impacts are expected to have magnitudes of two to three times greater than observed in the PG Seam.
- Natural features such as trees, creek channels and flat areas will be significantly disturbed by incremental subsidence up to three times greater than experienced in the PG Seam.
- The diversion of Bowmans Creek is not expected to be impacted by subsidence, however, subsidence of the excised channel and adjacent floodplain is expected to leave the diversion elevated above parts of the excised creek channel and surrounding landform. This will result in areas of ponding within the excised channel and within subsidence troughs on the floodplain.

### 4.1 Potential Impacts

Thematic mapping developed for subsidence impact contours overlaid with habitat for threatened Grey-crowned Babbler and Speckled Warbler have identified 94 hectares of habitat that could be potentially impacted by subsidence (Refer to **Appendix A** for details)

Impact types were categorised into 4 groups as follows:

- **Impact level 1:** No nesting or denning trees present and low levels of vertical displacement predicted (<1m). Moderate to high levels of subsidence induced cracking requiring major rehabilitation across large areas predicted within the northern remnants. The deeper overburden present in the southern remnants will reduce cracking severity and remnants within these southern areas will, where possible be remediated by hand. Impacts on populations could potentially be significant due to the size of these habitat elements relative to overall habitat availability.
- **Impact level 2:** Nesting or denning trees present with high levels of subsidence (>2m) and minor cracking likely to require some minor rehabilitation. Predicted impacts unlikely to disturb habitat trees, however if disturbance to nest and den trees is not monitored or managed there is the potential to result in impacts on the local population.
- **Impact level 3:** No nesting or denning trees present with low levels of subsidence (<1m) and some cracking requiring minor to moderate rehabilitation predicted due to increased overburden depth. Remediation will be undertaken by small machinery and where possible, by hand. Impacts on populations are likely to be minimal due to the habitat elements within this impact level remaining viable throughout and foraging habitat being responsive to "light" remediation/disturbance.
- **Impact level 4:** Nesting or denning trees present with moderate levels of subsidence predicted (1 – 2 m). Some minor cracking requiring minor rehabilitation may be possible and where possible, would be undertaken by hand. Predicted impacts are unlikely to disturb habitat trees and in the unlikely event that subsidence remediation works are required impacts to the local population would not be significant.

#### Grey-crowned Babbler

As detailed within **Table 1**, approximately 15% of the habitat identified within the Application Area will be significantly impacted by the predicted subsidence levels. This represents approximately 10.2% of the habitat occupied by the local population.



**Table 1. Impact of multi-seam 85% subsidence predictions for LW 1-8 on Grey-crowned Babbler habitat.**

Impact Level	Area (ha)	% of total habitat area
1	14.22	15.12
2	2.59	2.75
3	7.22	7.6
4	17.09	18.18

This species is more likely to be adversely impacted by the loss of arboreal foraging habitat and nest sites than ground habitats. Surveys of Grey-crowned Babbler foraging behaviour within the local area recorded Grey-crowned Babbler spreading foraging time between arboreal and ground foraging approximately 70% to 30% respectively (PEA, *in prep*). The likelihood of the predicted subsidence resulting in the loss of recorded nest and/or den trees is extremely low based on their location within the centre of the subsidence trough which will experience only moderate tilts and strains as the longwall progresses. It is less clear how surface cracking and subsequent remediation works will impact on Grey-crowned Babbler although they are documented to use moderately disturbed understoreys.

In summary, the secondary extraction of the ULD LW 1-8 will have a moderate to high level of impact on approximately 10.2% of the potential habitat available to the local population. Given that the impacts will occur over a relatively short time frame, monitoring programs will be designed to identify impacts and allow for timely remediation. ULD LW 1-8 is therefore unlikely to significantly impact the long term viability of the local Grey-crowned Babbler population.

#### Speckled Warbler

No nesting habitat for the Speckled Warbler has been identified within the Application Area. Notwithstanding the lack of breeding evidence the areas identified as potential habitat for the species are given equal ecological importance to the Grey-crowned Babbler.

Approximately 22 hectares of habitat occupied by Speckled Warbler will be impacted by the extraction, which represents 9.7% of the habitat used by the local population. Of this 22 hectares, 17 hectares will experience moderate to high levels of disturbance. Surface cracking and subsidence remediation is likely to result in greater impact to the species (than Grey-crowned Babbler assessed above) although the deeper overburden present in the southern remnants (the only area observed to be used by the local population) will reduce cracking severity. Where possible, remnants within these southern habitat areas will be remediated by hand.

Impacts on the local population could potentially be expansive due to the size of these habitat elements relative to overall habitat availability; however, impacts are predicted to be localised and not continuous through the landscape. Moreover, the utilisation of the landscape by Speckled Warbler is patchy with sporadic use of some areas. Given the discontinuous nature of the impacts and the proposed remediation of subsidence induced cracking and ponding, impacts are unlikely to be long term and would not be of a scale that would significantly impact on the local Speckled Warbler population.

## 5.0 Monitoring and Management

### 5.1 Current Management Actions for Terrestrial and Riparian Ecology

All activities on ACOL lands aim to conserve, monitor and manage ecology in the underground area pursuant to the development consent and environmental management plans. The environmental management plans relevant to terrestrial and riparian ecology within the Application Area are:

- Flora and Fauna (Biodiversity) Management Plan.
- Landscape and Revegetation Management Plan.
- Land Management Plan.

Specific management measures currently in place for the Grey-crowned Babbler and Speckled Warbler are provided in the Biodiversity Management Plan and summarised below and in **Table 2**.

#### Current ecological management actions include:

- Conduct pre-clearance inspections and utilise hollow limbs, felled trees and woody debris from clearing activities to provide habitat, shelter and foraging opportunities for relocated animals and to restore aquatic ecosystems;
- Placing felled trees between areas of remnant bushland to provide runways of ground cover for the dispersion of animals;
- Supplementary planting of locally occurring native species (using local provenance) to establish a connection between the Bowmans Creek and Glennies Creek riparian corridors and the southern woodland voluntary conservation area (VCA);
- Undertake weed control and revegetation within the creek north and south of the New England Highway to enhance wildlife movement along the riparian corridor;
- Fence the Bowmans Creek riparian zones (around diversions, the excised creek and the remaining creek) to exclude stock and provide stock watering points away from the protected riparian zones;
- Increase the existing riparian vegetated strip widths along Bowmans Creek such that the eastern diversion is planted out to a minimum of 93m and the western diversion is planted out to a minimum of 75m. Incorporate these expanded width riparian zones into the existing vegetation and terrestrial corridor system;
- Provide habitat offsets associated with the Bowmans Creek diversions, including 15.7 hectares of combined aquatic and riparian habitat, and 58.7 hectares of mixed riparian woodland and grassy floodplain woodland in accordance with the Rehabilitation Management Plan;
- Enhance the River Red Gum population by planting on the stream and upper banks of the Bowmans Creek diversions. Stock exclusion (fencing) will be provided to improve recruitment of juveniles;
- Create a seed bank from mature River red gum trees on Bowmans Creek in accordance with OEH guidelines and relevant licences;
- Manage the southern woodland voluntary conservation area in accordance with the Conservation Agreement;
- Vehicle access will be restricted to formed trails for access to private property, management purposes as approved by OEH, fire fighting and/or any emergency requirements;
- If subsidence induced pond formation occurs in the excised creek sections, riparian vegetation (i.e. stock exclusion and provision of edge and emergent vegetation) will be managed; and
- Where overall monitoring trends indicate that negative impact to species diversity or abundance is occurring as a result of mining, contingency measures to reverse this trend will be implemented as soon as practicable, in consultation with relevant government agencies, and monitoring continued to evaluate effectiveness.

**Table 2.** Performance indicators for the management of significant species and their habitats

Species	Status	Management Action	Timing	Performance Indicators
Grey-crowned Babbler ( <i>Pomatostomus temporalis temporalis</i> )	V	Biannual monitoring of populations within lands operated by Ashton Coal.	In progress	Populations remain stable or grow from the previous year. Individuals are progressively recorded expanding into new home ranges.
		Establishment of supplementary habitat within landscape corridors and regeneration area.	2011	Establish additional habitats by 2012 and continue expanding regeneration areas progressively until final land use sustainability is achieved.  Monitoring shows that key habitat features (foraging, nesting, refuge habitat) and structural complexity within remnant and rehabilitated/compensatory habitat areas are not declining and results are comparable with the pre-mining surveys.
Speckled Warbler ( <i>Chthonicola sagittata</i> )	V	Biannual monitoring of populations within lands operated by Ashton Coal.	In progress	Populations remain stable or grow from the previous year. Individuals are progressively recorded expanding into new home ranges.
		Establishment of supplementary habitat within landscape corridors and regeneration area.	2011	Establish additional habitats by 2012 and continue expanding regeneration areas progressively until final land use sustainability is achieved.  Monitoring shows that key habitat features (foraging, potential nesting, refuge habitat) and structural complexity within remnant and rehabilitated/compensatory habitat areas are not declining and results are comparable with the pre-mining surveys.

In regards to the success of the existing management of Grey-crowned Babbler habitats, the gradual expansion of the local population is hypothesised as being a function of improved landscape management. Over the last two years there has been a dramatic reduction in grazing intensity and improved fencing of important habitat areas. This presents several important flow on effects for the local population as follows:

- Improved breeding success within the core habitat areas leading to increased migration into uninhabited areas;
- New areas have improved ecological resources due to removal of grazing;
- Leading to increased nest success which is critical for this species long term viability as newly established troops generally have fewer numbers and a documented lower success rate;
- Continued occupation over a longer period leads to increase in troop size and health; which,
- Leads to a gradual radiation of the population into other adjoining areas.

Clearly the implemented management strategies are working effectively for Grey-crowned Babbler and would also benefit the local population of Speckled Warbler.

## 5.2 Additional Management Requirements

Comprehensive management strategies are already in place for many of the ecological issues in the underground area. However the increased risk of disturbance to trees from subsidence and cracking in conjunction with the expansion of woodland bird habitats requires some additional management and monitoring. Management recommendations proposed include:

- 
- Permanent marking of all nest and den trees within the impact area prior to the

- commencement of mining within ULD LW1;
- Fortnightly monitoring of all nest trees during active subsidence;
- Searches for new breeding sites within the impact area should commence immediately and continue for a minimum of 3 years, or until the completion of underground mining within the extraction area;
- Provision of engineering solutions for den or nest trees identified during the monitoring surveys that are at risk of damage, i.e. shoring up the tree and the ground with anchors and/or ground works;
- If a tree appears to be failing, apply for NPWS licence to relocate the nests;
- Undertake relocation actions; and
- Inclusion of these surveys and additional recommendations into the Biodiversity Management Plan.

## 6.0 Recommendations

The key recommendation that goes beyond that already established in the approved SMP is for the extension of the ecological monitoring to include newly identified habitat areas. The following summarises the recommendations made in this report, additional to those already included within existing management plans:

- Permanent marking of all nest and den trees within the impact area prior to the commencement of mining within ULD LW1;
- Fortnightly monitoring of all nest trees during active subsidence;
- Searches for new breeding sites within the impact area should commence immediately and continue for a minimum of 3 years, or until the completion of underground mining within the extraction area;
- Provision of engineering solutions for den or nest trees identified during the monitoring surveys that are at risk of damage, i.e. shoring up the tree and the ground with anchors and/or ground works;
- If a tree appears to be failing, apply for NPWS licence to relocate the nests;
- Undertake relocation actions; and
- Inclusion of these surveys and additional recommendations into the Biodiversity Management Plan.

## 7.0 Conclusions

The assessment of potential impacts of multi-seam underground mining (ULD LW1-8) on terrestrial and riparian ecology shows that there will be minimal impact on significant species, populations, communities or their habitats as follows:

- A moderate to high level of impact on approximately 15% of the potential habitat available to the local Grey crowned Babbler population. Given that the impacts will occur over a relatively short time frame, monitoring programs will be designed to identify impacts and allow for timely remediation. ULD LW 1-8 is therefore unlikely to significantly impact on the local Grey-crowned Babbler population.
- Approximately 7 hectares of Speckled Warbler habitat (21%) will experience moderate to high levels of disturbance (>1 metre vertical displacement). Surface cracking and subsidence remediation is likely to result in greater impact to the species (than Grey-crowned Babbler) although it is unlikely to be of a scale that would significantly impact on the local Speckled Warbler population.

These impacts can be managed by the implementation of the additional management and monitoring actions outlined above in **Section 5.0**.

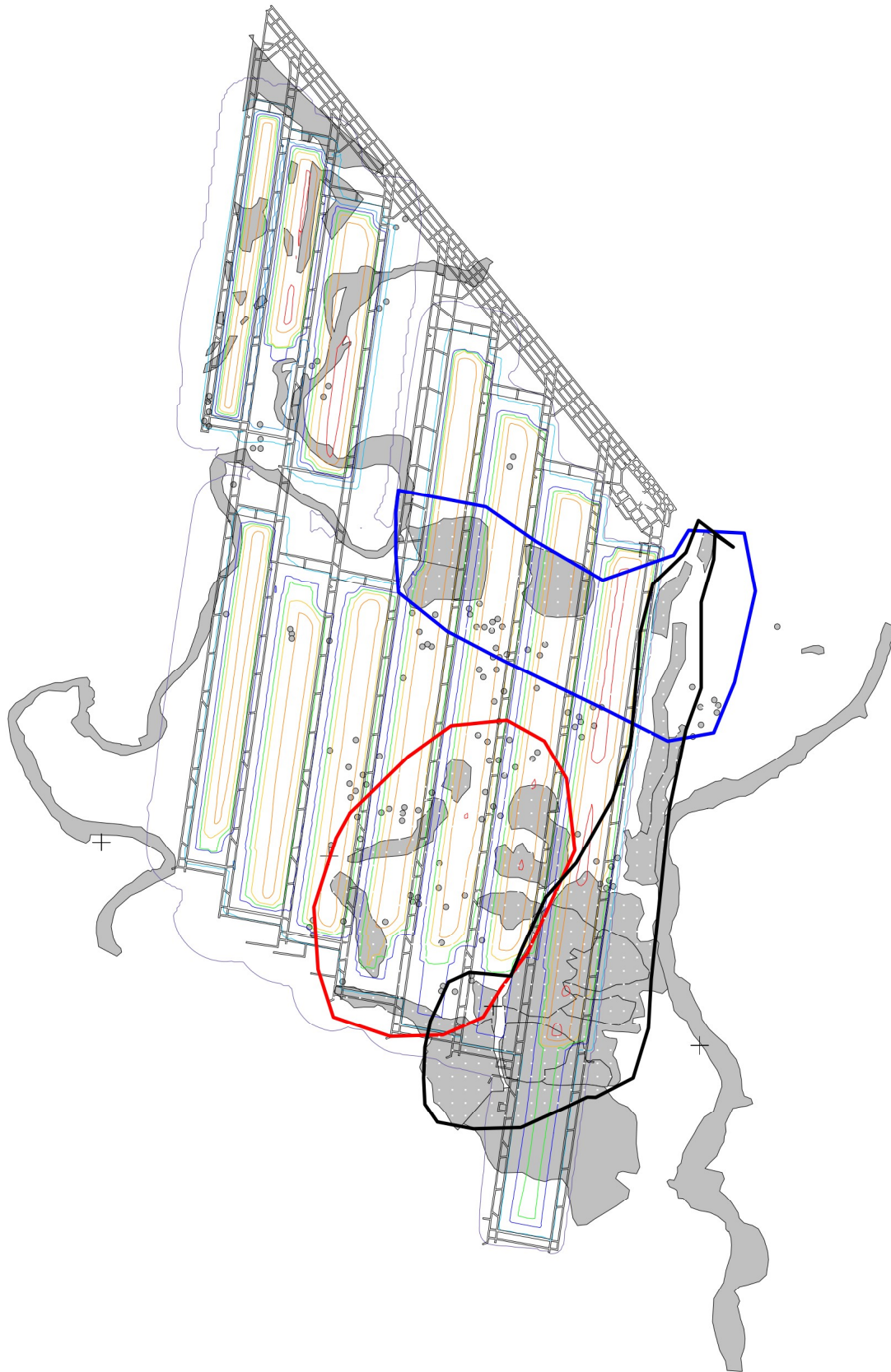
The findings of this assessment are consistent with the assessments and recommendations made in the Bowmans Creek Environmental Assessment (2009) and the approved LW 5-9 Subsidence Management Plan.

## References

- Allison F.R. (1989). Chapter 43. Molossidæ. In D.W.Walton and B.J. Richardson (Eds). Fauna of Australia Volume 1B Mammalia. Australian Government Publishing Service, Canberra.
- Eamus D, Hatton T, Cook P, Colvin C. 2006. *Ecohydrology: Vegetation Function, Water and Resource management*. CSIRO Publishing: Australia.
- Mensforth L.J., Thorburn P.J., Tyerman, S.D., Walker G.R., (1994). Sources of Water Used by Riparian *Eucalyptus camaldulensis* Overlying Highly Saline Groundwater *Oecologia*, Vol. **100**, No. 1/2, pp. 21-28
- Roberts J, Marston F. 2000. *Water Regime of Wetland and Floodplain Plants in the Murray-Darling Basin*. CSIRO, Land and Water: Canberra, ACT.
- Sinclair, S.J. (2006). The influence of Dwarf Cherry (*Exocarpus Stricta*) on the health of River red gum (*Eucalyptus camaldulensis*) *Australian Forestry* V **69** No2. pp 134-141.
- Thorburn, P.J., and Walker G.R., (1994). Variations in Stream Water Uptake by *Eucalyptus camaldulensis* with Differing Access to Stream Water. *Oecologia*, Vol. **100**, No. 3 pp. 293-301
- Wen, L., Ling, J., Saintilan, N., and Rogers, K. (2009). An investigation of the hydrological requirements of River red gum (*Eucalyptus camaldulensis*) Forest, using Classification and Regression Tree modelling. *Ecohydrol.* **2**, 143–155 (2009)

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Home ranges and habitat used 2011

- Vegetation that could be inhabited by Grey-crowned Babbler
- Home range of troops that have traditionally occupied the Southern Woodland
- New home range a one troop of 4 birds identified in 2011
- New home range for a troop of 11 birds identified in 2011



Design	John-Paul King
Modelling	John-Paul King
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Version	1.2

**Figure 1: Grey-crowned Babbler Home Ranges 2011**

2011 data analysis of subsidence data prepared by STC and ecological data collected by PEA Consulting

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Predicted Subsidence Impacts of Grey-crowned Babbler Habitat (metres)

- 4
- 3 to 4
- 2 to 4
- 1 to 2
- 0.5 to 1
- 0.2 to 0.5 (Cracking and tilting)
- 0.02 to 0.2 (Cracking and tilting)
- Cracking and tilting
- + Nest tree
- Den tree



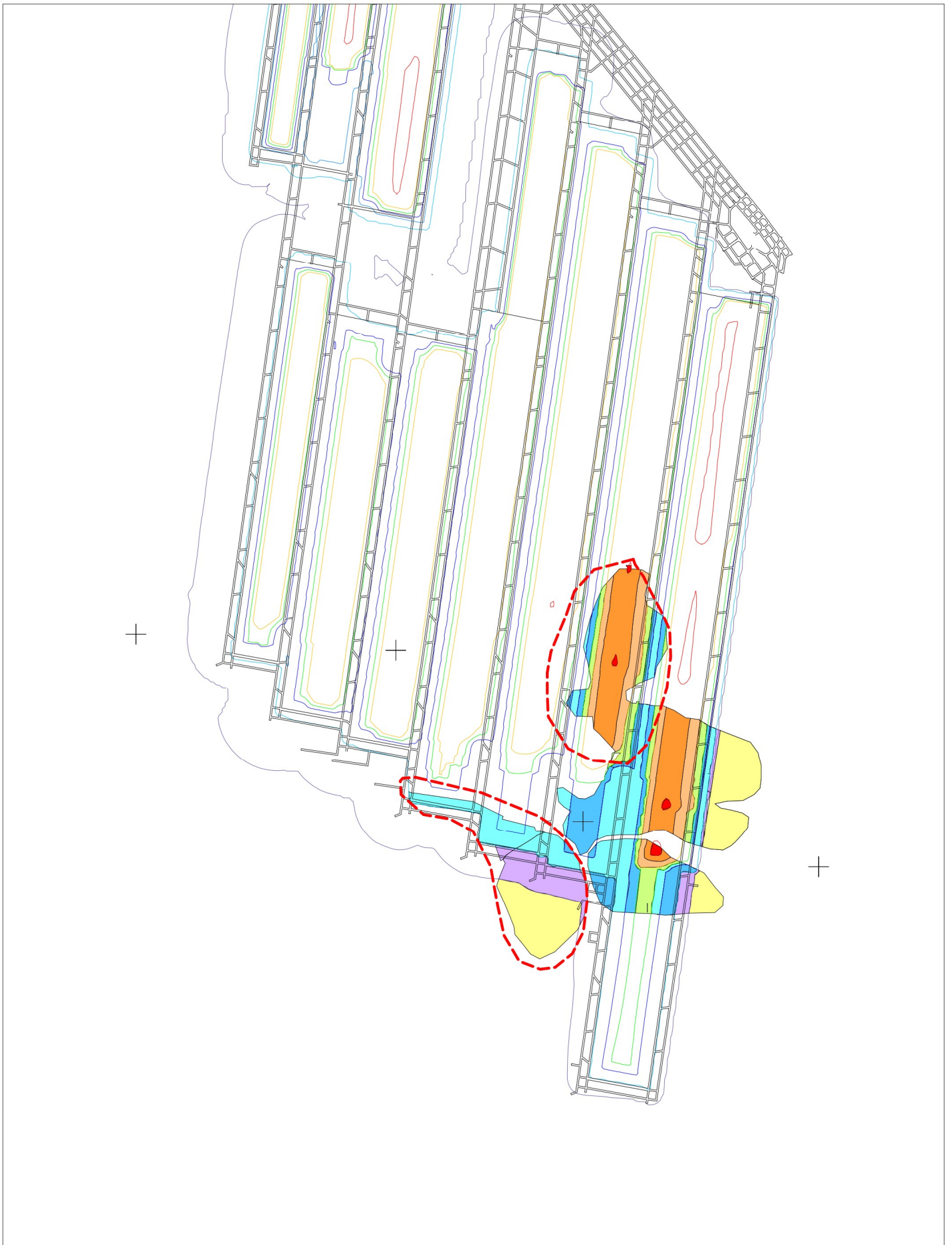
Design	John-Paul King
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**Figure 2: Grey-crowned Babbler Impact Area**

2011 data analysis of subsidence data prepared by STC and ecological data collected by PEA Consulting

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<b>Predicted Subsidence Impacts of Speckled warbler (metres)</b> <span style="display: inline-block; width: 15px; height: 15px; background-color: red; border: 1px solid black; margin-right: 5px;"></span> 4 <span style="display: inline-block; width: 15px; height: 15px; background-color: orange; border: 1px solid black; margin-right: 5px;"></span> 3 to 4 <span style="display: inline-block; width: 15px; height: 15px; background-color: #8B4513; border: 1px solid black; margin-right: 5px;"></span> 2 to 4 <span style="display: inline-block; width: 15px; height: 15px; background-color: #90EE90; border: 1px solid black; margin-right: 5px;"></span> 1 to 2 <span style="display: inline-block; width: 15px; height: 15px; background-color: #FF00FF; border: 1px solid black; margin-right: 5px;"></span> 0.5 to 1 <span style="display: inline-block; width: 15px; height: 15px; background-color: #00CED1; border: 1px solid black; margin-right: 5px;"></span> 0.2 to 0.5 (Cracking and tilting) <span style="display: inline-block; width: 15px; height: 15px; background-color: #FF69B4; border: 1px solid black; margin-right: 5px;"></span> 0.02 to 0.2 (Cracking and tilting) <span style="display: inline-block; width: 15px; height: 15px; background-color: #FFFF00; border: 1px solid black; margin-right: 5px;"></span> Cracking and tilting <span style="display: inline-block; width: 15px; height: 15px; border: 2px dashed red; margin-right: 5px;"></span> Speckled warbler expansion areas 2011			<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">Design</td> <td style="padding: 2px;">John-Paul King</td> </tr> <tr> <td style="padding: 2px;">Modelling</td> <td style="padding: 2px;">John-Paul King</td> </tr> <tr> <td style="padding: 2px;">Date</td> <td style="padding: 2px;">02/09/2011</td> </tr> <tr> <td style="padding: 2px;">Version</td> <td style="padding: 2px;">1.2</td> </tr> </table>	Design	John-Paul King	Modelling	John-Paul King	Date	02/09/2011	Version	1.2	<h3 style="margin: 0;">Figure 3: Speckled Warbler Impact Area</h3> <p style="font-size: small; margin-top: 10px;">2011 data analysis of subsidence data prepared by STC and ecological data collected by PEA Consulting</p>
Design	John-Paul King											
Modelling	John-Paul King											
Date	02/09/2011											
Version	1.2											

**Appendix A: Analysis of predicted subsidence outcomes on Grey-crowned Babbler and Speckled Warbler habitat. Extracted from modelled GIS data.**

Remnant No.	Habitat rating	Subsidence Impact	Area of impact	Impact rating
1	1	0.02	1.487	0.02974
1	1	0.10	1.08900	0.1089
1	1	0.10	0.38400	0.0384
1	1	1.00	0.38500	0.385
1	1	0.10	0.61250	0.06125
1	1	0.02	1.02400	0.02048
1	1	0.10	0.6994	0.06994
1	1	1.00	0.57000	0.57
1	1	2.00	0.39343	0.78686
1	1	3.00	0.28320	0.8496
2	1	3.00	0.03458	0.10374
2	1	3.00	0.14650	0.4395
2	1	2.00	0.39850	0.797
2	1	0.10	0.50310	0.05031
2	1	0.02	0.61360	0.012272
2	1	0.10	0.39910	0.03991
2	1	0.10	0.36050	0.03605
2	1	0.50	0.54420	0.2721
2	1	0.50	0.41060	0.2053
2	1	1.00	0.44910	0.4491
2	1	2.00	0.59990	1.1998
2	1	3.00	1.94600	5.838
2	1	2.00	1.03300	2.066
2	1	1.00	0.55120	0.5512
2	1	0.50	0.30530	0.15265
2	1	0.20	0.52910	0.10582
2	1	0.50	0.25960	0.1298
2	1	1.00	0.17600	0.176
2	1	2.00	0.16400	0.328
2	1	3.00	0.24900	0.747
3	1	0.50	0.05550	0.02775
3	1	0.10	0.19990	0.01999
3	1	0.50	0.16780	0.0839
3	1	1.00	0.70	0.695
3	1	2.00	1.01300	2.026
3	1	3.00	4.84000	14.52
3	1	2.00	2.15590	4.3118
3	1	1.00	1.23300	1.233
3	1	0.50	0.82280	0.4114
3	1	0.20	3.88600	0.7772

3	1	0.50	0.93800	0.469
3	1	1.00	0.69410	0.6941
3	1	2.00	0.87500	1.75
3	1	3.00	3.43700	10.311
3	1	4.00	0.07740	0.3096
3	1	2.00	1.55900	3.118
3	1	1.00	0.89310	0.8931
3	1	0.50	0.42200	0.211
3	1	0.20	0.82100	0.1642
3	1	0.02	0.39960	0.007992
3	1	0.00	4.88400	0
3	1	0.50	1.99700	0.9985
3	1	1.20	0.38800	0.4656
4	1	4.00	0.15500	0.62
4	1	3.00	0.51400	1.542
4	1	2.00	0.86100	1.722
4	1	0.10	0.70260	0.07026
4	1	0.02	0.28521	0.0057042
4	1	0.00	16.94000	0
5	1	0.50	0.07350	0.03675
5	1	0.10	0.13600	0.0136
5	1	0.02	3.15600	0.06312
5	1	0.00	4.51300	0
6	1	0.50	0.06950	0.03475
6	1	0.10	2.12500	0.2125
6	1	0.20	0.7320	0.1464
6	1	0.50	0.6390	0.3195
6	1	1.00	1.0450	1.045
6	1	2.00	0.3940	0.788
6	1	3.00	0.2740	0.822
6	1	4.00	0.1170	0.468
6	1	0.50	0.5160	0.258
6	1	0.20	0.9320	0.1864
6	1	0.02	0.6890	0.01378
6	1	0.00	1.1290	0
1	2	2.00	0.68800	2.752
1	2	1.00	0.87500	1.75
2	2	1.00000	0.36690	0.7338
2	2	2.00	0.61450	2.458
2	2	1.00	0.45120	0.9024
1	3	2.00	1.15600	6.936
2	3	3.00	1.73300	15.597
2	3	2.00	0.62560	3.7536
1	4	3.00	2.59000	31.08

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